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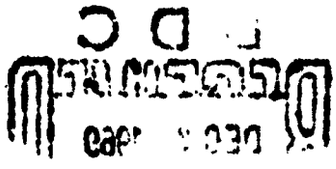

FOREWORD

The guiding concept of this series has been to provide high quality bibliographic accessibility to a highly specialized body of literature — the scientific results of research supported by the U.S. Air Force in university, industrial and other laboratories worldwide. Among the objectives have been completeness, convenience and usefulness. Completeness has been sought by comprehensive literature searches performed by the Library of Congress staff. Convenience has been provided by the kinds of indexes included, making it possible to find citations by reference to contract numbers, for example, in addition to authors, subjects, and institutions. Usefulness has been having a separate information channel for Air Force research, packaged for ready reference.

This bibliographic series has met these objectives. When it began, its only alternative was not doing it at all. Since then the Defense Documentation Center system, in conjunction with the Clearinghouse for Federal Scientific and Technical Information, has broadened its services, has become largely automated, and is in a position to assume many of the functions of this series. Thus it is now possible to say that while the series is desirable, its function is no longer exclusive. Therefore, this volume, covering 1965, will be numerically the last in the series. Another volume, covering 1963-1964, will appear later. While the services of DDC and CFSTI may not be as immediately accessible as these volumes, it is believed that most of the users of this series will be able to meet their requirements using them. Limited literature searches are available from DDC, for example, at no charge to qualified requestors. The public will find that the Clearinghouse offers somewhat comparable services. Inquiries may be directed to DDC, Cameron Station, Alexandria, Va. 22314, and to CFSTI, U.S. Dept. of Commerce, Springfield, Va. 22151. Descriptions of their complete services are available on request.

I wish to extend to the Special Bibliographies Section of the Science and Technology Division of the Library of Congress the thanks of AFOSR and of users of AFOSR-supported research for a most competent undertaking. Harold Wooster deserves special credit for planning and guiding this series through its various volumes.

William J. Price

William J. Price
Executive Director
Air Force Office of Scientific Research

PREFACE

Penultimate Prolegomenon

It is with deep regret that I announce that 1965, the year reported in this volume, will be the last year of this series. One more volume will be issued early in 1970 to cover the period 1963-1964 and complete the set, but no later volumes are anticipated.

This series has set a standard of bibliographic excellence. Excellence, unfortunately, costs money and takes time. Not all that much money, and perhaps not all that much time but enough to make it impossible to continue to support this effort.

The principal loss to the military, library and scientific communit[illegible] will be the convenience of having all AFOSR publications during a given period brought together in on[illegible]onveniently indexed volume. The established abstracting and indexing services will continue to include open literature publications by AFOSR-sponsored scientists and engineers. And all AFOSR publications should be announced, now as in the past, in U. S. Government Research and Development Reports, published semi-monthly by the Clearinghouse for Federal and Scientific Information at a subscription price of $30.00 a year.

Scope

This is the eighth volume of a continuing bibliographic series, and includes within the limitations of the law of diminishing returns, abstracts of all technical reports, journal articles, books, symposium proceedings, and monographs produced and published by scientists supported in whole or in part by the Air Force Office of Scientific Research during the calendar year 1965. Previous publications in this series have been:

Vol. I (1950-1956), issued in 1961
Vol. II (1957-1958), issued in 1964
Vol. III (1959), issued in 1965
Vol. IV (1960), issued in 1966
Vol. V (1961), issued in 1967
Vol. VI (1962), issued in 1968

The Air Force Office of Scientific Research supports fundamental research in the six major scientific disciplines: physics, chemistry, engineering sciences (subsuming electronics, mechanics, and propulsion), life sciences (both biological and behavioral, but not medical), mathematics, and the information sciences. Thus the publications abstracted herein are multi-disciplinary, their common link being task support by AFOSR.

Sources Searched

References, reports, and clues to the existence of reports were found by searching the indexes and report collection of the Air Force Office of Scientific Research Technical Library, and the collection of the Defense Documentation Center. Detailed searches were made of each contract file in the several AFOSR Directorates. In addition, cover-to-cover searches were made of over 300 scientific journals issued mostly in the time period 1965-1968.

Form of Entry and Arrangement

Inherent in the organization of this book is the concept of the reports within a contract as an unanalyzed monographic series. Reports are posted chronologically and/or alphabetically under contracts, these in turn under departments or laboratories, and these under contractors. This does, in fact, provide a rough subject grouping with the detailed subject index leading into clusters of like reports.

The abstracts are indentified by item numbers and are listed under the numbers in the indexes. The form of entry is, in general, that being used for DDC catalog cards i.e., source of the document; title, personal author, if any; date; pagination; report number; contract number; and accession number.

The chief exception to DDC form of entry is that the primary entry is by the parent organization followed by the name of the specific laboratory or important subdivision.

Availability of Reports

The principal accession or control numbers, which indicate the locations of reports in collections are:

AD ASTIA Document or Accessioned Documents (available at DDC, Defense Documentation Center), Cameron Station, Alexandria, Virginia 22314

PB Publication Board for sale by the Clearinghouse for Federal Scientific and Technical Information (CFSTI), Sills Building, 5285 Port Royal Road, Springfield, Virginia 22151.

The fact that a report is abstracted in this book means that a copy of this report existed at the time the abstract was written; it should not be construed to imply that either AFOSR or the Library of Congress necessarily has a copy available for distribution. Those seeking reports should do so from the cited agencies, not from AFOSR.

Indices

A detailed subject index, arranged alphabetically, has been provided. In addition, there are a contract index, an AFOSR control number index, and a personal author index.

Acknowledgments

Many people shared in the production of this volume. The work has been fostered and nurtured by the previous Commanders and Executive Director of Air Force Office of Scientific Research, Brigadier Generals H. F. Gregory and B. G. Holzman; Colonels A. P. Gagge, Jack L. Deets, and Ivan Atkinson, Dr. Knox Millsaps and the present Executive Director, Dr. William Price. During the period of compilation of this volume (not the period of the literature covered) much of the responsibility for documentation within AFOSR was transferred to the Office of the Assistant Executive Director for Research Operations, Lt. Colonel Harry Jaffers. He, his administrative assistant for documentation, Miss Arlene D. Blose, and their intermittently faithful computer have been in large part responsible for providing the AFOSR input to this volume.

Library of Congress, protocol dictates the form and order of acknowledgment of contributions made by LC staff members to a bibliography. Formally, the credit lines read as follows:

"The bibliographic team worked under the guidance and leadership of Thomas C. Goodwin, Jr., Head of the Special Bibliographies Section, Science and Technology Division. The chief bibliographers have been, Doris C. Yates, Joyce F. Lindsay, Norman G. Lamb, Joycelyn A. Gunn, and Lorraine B. Trent. A special note of gratitude is due to the invaluable work in preparation of this manuscript, searching, and preliminary cataloging done by Mrs. Marion S. Carr, Mrs. Phyllis M. Martin, and Mrs. Lillie M. Frye. Recognition is also due to those who have aided in abstracting, subject indexing, and typing, especially Dr. Madeleine J. Wilkins, Jeanne D. Weber, Beatrice T. Treese, Virginia M. Sims, and May Faye Dunsmore."

Harold Wooster

HAROLD WOOSTER
Director of Information Sciences
Air Force Office of Scientific Research

Arlington, Va.
June 1969

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Aarhus U. (Denmark).

ORTHOGONAL POLYNOMIALS IN 2 OR n VARIABLES, by T. Busk. Final rept. Jan. 1, 1960-May 31, 1965, 7p. incl. diagrs. (AFOSR-65-1568) (AF 61(052)322) Unclassified

In order to provide a tool for handling numerical, multivariate problems attempts have been made to construct a general interpolation formula in n variables for an arbitrary set of arguments. This means that the formulas should not be restricted to intersections of parallel lines, but can be spread in an arbitrary way in the plane or n-dimensional space. In order for a formula of this type to be considered satisfactory, it must fulfill the following requirements: (1) The formula must be symmetric in the arguments and (2) When the arguments are placed in accordance with a simple pattern, the formula ought to be simplified correspondingly, preferably to some known, well-established formula.

2

Advanced Kinetics, Inc., Costa Mesa, Calif.

STUDIES ON THE INTERACTION OF LIGHT AND PARTICLE BEAMS. Final rept. Aug. 1, 1964 - Feb. 28, 1965. Mar. 5, 1965 [23]p. incl. illus. diagrs. table, refs. (AFOSR-65-0492) (AF 49(638)1359) AD 614790 Unclassified

Theoretical and experimental studies were conducted on the interaction of coherent electromagnetic waves with matter in high magnetic fields. Verdet coefficients for 10 optical media at λ = 6328A were determined (Appl. Optics, v. 4: 253, 1965). The interaction of coherent electromagnetic waves with macroscopic particles was also studied.

3

Advanced Kinetics, Inc., Costa Mesa, Calif.

FARADAY EFFECT AT OPTICAL FREQUENCIES IN STRONG MAGNETIC FIELDS, by R. W. Waniek, N. George, and S. W. Lee. [1965] [7]p. incl. illus. diagr. table. (AFOSR-65-1140) (Bound with its AFOSR-65-0492; AD 614790) (AF 49(638)1359) AD 619134 Unclassified

Also published in Appl. Opt., v. 4: 253, Feb. 1965

Direct measurements of rotary power at 6328A are made for several optical materials subjected to transient fields up to 400 k-oersteds. The Verdet coefficients for these materials are extended into the very high-field region. The angle of rotation of the plane of polarization vs magnetic field is also plotted in a graph. These data have an estimated accuracy of ± 5%.

4

AeroChem Research Labs., Inc., Princeton, N. J.

ENHANCED CHEMICAL ENERGY TRANSPORT EFFECTS ON CONVECTIVE HEAT FLUXES IN THE HYDROGEN-OXYGEN SYSTEM, by D. E. Rosner. [1965] [3]p. incl. diagrs. refs. (AFOSR-65-2265) (AF 49(638)1138) AD 629247 Unclassified

Also published in Combust. and Flame, v. 9: 199-201, June 1965.

The effects of Lewis number greater than unity on convective heat flux in the hydrogen-oxygen system has been estimated. It is seen that the maximum value of the $Le_i > 1$ heat transfer enhancement increases at reduced pressures and always at near-stoichiometric conditions. In the pressure range of 10 to 100 atm, this enhancement increases with increasing wall temperature. These estimates reveal the extent to which current prediction techniques systematically under-estimate convective energy transfer rates in chemically reacting rocket motor systems due to this cause alone ($Le_i > 1$). In the hydrogen-oxygen system this effect is seen to be typically larger than 5% at chamber conditions. Larger values may be achieved in the vicinity of the rocket nozzle throat owing to the fact that pressure levels are lower there, yet viscous dissipation produces large H atom concentrations within the boundary layer.

5

AeroChem Research Labs., Inc., Princeton, N. J.

THE OXIDATION OF PYROLYTIC GRAPHITE AT TEMPERATURES OF 1400° – 1800°F AND AT AIR VELOCITIES OF 25 – 100 CM/SEC, by D. E. Rosner and H. D. Allendorf. [1965] [2]p. incl. diagr. (AFOSR-65-2489) (AF 49(638)1138 and AF 49(638)1195) AD 628276 Unclassified

Also published in Jour. Electrochem. Soc., v. 112: [653-654] June 1965.

Several questions relating to the high-temperature oxidation kinetics of pyrolytic graphite which were raised by M. Levy and P. Wong (Jour. Electrochem Soc., v. 111: 1088-1091, 1965) are discussed from the point of view of current investigations in the laboratory of Rosner and Allendorf. Topics include: Departures from Arrhenium behavior; kinetics of the attack of graphite by atomic oxygen; and diffusional effects for exothermic surface reactions.

6

AeroChem Research Labs., Inc., Princeton, N. J.

TRANSPIRATION COOLING WITH CHEMICAL REACTIONS, by D. E. Rosner. [1965] [27]p. incl. diagrs. tables, refs. (AFOSR-65-2266) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-1138 and General Motors Corporation) AD 625367 Unclassified

Also published in Pyrodynamics, v. 2: 221-247, 1965.

Protecting a surface by actually passing the coolant through it is known to be a highly efficient technique and may provide the only feasible method of preventing material failures in regions of extreme convective heat flux. While transpiration cooling has not in the past provided a practical solution to some problems (e.g., turbine rotor blades) owing largely to structural considerations, the approach holds promise for non-rotating systems (e.g., stators, ramjet components) in which the dominant heating mechanism is convective. In the present paper, transpiration coolant requirements are examined for gas/solid systems in which the thermal effects of chemical reactions must be taken into account. For example, a coolant may undergo phase change and chemical decomposition in passage through the wall itself. This would alter the effective heat absorption capability of the coolant and the mean molecular weight of the effluent gas. Further chemical reaction may occur when the coolant vapors (or decomposition products) mix with the hot gases in the external boundary layer. In general, both processes will (1) influence the amount of coolant required to maintain a prescribed surface temperature, and therefore (2) significantly alter the relative merits of possible coolants. As such, thermochemical effects are of great practical interest. Simple computational techniques and numerical examples are given herein, together with a discussion of several factors governing the rates of these chemical reactions. (Contractor's abstract)

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AeroChem Research Labs., Inc., Princeton, N. J.

CONTRIBUTIONS TO THE THEORY OF INTERFACIAL RATE PROCESSES IN FLOW SYSTEMS, by D. E. Rosner. Final rept. Dec. 11, 1961-Dec. 10, 1965. Dec. 27, 1965. 7p. incl. refs. (Rept. no. TP-126) (AFOSR-65-2943) (AF 49(638)1138) AD 628132
Unclassified

A synopsis is presented of a 4-yr basic research program on the theory of interfacial rate processes in flow systems. A chronological list is provided of 16 resulting publications relevant to: (1) interpretation of arc-tunnel and combustion torch test results (heat flux, ablation rates), (2) design of advanced re-entry heat protection systems (radiation, transpiration cooling), (3) instrumentation for probing high-speed flows for local atom concentrations, (4) determination of heterogeneous kinetic constants in flow reactors, and (5) extensions of heat-mass transfer theory. (Contractor's abstract)

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AeroChem Research Labs., Inc., Princeton, N. J.

DISCUSSION OF R. M. DAVIES' PAPER: HEAT TRANSFER MEASUREMENTS ON ELECTRICALLY BOOSTED FLAMES, by D. E. Rosner. [1965] [2]p. (AF 49(638)-1138)
Unclassified

Published in Tenth Symposium (Internat'l.) on Combustion, Cambridge (Gt. Brit.) (Aug. 17-21, 1964), Pittsburgh, Combustion Inst., 1965, p. 764-765.

It is possible to make a simple quantitative estimate of the effect of high H-atom mobility on the prediction of convective heat fluxes from electrically boosted flame gases. It is shown that Le = 1 predictions systematically underestimate the heat flux by a factor which can easily amount to 20% or more.

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AeroChem Research Labs., Inc., Princeton, N. J.

THEORY OF INTERFACIAL RATE PROCESSES IN FLOW SYSTEMS (Abstract), by D. E. Rosner. [1965] [2]p. (Bound with its AFOSR-65-2238) (AF 49(638)1138)
Unclassified

Chemical kinetic and energy transfer consequences of the interplay between convection diffusion and heterogeneous chemical reactions are under investigation. Recent quantitative studies of the effect of the interfacial mass velocity (the Stefan-Nusselt flow), normal to surfaces undergoing heterogeneous reaction, on the apparent kinetics of such reactions are described. A simple algebraic model has been developed which enables all pertinent non-dimensional reaction rate coefficients to be obtained over the entire range from reaction rate (chemical) control to diffusion control for one-step irreversible heterogeneous reactions of arbitrary kinetic order. Illustrative results are presented for the case of turbulent boundary layers on flat surfaces undergoing first order reaction. The Stefan-Nusselt flow results appeared to (1) destroy the time-honored notion that diffusional limitations ultimately cause all surface reactions to masquerade as first order reactions; (2) introduce a connection between the profile drag on reacting surfaces and the true kinetics of the reaction; and (3) leave unaltered the form of a potentially useful relation between the power required to maintain a reacting surface at a prescribed temperature and the true kinetics of the chemical reaction at that temperature. Applications of the theory to specific heterogeneous reactions (e.g., oxidation, chlorination, chemical vapor plating) are facilitated by the compilation of representative values of the mass transfer parameter B_{diff}. The errors committed by neglecting the Stefan-Nusselt flow are discussed for the high temperature oxidation of graphite and molybdenum in air. The results of the theory emphasize their generality as well as the physicochemical conditions under which simple computational procedures are likely to be acceptable

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AeroChem Research Labs., Inc., Princeton, N. J.

HIGH-TEMPERATURE KINETICS OF GRAPHITE OXIDATION BY DISSOCIATED OXYGEN, by D. E. Rosner and H. D. Allendorf. [1965] [2]p. incl. diagrs. refs. (AFOSR-65-2499) (AF 49(638)1195) AD 628282
Unclassified

Also published in AIAA Jour., v. 3: 1522-1523, Aug. 1965.

A report is given of preliminary researches on the true kinetics of the high-temperature oxidation of graphite by atomic and molecular oxygen. Implications of the results on ablation analyses are discussed.

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AeroChem Research Labs., Inc., Princeton, N. J.

KINETIC AND AERODYNAMIC ASPECTS OF THE OXIDATION OF MATERIALS BY PARTIALLY DISSOCIATED GASES, by D. E. Rosner and H. D. Allendorf. Final rept. Nov. 15, 1962—Nov. 14, 1965. Dec. 3, 1965, 20p. incl diagrs. refs. (Rept. no. TP-124) (AFOSR-66-0146) (AF 49(638)1195) AD 628515
Unclassified

A synopsis is presented of the most significant results of a 3-yr research program carried out on the oxidation kinetics of refractory materials in dissociated gases. Microwave-discharge fast flow system techniques, coupled with electrical resistance heating and monitoring of the reacting specimens were used throughout. Experimental results are included for the attack of (1) polycrystalline molybdenum, tungsten, graphite, iridium and vitreous boron by atomic oxygen, (2) polycrystalline molybdenum and nickel by atomic chlorine, and (3) polycrystalline molybdenum by hydroxyl radicals. Reactant (O, Cl, and OH) partial pressures were of the order of 0.001 to 0.05 and surface temperatures were within the range 400 to 2600°K. A chronological list is provided of the 7 publications and 11 reports describing these results and the underlying methods in greater detail. (Contractor's abstract)

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AeroChem Research Labs., Inc., Princeton, N. J.

HIGH-TEMPERATURE OXIDATION OF CARBON BY ATOMIC OXYGEN, by D. E. Rosner and H. D. Allendorf. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-0350) (AF 49(638)1195) AD 632227 Unclassified

Also published in Carbon, v. 3: 153-156, 1965.

The true kinetics of the attack of high temperature graphite by both atomic and diatomic oxygen have been studied using microwave discharge-fast flow system techniques. In the surface temperature range 1100°K—2000°K the oxidation probability for O-atom attack (1) exceeds that for O_2 by factors between 5 and as much as 80, (2) passes through a maximum in this temperature range, as does the O_2 attack probability on same surface, and (3) is independent of oxygen partial pressure (corresponding to a first order reaction), in contrast to the kinetic order of the O_2/carbon reaction. Several mechanistic implications of these results are briefly discussed. (Contractor's abstract)

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AeroChem Research Labs., Inc., Princeton, N. J.

KINETICS OF THE ATTACK OF MOLYBDENUM BY DISSOCIATED CHLORINE, by D. E. Rosner and D. L. Allendorf. [1965] [26]p. incl. diagrs. refs. (Rept. no. TP-117) (AFOSR-66-0357) (AF 49(638)1195) AD 624543
Unclassified

Also published in Jour. Phys. Chem., v. 69: 4290-4296, Dec. 1965.

The true kinetics of the attack of molybdenum surfaces by both atomic and diatomic chlorine have been studied using microwave discharge-fast flow system techniques coupled with electrical resistance heating and monitoring of the reacting specimens. Experimental results are reported herein over the surface temperature range from 400 to 1530°K, at reactant partial pressures of the order of 10^{-3} to 10^{-1} torr. In contrast to the behavior of nickel, dissociation markedly increases the chlorination probability of molybdenum over the entire temperature range investigated, the enhancement being of the order of 100-fold at about 1000°K. The high reaction probability for Cl_2(g) attack of high-temperature nickel, previously reported by McKinley and Shuler, has been verified. When exposed to dissociated chlorine, the ratio of the nickel chlorination rate to the Cl atom recombination rate decreases with decreasing surface temperature—on 420°K nickel filaments the recombination coefficient γ has been found to be $\frac{1}{2}$. The implications of these results with regard to dissociative adsorption on and evaporation from nickel and molybdenum surfaces are discussed in the light of available kinetic and thermochemical data for these and related heterogeneous reactions. (Contractor's abstract)

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AeroChem Research Labs., Inc., Princeton, N. J.

KINETIC AND AERODYNAMIC ASPECTS OF THE ATTACK OF REFRACTORY MATERIALS BY DISSOCIATED GASES (Abstract), by D. E. Rosner and H. D. Allendorf. [1965] [2]p. (Bound with its AFOSR-65-2238) (AF 49(638)1195)
Unclassified

The true kinetics of the attack of refractory materials by gaseous free radicals are being studied using microwave discharge-fast flow system techniques. Experimental results are reported for the attack of graphite by O-atoms (AeroChem TP-110, Mar. 22, 1965, CARBON - in press) and molybdenum by OH(g) and Cl(g) (AeroChem TP-117, July 7, 1965, Jour. Phys. Chem. - in press). In the surface temperature range 1100°—2000°K, the oxidation probability for O-atom attack of graphite is as follows: (1) exceeds that for O_2 by factors between 5 and as much as 80; (2) passes through a maximum in this temperature range, as does the O_2 attack probability on the same surface; and (3) is independent of oxygen partial pressure (corresponding to a first order reaction), in contrast to the O_2/carbon reaction. Several implications of these results are briefly discussed, with particular emphasis on the design of heat protection systems for lifting re-entry vehicles. Experimental results are reported on the attack of molybdenum by OH-radicals

formed from the reduction of $NO_2(g)$ by H-atoms. Molybdenum is also attacked by atomic chlorine at a rate which greatly exceeds the corresponding reaction rate with $Cl_2(g)$. Chlorination probabilities are presented over the surface temperature range 400° to 1300°K. In contrast to the behavior of nickel, dissociation markedly increases the chlorination probability of molybdenum over the entire temperature range investigated, the enhancement being of the order to 100-fold at about 1000°K. The implications of these results with regard to dissociative adsorption and evaporation are discussed in the light of available kinetic and thermochemical data for these and related heterogeneous reactions.

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Aerojet-General Corp., Sacramento, Calif.

SURFACE RATE PROCESSES AND SENSITIVITY OF HIGH EXPLOSIVES, by R. F. Chaiken and F. J. Cheselske. [1965] [32]p. incl. diagrs. tables, refs. (AFOSR-65-1622) (Bound with its AFOSR-65-1801; AD 458854) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)851 and Office of Naval Research) AD 623860 Unclassified

Also published in Jour. Chem. Phys., v. 43: 3228-3236, Nov. 1, 1965.

The nature and rate of linear surface regression of TNT, RDX, tetryl and PETN are studied utilizing a hot plate pyrolysis technique over surface temperatures ranging as high as 500°C. The data, when compared to similar data for benzoic acid, suggest that the primary surface rate process appears to be an endothermic melt-flow having an apparent activation energy suggestive of heat transfer and viscous flow as a rate controlling step. These data, when used as a measure of surface heat dissipation, correlate very well with the measured values of impact sensitivity. Also, they offer an explanation for the fact that attempts to correlate impact and/or friction sensitivity with melting point alone could lead to misleading results when PETN and RDX are considered. (Contractor's abstract)

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Aerojet-General Corp., Sacramento, Calif.

ON THE EXTINCTION OF OPPOSED-JET DIFFUSION FLAMES: A PHYSICAL CRITERION FOR EXTINCTION, by R. F. Chaiken. [1965] [29]p. incl. diagrs. tables. (AFOSR-65-1625) (Bound with its AFOSR-65-1801; AD 458854) (AF 49(638)851) AD 623859 Unclassified

A physical criterion for the extinction of opposed-jet diffusion flames is presented. This criterion, when used in conjunction with the Spalding theory of mixing in opposed-gas jets, enables the apparent flame strength to be related to (1) the effective maximum chemical reaction rate in the opposed-jet flame, and (2) the laminar flame speed of an equivalent pre-mixed diffusion flame. The derived relationships differ somewhat from similar relationships given by Spalding's earlier theoretical treatment of the phenomena in the thin-flame approximation, but do yield quantitatively similar results when compared with experimental data reported for opposed-jet diffusion flames involving oxidation of simple hydrocarbons and ammonia. (Contractor's abstract)

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Aerojet-General Corp., Sacramento, Calif.

INVESTIGATIONS OF THE MECHANISMS OF DECOMPOSITION, COMBUSTION, AND DETONATION OF SOLIDS, by F. J. Cheselske. Final rept. Mar. 1964-Feb. 1965. Mar. 15, 1965 [245]p. incl. illus. diagrs. tables, refs. (Rept. no. 0372-01F) (AFOSR-65-1801) (AF 49(638)851) AD 458854 Unclassified

This report summarizes the results of research on the mechanisms of decomposition, detonation and combustion of solids. Extensive kinetic studies are reported on (1) linear surface regression rates of solid high explosives, (2) sublimation of ammonium halides, (3) thermal decomposition of anhydrous perchloric acid, and (4) apparent flame strength measurements on NH_3 with O_2, Cl_2, NO and N_2O in the opposed-jet diffusion flame reactor. Preliminary phenomenological studies have been carried out on the decomposition of pure or nearly pure single crystals of ammonium perchlorate. Theoretical studies were made on reactions in opposed-jet diffusion flames. New models were developed to explain extinction phenomena in solid rocket motors and a low pressure deflagration limit. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

A MODEL FOR LOW PRESSURE EXTINCTION OF SOLID ROCKET MOTORS, by R. F. Chaiken. [1965] [8]p. incl. diagr. tables, refs. (AFOSR-65-2166) (Bound with its AFOSR-65-1801; AD 458854) (AF 49-(638)851) AD 629026 Unclassified

Also published in AIAA Jour., v. 3: 1144-1146, June 1965.

A new model is offered as an explanation of the observation that aluminized ammonium perchlorate composite propellants exhibit a low-pressure burning limit that is generally higher than the low-pressure stable deflagration limit as determined in a strand burner. The model resolves some of the difficulties which are apparent when attempting to identify criteria for low frequency combustion instability with low pressure extinction criteria. The model also enables a treatment of extinction in terms of the kinetics of the propellant flame reactions, yielding a new form of equation for relating L* (ratio of chamber volume to nozzle throat area) and extinction pressure, which is in satisfactory agreement with the available data.

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Aerojet-General Corp., Sacramento, Calif.

IMPLICATIONS OF A STEADY-STATE SOLID

PROPELLANT COMBUSTION MODEL TO A LOW PRESSURE DEFLAGRATION LIMIT, by R. F. Chaiken. [1965] 11p. incl. refs. (Bound with its AFOSR-65-1801; AD 458854) (AF 49(638)851) Unclassified

Many experimental and theoretical studies on solid propellant combustion, have led to a concept of combustion in which the solid ingredients gasify under the thermal influence of a flame to form reactive species which then undergo gas-phase redox reactions to propagate that flame. The mass-flow and energy of each reaction in the burning process is of necessity coupled to each other by the conservation equations. Several mathematical models of varying complexity have been developed to describe the steady-state coupling process, but few theoretical studies have been made of extending these models to low pressure deflagration limits. A notable exception to this is the work of Johnson and Nachbar in describing the pressure deflagration limit (P_{DL}) of burning strands of ammonium perchlorate (AP) monopropellant. These authors attempted to ascribe the low P_{DL} of AP strand burning to radiation heat losses from the burning surface. A somewhat simpler approach to the P_{DL} problem can also be obtained from the two-temperature postulate and thermal-layer treatment of steady-state combustion. This treatment of composite propellant burning yields a generalized burning rate expression in terms of parameters which can be readily related to the chemical kinetic processes occurring during combustion. It is the purpose of this note to show that this treatment also leads directly to a minimum burning rate with implications towards a low pressure deflagration limit.

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Aerojet-General Corp., Azusa, Calif.

KINETICS OF THE DECOMPOSITION OF ANHYDROUS PERCHLORIC ACID, by D. J. Sibbett and I. Geller. [1965] [32]p. incl. diagrs. refs. (Bound with its AFOSR-65-1801; AD 458854) (AF 49(638)566 and AF 49(638)851) Unclassified

The kinetics of the decomposition of gaseous anhydrous acid in the heterogeneous range between 165 and 256°C is studied. The decomposition reaction appears to be a surface catalyzed, consecutive step process. The initial step appears to be $HClO_4 + HClO_4 \rightarrow H_2O \cdot Cl_2O_7$. The decomposition of the latter species appears consistent with the mechanism suggested by Figini, Colloccia, and Schumacher for Cl_2O_7. However, the presence of water is believed to inhibit the surface reaction by competing more strongly for the reactive sites than can $HClO_4$. As the concentration of adsorbed water increases the reaction $HClO_4 + H_2O \rightarrow H_2O \cdot HClO_4$ forms a relatively more stable species than the anhydrous acid. The decomposition of the monohydrate is believed to continue until all of the species, $HClO_4$ is exhausted. It appears possible that a relatively minor part of the decomposition proceeds by a gas phase reaction under the conditions of these experiments.

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Aerojet-General Corp., Azusa, Calif.

STUDY OF THE REACTION OF PENTABORANE WITH HYDRAZINE AND SUBSTITUTED HYDRAZINES, by H. V. Seklemian, R. W. Lawrence, and G. A. Cuter. Final rept. Mar. 1, 1962-Feb. 28, 1965. Apr. 1965 [41]p. incl. illus. diagrs. tables, refs. (Rept. no. 3015) (AFOSR-65-1058) (AF 49(638)1122) AD 619513 Unclassified

Pentaborane and hydrazine were allowed to react in an inert solvent under dilute conditions. The process includes an initial fast reaction followed by a slow reaction that evolves hydrogen and an insoluble solid product. The hydrogen evolution was found to be first-order process with a rate constant of $1.74 \pm 0.1 \times 10^{-4}$ sec^{-1} at 25°C. The rate-determining step was found to be dependent only on the hydrazine concentration. Traces of hydrazine are believed to catalyze the decomposition of a postualted soluble intermediate so that an ionic-type mechanism involving acid-base catalysis is proposed. The reaction in the gas phase yields the same reaction products; however, the reaction is considerably faster. The same process and mechanism holds true for monomethylhydrazine or unsym-dimethylhydrazine in place of normal hydrazine. The products of these reactions with hydrazine and monomethylhydrazine are insoluble in non-polar solvents. They thermally decompose, evolving hydrogen, and they are believed to be polymeric substances. Attempts to obtain a definitive structure for the insoluble products by nuclear-magnetic-resonance techniques and high-resolution infrared analysis were unsuccessful. (Contractor's abstract)

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Aerojet-General Nucleonics, San Ramon, Calif.

RESEARCH ON VOLTAGE GRADIENTS FROM ELECTRON-ACOUSTICAL WAVES, by C. B. Kretschmer. Final technical rept. Mar. 1965, 29p. incl. illus. diagrs. tables, refs. (Rept. no. AN-1398) (AFOSR-65-1044) (AF 49(638)1347) AD 620223 Unclassified

Experimental work was conducted on an energetic argon-fed hollow cathode arc. Microwave interferometer measurements at 1.20×10^{11} cps gave a plasma density of 1.8×10^{14} electrons/cm^3, and spectroscopic line intensity measurements yielded an electron temperature of 1.1 ev. The voltage gradient along the arc was less than 0.1 v/cm. Since a voltage gradient of 10 to 20 v/cm is required to produce current densities of the observed magnitude in a plasma with an electron temperature of 1.1 ev by ordinary conduction, it is believed that the arc current is carried by electrons which are trapped in electron plasma waves and accelerated to high velocity by the waves. Attempts to detect radiation emitted by the plasma at the electron plasma frequency gave inconclusive results. The arc column was found to radiate as much as 73% of the input power in the vacuum UV region between 400A and 1000A, with a large fraction concentrated between 430A and 540A. Many lines of singly through quadruply ionized argon were identified. Doubly ionized argon appeared to be the most abundant species.

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Aerojet-General Nucleonics, San Ramon, Calif.

UNSTABLE OSCILLATIONS IN ENERGETIC ARCS (Abstract), by C. P. Kretschmer [1965] [1]p. (Bound with its AFOSR-65-1266, AD 622527) (AF 49(638)1347) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Experimental work was conducted on an energetic argon-fed hollow cathode arc. The arc was operated at currents of 100 to 200 amp with a total voltage drop of about 75 v, in a longitudinal magnetic field of 4400 gauss. The gas pressure in the region adjacent to the arc was less than 10^{-3} torr. The arc column had a diameter of 1.27 cm and a length of 60 cm. Microwave interferometer measurements at 1.20×10^{11} cps gave a plasma density of 1.8×10^{14} electrons/cm^3, and spectroscopic line intensity measurements yielded an electron temperature of 1.1 ev. Langmuir probes inserted into the arc column assumed floating potentials 0.5 to 2 v positive with respect to the anode. The dc difference in floating potential between probes separated by 22 cm indicated that the voltage gradient along the arc was less than 0.1 v/cm. The arc column was found to radiate as much as 73% of the input power in the vacuum ultraviolet region between 400A and 1000A, with a large fraction concentrated between 430A and 540A. Many lines of singly through quadruply ionized argon were identified. Doubly ionized argon appeared to be the most abundant species.

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Aeronautical Research Associates of Princeton, Inc., N. J.

[NEW METHODS IN NONEQUILIBRIUM STATISTICAL MECHANICS] by G. Sandri. Final technical rept. Jan. 1-Dec. 31, 1964. Jan. 20, 1965 [5]p. (AFOSR-65-0204) (AF 49(638)1224) Unclassified

The aim of the research program is a complete theory of gases based on the first principles of nonequilibrium statistical mechanics. The main controllable properties of the relevant gases and plasmas are their transport coefficients, these coefficients are completely determined by the probability distribution for the velocity of the particles that constitute the medium. A new method of analysis of the velocity distribution is being developed which has proven successful in major areas where older approaches are inadequate. The limitations of previous theories have confined their applicability to unrealistic potentials and to unrealistic density and temperature regimes. Through the new methods, several of these limitations have been removed. The complete Coulomb interaction as well as short-range attraction can be treated systematically for the first time. The major problem of nonequilibrium 3-body contributions has received an important contribution by the recent solution of the hard-sphere 3-body problem. A list of publications is appended.

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Aeronautical Research Associates of Princeton, Inc., N. J.

GLOBAL MASTER EQUATION. II, by G. Sandri. [1965] [13]p. incl. diagrs. (AFOSR-65-1741) (AF 49-(638)1224) AD 625962 Unclassified

Also published in Nuovo Cimento, Series X, v. 36 309-321, Mar. 16, 1965.

The structure of the global master equation is clarified by means of a projection operator formalism which allows one to exhibit the physical meaning of the quantities that appear in the evolution of the momentum distribution. With the help of the new formulation, an explicit form is given to the H-theorem for the master equation and the effect of phase mixing on the propagator is calculated to first order. (Contractor's abstract)

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Aeronautical Research Associates of Princeton, Inc., N. J.

A NEW METHOD OF EXPANSION IN MATHEMATICAL PHYSICS. I, by G. Sandri. [1965] [27]p. incl. diagrs. (AFOSR-65-1742) (AF 49(638)1224) AD 625693 Unclassified

Also published in Nuovo Cimento, Series X, v. 36 67-93, Mar. 1, 1965.

The general method for uniformizing perturbation expansions introduced recently in The New Foundations of Nonequilibrium Statistical Mechanics, by G. Sandri, Rutgers Lectures 1961-1962 (method of extension) is further developed. The presentation given in this paper is self-contained and does not rely on explicit use of composition of mappings. The compatibility conditions that the method gives rise to are discussed and so is the basic induction theorem. A new very general uniformizing formula is derived. The Poincare-Lighthill procedure is deduced from this formula in a simpler fashion than in the previous paper. A general theory for the Fourier transforms of extended functions is developed. (Contractor's abstract)

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Aeronautical Research Associates of Princeton, Inc., N. J.

CLASSICAL HARD-SPHERE N-BODY PROBLEM (Abstract), by P. Woodrow and G. Sandri [1965] [1]p [AF 49(638)1224] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 530, Apr. 26, 1965

The analysis previously employed for the solution of the 3-body problem for hard spheres is extended to classify the binary collision chains for 4 and more bodies. The

precise, necessary, and sufficient conditions for the occurrence of a chain are given. The interlocking of the 4 collision chains discovered in the 3-body problem is discussed.

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Aeronautical Research Associates of Princeton, Inc., N. J.

HARD-SPHERE THREE-BODY PROBLEM. I (Abstract), by G. Sandri, R. Sullivan, and W. Thurston. [1965] [1]p. [AF 49(638)1224] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10, 236, Feb. 25, 1965.

In view of the importance of calculating in detail 3-body phase-space integrals for nonequilibrium problems, we have developed the rigorous solution for the hard-sphere model. Contrary to expectation (and to existing "proofs"), 4 successive binary collisions are possible among 3 identical spheres. We give now (1) the exact form of the 4-collision domain and (2) a rigorous proof of the impossibility of 5 collisions, in 3 or more dimensions.

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Aeronautical Research Associates of Princeton, Inc., N. J.

HARD-SPHERE THREE-BODY PROBLEM. II (Abstract), by P. Norem, G. Sandri, and R. Sullivan. [1965] [1]p. [AF 49(638)1224] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10, 236, Feb. 25, 1965.

Extensive numerical calculations have been made giving a systematic scanning of the 3-body phase space for which 4 and 5 successive binary collisions are possible among 3 identical spheres of finite radius. The coplanar configuration has been fully investigated, yielding a confirmation for the 4-collision domain and showing that a 5 collision is impossible.

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Aeronautical Research Associates of Princeton, Inc., N. J.

TWO-PARTICLE CORRELATIONS FOR GASES NOT IN EQUILIBRIUM (Abstract), by P. Woodrow, R. Sullivan, and G. Sandri. [1965] 1]p. [AF 49(638)1224] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10, 8, Jan. 27, 1965.

It has been calculated explicitly, both in coordinate and Fourier space, the correlation functions for gases not in equilibrium under the assumption that the 3 particle correlations are negligible. These results are applied to the study of the electrical conductivity of a plasma given by the complete kinetic equation previously derived.

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Aeronautical Research Associates of Princeton, Inc., N. J.

VARIATIONAL TECHNIQUE FOR THE ELECTRICAL CONDUCTIVITY OF A PLASMA (Abstract), by F. Terkelsen and G. Sandri. [1965] [1]p. [AF 49(638)1224] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10, 232, Feb. 25, 1965.

The variational principle for the electrical conductivity of a plasma, recently used by Bernstein and Robinson, is established rigorously under very general conditions and applied to the complete kinetic equation obtained recently.

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Aeronautical Research Associates of Princeton, Inc., N. J.

[INTERACTION PHENOMENA IN ROTATIONAL STREAMS] by C. D. Donaldson. Final rept. Oct. 29, 1965, 3p. incl. refs. (AFOSR-65-2206) (AF 49(638)-1437) AD 627453 Unclassified

Methods were derived for solving equations of motion for an inviscid, incompressible fluid with rotation. These solutions are valuable in understanding fluids undergoing strong interactions. Both analytical and numerical approaches were made. It is concluded that a numerical approach is quite likely to be successful.

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Aeronautical Research Associates of Princeton, Inc., N. J.

ROTATIONAL SOLUTIONS OF THE EULER EQUATIONS, by D. A. Barnes and R. D. Sullivan. Sept. 1965 [30]p. incl. diagrs. refs. (ARAP rept. no. 79) (AFOSR-65-2656) (AF 49(638)1437) AD 627972 Unclassified

Steady-state rotational solutions of the Euler equations for an incompressible fluid are discussed, with emphasis on flows characterizing the impingement of a rotational jet upon a plane surface. These solutions are aimed at understanding actual rotational flows undergoing strong interactions, where, to a first approximation, viscous stresses may be ignored after the creation of vorticity. Of particular interest are 2 axially symmetric flows which have finite velocity profiles at large distances from the impingement plane. One of these has a parabolic profile and represents a flow inside a cylindrical cup of finite radius, the other has a Gaussian profile with

streamlines extending to infinity. Analytical expressions and computed values for velocities, velocity gradients, and pressures are given, and a comparison is made with experimental data. (Contractor's abstract)

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Aeronautical Research Associates of Princeton, Inc., N. J.

THREE-DIMENSIONAL ROTATIONAL SOLUTIONS OF EULER'S EQUATIONS FOR AN INCOMPRESSIBLE FLUID (Abstract), by D. A. Barnes. [1965] [1]p. (AF 49(638)1437) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 537, Apr. 26, 1965.

A class of axially symmetric solutions of the inviscid hydrodynamic equations is discussed, with particular emphasis on flows that resemble the impingement of a rotational jet upon a flat plate. Depending upon the axial velocity gradient, the stream lines can adopt a 1- or many-celled pattern, similar to the behavior of viscous fluids between rotating cylinders. It is possible for these cells to exist in both the radial and axial directions. In some cases, the cell structure is replaced by an undulating flow.

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Aeronautical Research Associates of Princeton, Inc., N. J.

CONSTRUCTIVE APPROACH IN THE METHOD OF EXTENSION, by G. Sandri and R. Sullivan. [1965] [2]p. incl. refs. (AFOSR-65-1746) (AF 49(638)1461) AD 625978 Unclassified

Also published in Nuovo Cimento, Series X, v. 37: 1799-1800, June 16, 1965.

A constructive procedure is presented to determine the fundamental variables required by a method of extension introduced earlier. The construction allows for the introduction of arbitrary scaling functions which are determined by the requirement that the expansion of the unknown function be uniformly valid. The theory is illustrated through the example of an exponential decay for which: $\frac{\partial f}{\partial t} = \epsilon f$, $f(0) = 1$. The extension $f(\tau_0, \tau_1)$ of $f(t)$ is introduced where τ_0 and τ_1 are functions of t. These functions are solved to yield $\tau_1(t) = \epsilon kt + \tau_1(0)$.

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Aerospace Research Associates, Inc., West Covina, Calif.

RESEARCH ON ENERGY ABSORBING STRUCTURES. PART III, by S. Uchiyama, D. H. Platus and others. Final rept. Feb. 1964-Feb. 1965, 95p. incl. illus. diagrs. table, refs. (AFOSR-65-0420) (AF 49(638)1144) AD 615653 Unclassified

Three studies related to expandable and energy-absorbing structures for aerospace application are presented. The first study is a very-large-deflection analysis of corrugated thin-shell structures employing the principle of minimum complementary energy in conjunction with a variational technique. A second area of study is an investigation of structural damping from hysteresis effects in metals associated with large inelastic deformations. Finally, a novel concept is introduced for a flexible metallic seal, and a theoretical and experimental study is described which demonstrates the feasibility of the concept as applied to a fuel expulsion tank.

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Aerospace Research Associates, Inc., West Covina, Calif.

VERY-LARGE-DEFLECTION BEHAVIOR OF CORRUGATED STRIPS, by D. L. Platus and S. Uchiyama. [1965] [4]p. incl. diagrs. table. (AF 49(638)1144) Unclassified

Published in AIAA Jour., v. 3: 1549-1552, Aug. 1965.

A technique is described for handling the very-large-deflection behavior of a corrugated strip in terms of the solution to a curved cantilever beam with an end load. A stepwise incremental solution is obtained for a modified Bernoulli-Euler equation, which permits both elastic and plastic deformation of beams of arbitrary shape. The technique involves incremental loads as well as incremental elements of the structure. For each incremental load application, the corresponding deformation of the curved cantilever beam is determined by accumulating rotations and deflections of short straight cantilever beams which approximate the structure. Each incremental cantilever beam is subjected to a linearly varying moment and in the plastic-range, linearly varying flexural rigidity. Results of the method are compared with a closed-form elastic solution and with experimental results. Few increments of load and length are required, so that the method is suitable for use with a desk calculator.

38

Air Force Office of Scientific Research. Directorate of Information Sciences, Washington, D. C.

INFORMATION SCIENCES 1964, by H. Wooster. Mar. 1965, 110p. incl. refs. (AFOSR-65-0271) AD 616883 Unclassified

The Directorate of Information Sciences of the Air Force Office of Scientific Research sponsors basic research in the information sciences and research in the technology of information handling. This book is a report on the research sponsored by the Directorate during 1964. The areas covered are information systems research, information extraction and classification, information transmission, adaptive and self-organizing systems, language and linguistic research, theoretical foundations of the information sciences, and related seminars and symposia.

39

Air Force Office of Scientific Research. Directorate of Information Sciences, Washington, D. C.

AS LONG AS YOU'RE UP GET ME A GRANT: THE PREPARATION OF UNSOLICITED RESEARCH PROPOSALS, by H. Wooster. Mar. 1, 1965, 18p. (AFOSR-65-0392) AD 614894 Unclassified

Presented at meeting of the Society of Technical Writers and Publishers, Delaware Valley Chapter, Drexel Inst., Philadelphia, Pa., Feb. 23, 1965.

The preparation of unsolicited research proposals is an art form peculiar to the R & D or Gilded Age. There are 4 stages in the search for research support: reconnaissance and target identification; contact; proposal writing and submission; and patient waiting. Target identification is a sort of technical intelligence. A list of source documents for determining the research interests of potential fund sources is given; the search should not end until the lowest level in an agency who can say "Yes" and make it stick is identified. Rules for bearding bureaucrats in their lairs during the contact, and ascertaining the oestrus cycle of the agency are followed, at long last, by suggestions for proposal preparation—title, abstract, detailed description of the work to be undertaken, and a cost estimate. Three of these are described as exercises in creative writing, the appendix gives specific recommendations for the preparation of cost estimates for grants and contracts.

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Air Force Office of Scientific Research. Directorate of Information Sciences, Washington, D. C.

REPORT ON A CONFERENCE ON THE EDUCATION OF SCIENCE INFORMATION PERSONNEL HELD JULY 27-28, 1964, IN CLEVELAND, OHIO, by R. Swanson. [1965] [2]p (AFOSR-65-0859) AD 618426 Unclassified

Also published in Amer. Doc., v. 16: 34-35, Jan. 1965.

This conference, sponsored by the Center for Documentation and Communication Research of the School of Library Science, Western Reserve U., was intended as a sequel to conferences on training held at the Georgia Inst. of Tech. in Oct. 1961 and Apr. 1962. Recent progress in the education of science information personnel was the main topic and included discussions of the training of librarians, inter-university efforts and cooperative efforts between universities and industry for program enrichment and on-the job training for students, and the need for more sponsorship of education programs in the information sciences The conference served as a forum for self appraisal as well as a medium for information exchange.

41

Air Force Office of Scientific Research. Directorate of Information Sciences, Washington, D. C.

SOME OBSERVATIONS ON INSDOC SERVICES, by H. Wooster. [1965] [10]p. incl. tables. (AFOSR-65-1979) AD 623537 Unclassified

Also published in IASLIC Bull., v. 10: 1-10, Mar. 1965.

The Indian National Scientific Documentation Center (INSDOC) is reviewed as a prototype of a national documentation center, viewed against plans for similar activities in the United States. Information was gathered during the author's visit to INSDOC in Feb. 1964. A description of INSDOC's use of Colon Classification in preparing a classified list of titles of overseas scientific journal articles is followed by the suggestion that their efforts might be better spent in distributing facsimile tables of contents; that preparation of more detailed abstract lists might better be delegated to the several Indian Scientific Institutes; that INSDOC strengthen its role as a national referral center and become a coordinator among the technical information activities of the various Institutes rather than try to do the job alone.

42

Air Force Office of Scientific Research, Washington, D. C.

MANAGEMENT ASPECTS OF THE AFOSR MANAGEMENT CONTROL DATA SYSTEM "SOFTWARE", by D. R. Currier. Mar. 1, 1965 [41]p. incl. tables. (AFOSR-65-0272) AD 612080 Unclassified

The development of the AFOSR Management Control Data System input software is discussed. The vital relationship of this input software in the concept of the total system is stressed. The nature of MCDS input, the input/output data relationships, and the significance of the data transition points are defined. Ten Commandments of input data handling necessary to provide accurate, reliable, and timely output from the data store are presented. The application of behaviorism and communication theory to the handling of input software are described and related to the design of forms, methods, and procedures used by AFOSR to generate, record, process, and control the flow of input data to the data store of the MCDS.

43

Air Force Office of Scientific Research, Washington, D. C.

DIRECTORATE OF CHEMICAL SCIENCES PROGRAM REVIEW, FISCAL YEAR 1965. ELEVENTH ANNUAL CHEMISTRY PROGRAM REVIEW, ed. by A. J. Matuszko and M. D. Sprinkel. Nov. 1965, 2[illegible]9p. incl. illus. diagrs. table. (AFOSR-65-1559) AD 627666 Unclassified

The purpose of the review is to provide a unified record of research in progress together with the achievements resulting from the AFOSR program of supported basic research in chemistry There are 3 main sections in

the review. For each project which was completed during fiscal year 1965, a concise factual summary (including administrative data as well as research accomplishments) is provided. Another section contains geographic and other program statistics, a list of all scientific reports received during the year, and a list of the active projects. A third section is devoted to research high-lights, items of special interest described in terms understandable by the nonspecialist.

44

Air Force Office of Scientific Research, Washington, D. C.

MULTIVARIABLE SYSTEMS, by B. S. Morgan, Jr. [1965] [9]p. incl. diagr. refs. (AFOSR-65-1978) AD 626566 Unclassified

Also published in IEEE Internat'l. Conv. Rec., Pt. 6: 87-95, 1965.

The central theme of the paper is what to do with the coupling or interaction as it exists in multivariable systems. In a discussion of descriptions of multivariable systems, emphasis is placed on the influence that the design of multivariable systems has had on the theory of dynamical systems. Discussed briefly is the future influence of automata theory on multivariable systems. Reported in detail are design techniques for noninteracting systems and for improvement of performance by use of interaction. Under applications a discussion of design techniques used in practical multivariable systems is presented. (Contractor's abstract)

45

Air Force Office of Scientific Research, Washington, D. C.

VELA UNIFORM PROGRAM. RESEARCH IN SEISMOLOGY. 1961-1965. Jan. 1965, 83p. incl. refs. (AFOSR-65-2667) AD 623453 Unclassified

A program of basic research in seismology was carried out to improve the capability to distinguish seismically between nuclear explosions and natural geological events. Research efforts were applied in areas of identification techniques, data processing, array configuration, deep-hole and ocean bottom detection, instrumentation techniques, magnitude-energy scale relationships, noise studies, earth seismicity, explosion and earthquake source mechanism studies, crustal studies, and theoretical studies.

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Air Force Office of Scientific Research, Washington, D. C.

THE FUNDAMENTAL RESEARCH ACTIVITY IN A TECHNOLOGY-DEPENDENT ORGANIZATION, by H. M. Vollmer, L. W. Bass and others. [1965] [109]p. incl. refs. (AFOSR-65-2691) AD 628747 Unclassified

Presented at Tenth Inst. on Research Administration, Washington, D. C., Apr. 26-29, 1965, under the sponsorship of American U.

The fundamental research activities of an R and D organization are presented as important both for providing specific research results in areas of potential payoff for the organization and in providing a window between science and technology. The need and potential for the latter activity are inherent in the recognition that a very large portion of the scientific research on which a given technology depends is always done by other organizations. The discussion deals primarily with the opportunities and techniques for providing this window.

47

Air Force Office of Scientific Research, Washington, D. C.

THE IMPORTANCE OF PROPERLY DESCRIBING THE OBJECTIVES OF THE AFOSR PROGRAM, by W. J. Price. Oct. 1965 [17]p. incl. diagrs. (AFOSR-66-0191) AD 628527 Unclassified

Presented at meeting of the OAR Scientific Advisory Group, Nov. 19, 1965.

The role of fundamental research in a mission-oriented agency is discussed with particular reference to the external contract and grant program of the Air Force Office of Scientific Research. A brief historical account of the evolution of this program points up the tendency to describe the contribution of Air Force research in terms of extreme positions — either in completely mission-orientated terms in which all research supported shows clearly its relationship and application to service needs, or completely science-oriented terms which describe the Air Force research roles as primarily a contribution to the large pool of scientific knowledge from which the Air Force and others draw. The point is made that the neglect of either position, and particularly of the ole that lies between the extremes, is very unfortunate inasmuch as it results in missing important justification for the research program, and important guidance for the management of the program. The AFOSR is described as a Research Institute — consisting of managers, researchers, and advisors — seeking to help insure the timely impact of science on the Air Force In carrying out this role it accomplishes research and also it provides communication between the scientific community and the Air Force. The research accomplished is described as phenomena-oriented research which is motivated by either helping a development group obtain the required understanding of phenomena key to technological barriers or by seeking to pioneer or colonize new fields of science holding out high promise for scientific discovery out of which innovations may arise which will bypass current technology barriers.

48

Alabama U. Dept. of Physics, University.

ESR OF X-IRRADIATED SILVER NITRATE, by W. C. Mosley and W. G. Moulton. [1965] [8]p. incl. diagrs tables, refs. (AFOSR-65-2591) (AF AFOSR-63-288) AD 629663 Unclassified

Also published in Jour. Chem. Phys., v. 43: 1207-1214, Aug. 15, 1965.

Four paramagnetic species have been detected by ESR in single crystals of $AgNO_3$ x irradiated at 77°K. The principal values and corresponding principal axes of the g tensors and hyperfine tensors have been determined. An 8-line spectrum, 4 doublets, is due to Ag^{++}. A 24-line spectrum, 4 sextets, has been assigned to a species believed to be $AgNO_3^-$. A spectrum of 4-triplets characteristic of stationary NO_2 molecules was observed in previously irradiated crystals and crystals doped with $AgNO_2$. A spectrum consisting of 2 weak singlets is due to an unidentified species. This is the only species stable at room temperature. Discussions of the orientations, configurations, mechanisms for production, and annealing characteristics of the several species are given. (Contractor's abstract)

49

Alberta U. [Dept. of Mathematics] Calgary (Canada).

VECTOR LYAPUNOV FUNCTIONS AND CONDITIONAL STABILITY, by V. Lakshmikantham. [1965] [10]p. (AFOSR-66-1209) (AF AFOSR-64-670) AD 641881 Unclassified

Also published in Jour. Math. Anal. and Appl., v. 10: 368-377, Apr. 1965.

Sufficient conditions for conditional stability and boundedness of solutions to non-linear differential equations are obtained in terms of vector Lyapunov functions. Ordinary differential equations, differential equations with unbounded operators in Banach spaces, functional differential equations, and parabolic differential equations are classes for which this theory is applicable.

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American Mathematical Soc., Providence, R. I.

APPLICATIONS OF NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS IN MATHEMATICAL PHYSICS; PROCEEDINGS OF SYMPOSIA IN APPLIED MATHEMATICS, VOL XVII, New York (Apr 20-23, 1964), ed by R. Finn. Providence, American Mathematical Soc., 1965, 1v. incl. diagr. table, refs. (AFOSR-66-0641) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-562 and Army Research Office (Durham)) Unclassified

Seventeen papers dealing with various applications of nonlinear differential equations are presented Topics include, (1) general nonlinear theory, (2) finite elasticity and compressible fluids, (3) viscous fluids and magnetohydrodynamics, and (4) general relativity and quantum field theory.

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American Soc. of Mechanical Engineers, New York

APPLIED MECHANICS REVIEWS, ed by S. Juhasz, M. Goland and others. Jan. 1965—Dec. 1965. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)1549], National Science Foundation, Office of Naval Research, Southwest Research Inst., and Texas U.) Unclassified

A comprehensive, current, easily and readily usable abstract and index service to published materials is an invaluable tool to researchers. This effort is for partial support of one such service, in the field of mechanics and related sciences. This service provides abstracts, in English, to literature in 25 languages from 900 serial publications, furnishes "state-of-the-art" summaries, and provides book reviews and some translations. To improve subject retrieval experimentation is being conducted in mechanized information processing and announcement techniques.

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American Soc. of Mechanical Engineers, New York.

WADEX WORD AND AUTHOR INDEX. PART I. DESCRIPTION. PART II. PROGRAM DOCUMENTATION, by E. A. Ripperger, H. Wooster and others. June 1965 [193]p. incl. diagrs. tables. (Rept. no. AMR 38) (AFOSR-65-2001) [AF AFOSR-64-33] AD 623162 Unclassified

The WADEX (Word Author inDEX) for Applied Mechanics Reviews, v. 16, 1963 is described. Titles are printed fully, including the author's name. Each title begins at the left side of the column and occupies as many lines as necessary. A designator is either a word in the title (except forbidden words) or an author's name. Designators are sequenced alphabetically and are given out of context at the left of the title. If there is more than one identical designator, titles are alphabetized according to the alphabetical position of the first author. If there are several identical designators with indentical authors, they are sequenced according to review number. The reference number indicates year, month, and review number in Applied Mechanics Reviews proper. It is printed in line with the designator on the right side of the column. WADEX is arranged in 2 columns with pagination at the bottom and a dictionary entry at the top of the page. The page is reduced about 50% from the compuscript. Certain combinations of words are artificially hyphenated to make listing of some papers more meaningful and useful. Whenever a designator is repeated in a given column, subsequent printing of the designator out of context is suppressed. However, the first instance of a designator out of context in any column is always printed. This is designed to improve readability The computer printout is a camera-ready copy with 6 5 average entry per paper including 1.5 for authors.

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Analytic Services, Inc. [Falls Church] Va.

DECISION NETWORKS, by C. W. Foreman and F. P. Mertes. Development planning memo. Jan. 1965, 85p. (Rept. no. DPM 65 1) (AF 49(638)1259) AD 457925 Unclassified

The purpose of this Memo is to disseminate some early thoughts and conclusions on the applicability of network techniques to the analysis of decisions that must be made during the Air Force planning process. Two related briefings make up this Memo. The first of these is a short introductory briefing entitled 'Introduction—Decision Networks,' which states the reasons AFRDP and ANSER are interested in developing new techniques of analysis. The second, 'Decision Networks,' describes the theoretical basis for the formulation and use of decision networks and demonstrates, by an example, their planning applications.

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Analytic Services, Inc., Falls Church, Va.

ANALYSIS OF AEROSPACE FUNDING AND EMPLOYMENT—FISCAL YEARS 1956 TO 1966, by R. D. George and E. M. Phelan. Sept. 1965 [42]p. incl. diagrs. tables, refs. (Rept. no. AR-65-5) (AF 49-(638)1259) AD 478017 Unclassified

U. S. Government aerospace funding for fiscal years 1956 to 1966 were analyzed to determine significant trends and their effects on employment in the aerospace industry. Analysis showed that aerospace expenditures followed an uninterrupted upward trend for almost a decade and then turned downward in fiscal 1964. Aerospace expenditures are now beginning to increase because of world conditions. This increase and the emphasis on R and D funding indicate the importance of maintaining teams of qualified scientists and engineers during periods of reduced funding. Assigning aerospace scientists and engineers to area of opportunity programs may be a way of keeping industry teams intact.

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Analytic Services, Inc., Falls Church, Va.

METHODOLOGICAL APPROACH TO PLANNING AND PROGRAMMING AIR FORCE OPERATIONAL REQUIREMENTS, RESEARCH, AND DEVELOPMENT (MAPORD), by H. E. Emlet, Jr. Oct. 1965 [96]p. incl. diagrs. tables. (Rept. no. AR-65-4) (AF 49(638)1259) AD 479811 Unclassified

The methodological approach to planning and programming Air Force operational requirements, research, and development (MAPORD) is a technique for identifying, according to the best available judgments, the elements and relations which are the basis for decisions in planning and programming Air Force operational requirements, research, and development. The technique employs a series of interlocking matrices which provide high visibility of the pattern of elements and relations; flexibility in modifying the pattern in response to changing events, changing emphases, and experimentation on the effects of altering judgments; and as rigorous a means as possible of relating judgments to each other and to a balanced program. The method is designed for application to electronic computers to afford high-speed updating, revision, interrogation, printout, and performance of all routine identifications of relations in the creation and maintenance of the MAPORD pattern. The method at its present stage of development incorporates a rigorous means for identifying certain broad categories of importance and is designed to accommodate techniques for further sorting of relative importance if and when such techniques can be defined.

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Analytic Services, Inc., Falls Church, Va.

AN APPLICATION OF GAME THEORY TO AN OFFENSE-DEFENSE RESOURCE ALLOCATION PROBLEM, by J. D. Matheson. [1965] [36]p. incl. illus. tables. (Rept. no. AR-65-7) (AF 49(638)1259) AD 478569 Unclassified

This report presents a two-sided resource allocation game in which one player allocates his resources between two offensive weapon systems to maximize target destruction. The opponent allocates his resources between two defensive weapon systems to minimize target destruction. The game is continuous in the sense that all variables are assumed to be continuous, and static in the sense that time is not a variable. Explicit solutions are obtained in terms of the parameters of the problem. (Contractor's abstract)

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Antioch Coll. Behavior Research Lab., Yellow Springs, Ohio.

HUMAN AND ANIMAL VIGILANCE, by H. J. Jerison. [1965] [3]p. incl. table. (AFOSR-66-1191) (AF AFOSR-64-150) AD 641703 Unclassified

Presented at Fifteenth Internat'l. Cong. of Applied Psychology, Ljubliana (Yugoslavia), Aug. 6, 1964.

Also published in Perceptual and Motor Skills, v. 21, 580-582, 1965.

Experiments with both men and monkeys, summarized in this report, indicate that vigilance decrements are associated with the ease or difficulty of observing. A given set of signals may be detected often or rarely by human observers, depending on how easy it is to watch the background of stimulus events within which signals can occur.

58

Antioch Coll. Behavior Research Lab., Yellow Springs, Ohio.

THE ELICITED OBSERVING RATE AND DECISION PROCESSES IN VIGILANCE, by H. J. Jerison, R. M. Pickett, and H. H. Stenson. [1965] [22]p. incl. diagrs. tables, refs. (AFOSR-66-1170) (Sponsored jointly by Aerospace Medical Research Laboratories; and Air Force Office of Scientific Research under AF AFOSR-65-150) AD 638785 Unclassified

Also published in Human Factors, v. 7 107-128, 1965.

Observers detected many more of a fixed number of signals when these were among stimuli presented at 5 per min than when these were among stimuli presented at 30 to 60 per min. The effect, which is associated with either the signal probability or the non-signal stimulus density, is analyzed with conventional measures and with measures from the theory of signal detectability (TSD). The TSD measures were used to define several possible modes of observing, and the model of vigilance based on decisions about observing could then be related to decision processes in detection performance as considered in TSD. If a single measure of the probability of alert observing is required, the best one is the percentage of detections of the readily detectable signal of the vigilance task. However, the TSD analysis suggested various different "mixes" of modes of observing for the sub-groups in this experiment, and these mixes could be specified with the help of heuristic models relating performance measures to the probability of observing.

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Arctic Inst. of North America, Montreal (Canada).

VARIATIONS IN SHORT-PERIOD RECORDS FROM CANADIAN SEISMOGRAPH STATIONS, by M. Ichikawa and P. W. Basham. [1965] [33]p. incl. diagrs. tables, refs. (AFOSR-66-0429) (AF AFOSR-62-453) AD 625677 Unclassified

Also published in Canad. Jour. Earth Sci., v. 2: 510-542, 1965.

A study of the relative recording ability of some of the Canadian seismograph stations has indicated a pattern of P-wave amplitude anomalies varying from station to station and, at any one station, showing a significant regional variation which does not seem to be entirely produced by source mechanism effects. Rather local crustal effects appear important, and spectral studies indicate that significant effects can be produced in low velocity upper crustal layers. The initial investigation of early P-wave trains and theoretical models suggests that these crustal effects can best be examined by the use of apparent incident angles, and that spectral amplitude decrements change significantly from station to station, although this is unexplained. It appears that the different recording ability of stations can be explained by a combination of shallow crustal effects operating on the signal amplitude and the local noise properties. (Contractor's abstract)

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Argentine National Commission on Space Research, Buenos Aires.

INTERNATIONAL YEARS OF THE QUIET SUN (ANOS INTERNACIONALES DEL SOL CALMO); PROCEEDINGS OF THE REGIONAL SYMPOSIUM, VOL. I, Buenos Aires (Argentina), Aug. 1964. 1965 [108]p. incl. illus. diagrs. tables, refs. (Rept. no. CNIE-PE-2, Special publ. no. 2) (AFOSR-65-1730) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-716, Army Research Office (Durham), Special Committee for the I. Q. S. Y. and others) AD 625036 Unclassified

The Regional Symposium of the International Years of the Quiet Sun was held at Buenos Aires and attended by several Argentine and foreign scientists. This publication includes the following invited papers: Recent techniques in geomagnetic measurements; Variations of solar origin in the earth's upper atmosphere; Geophysical effects of high altitude nuclear explosions; Acceleration processes in the sun for high energy particles; Fireballs, isobars and extensive air showers, and Problems of stratospheric circulation for study in the IQSY.

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Argentine National Commission on Space Research, Buenos Aires.

INTERNATIONAL YEARS OF THE QUIET SUN (ANOS INTERNACIONALES DEL SOL CALMO); PROCEEDINGS OF THE REGIONAL SYMPOSIUM, VOL. II, Buenos Aires (Argentina), Aug. 1964. 1965 [58]p. incl. illus. diagrs. refs. (Rept. no. CNIE-PE-7; Special publ. no. 7) (AFOSR-66-0631) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-716, Army Research Office (Durham), Special Committee for the I. Q. S. Y. and others) AD 630805 Unclassified

The following papers are included in this publication: Observations of the atmospheric scintillation of radio star and satellite signals. Applications of the optical model for 2 Bev/C K^- interactions; Directional and energy dependence of cosmic ray variations; Cosmic ray fluxes and rigidity calculations; Differential faraday measurement of electron content with the S-66 satellite; and Cosmic ray storms and the daily variation.

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Arizona State U. [Dept. of Physics] Tempe.

EVIDENCE FOR IONIC CONDUCTION IN CERIUM OXIDE (Abstract), by E. L. Holverson and C. J. Kevane. [1965] [1]p. [AF AFOSR-64-609] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 172, Feb. 25, 1965.

Electrical conduction in ceramic cerium oxide was studied in the temperature range from 300° to 800°C and over a range of oxygen partial pressures from 1 to 10^{-4} atm. The impurity concentrations in the material studied were determined spectrographically and by controlled addition of impurities. The study consisted of applying a constant direct voltage across cerium oxide samples doped with varying amounts of calcium oxide, and observing the current transients as well as the potential distribution as a function of the oxygen pressure and the temperature. Ohm's law was found to be applicable for the potential difference between the potential probes. The potential distribution was found

to be inconsistent with the concept of a decomposition potential. Polarization effects were found to be prominent: anomalous potential distributions, large polarization voltages, and decays in current immediately after application of a voltage were found. It was concluded that the results were consistent with the space-charge polarization theory of Jaffé. The passage of direct current through a calcium-doped cerium oxide sample was accompanied not only by sample discoloration but also by the evolution of oxygen, as was confirmed by mass spectrographic analysis. This positive identification of oxygen as the evolved gas confirms the previous interpretation that conduction in calcium-doped cerium oxide is partially ionic in nature.

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Arizona U., Tucson.

DOCUMENT ASSOCIATION AND CLASSIFICATION BASED ON L-LANGUAGES, by J. Sanders. [1965] [5]p. (AFOSR-65-1589) (AF AFOSR-62-289) AD 623495 Unclassified

Also published in Jour. Assoc. Comput. Machinery, v. 12: 249-253, Apr. 1965.

Measures of document connectedness and association are defined whose nature arises from the internal structure of the documents themselves rather than via the judgment of an external observor. The intent is to develop the theoretical structure in such a way that the processing of documents into the various classifications can be done entirely by machine. The theory is founded on a set of formal languages, the L-languages. A formal presentation of the theory is made and examples of 5 documents are given and discussed. The implications of the theory for automated document retrieval are discussed in conjunction with various extensions of the formal theory. (Contractor's abstract)

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Arizona U., Tucson.

A HYBRID ANALOG-DIGITAL PSEUDO RANDOM NOISE GENERATOR, by R. L. T. Hampton. Jan. 1964, 45p. incl. diagrs. table, refs. (AFOSR-64-0393) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-89 and National Aeronautics and Space Administration) AD 434556 Unclassified

Also published in 1964 Spring Joint Computer Conf.; AFIPS Conf. Proc., Washington, D. C. (Apr. 1964), Baltimore, Spartan Books, Inc., v. 25: 287-301, 1964.

Also published in Simulation, v. 4. 179-187, Mar. 1965.

The design of a hybrid analog-digital pseudo-random noise generator intended to replace conventional random-noise generators in analog and hybrid computer simulating is described. It is capable of producing 4 essentially uncorrelated binary outputs from a single 25-stage shift-register. The length of the pseudo-random output sequence is 33, 554, 431 bits which is equivalent to several thousand computer runs.

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Arizona U., Tucson.

A HYBRID ANALOG-DIGITAL PARAMETER OPTIMIZER FOR ASTRAC II, by B. A. Mitchell, Jr. Jan. 16, 1964, 37p. incl. illus. diagrs. table, refs. (ACL memo. no. 90) (AFOSR-84-0397) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-89 and National Aeronautics and Space Administration) AD 434559 Unclassified

Also published in 1964 Spring Joint Computer Conf., AFIPS Conf. Proc., Washington, D. C. (Apr. 1964), Baltimore, Spartan Books, Inc., v. 25. 271-285, 1964.

Also published in Simulation, v. 4. 399-411, June 1965.

A new automatic multi-parameter optimizer for iterative differential analyzers employs sequential random parameter perturbation. The nominal parameter point changes whenever the random perturbations improve the system performance measure. Binary counters operate simple digital-to-analog converters to implement parameter storage, multiplication, and step-size changes. All-digital logic yields different types of random perturbations, viz. simple random walk, random walk with reflecting or absorbing barriers, and various types of correlation over successive perturbations.

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Arizona U., Tucson.

HYBRID ANALOG-DIGITAL TECHNIQUES AND RANDOM-PROCESS STUDIES 1964-1965, by G. A. Korn, J. L. Melsa and others. [1965] 30p. incl. diagrs. tables, refs. (EES series rept. no. 5) (AFOSR-65-2313) [AF AFOSR-63-89] AD 631635 Unclassified

This report on hybrid computing systems contains the following 4 articles: (1) Hybrid-computer techniques for measuring statistics from quantized data, by G. A. Korn (see item no. 71); (2) Iterative-differential-analyzer study of prediction networks, by J. L. Melsa and M. J. Wozny, (3) A simple first-order-hold circuit, by G. A. Korn, and (4) Digital program control for iterative differential analyzers, by H. R. Eckes and G. A. Korn.

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Arizona U., Tucson.

EXPERIMENTS USING PSEUDO-RANDOM NOISE, by R. L. [T.] Hampton. [1965] [9]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-89 and National Aeronautics and Space Administration) Unclassified

Published in Simulation, v. 4: 246-254, Apr. 1965.

The results of experiments performed with pseudo-random noise sequences are described. It is shown that Gaussian noise can be easily produced from such sequences. It is also demonstrated that the sequences themselves have a binomial probability distribution The

correlation technique investigated, using pseudo-random noise, makes possible a continuous recording of a system's impulse response without the use of sophisticated hardware. The impulse response obtained from the cross-correlation experiment can be approached from either the positive or negative direction, i.e., τ can be made not only a time delay, but also a time advance. This enables one to observe the trailing end of a waveform before viewing its leading end. It also permits a quick experimental verification of the correlation property that $R_{xy}(\tau) = R_{xy}(-\tau)$. Examples for a first- and second-order system are given. (Contractor's abstract)

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Arizona U., Tucson.

ASTRAC II PLUG-IN DIODE FUNCTION GENERATOR, by R. H. Whigham. [Feb. 1965] 1p. incl. diagr. (ACL memo no. 101) (AFOSR-65-0585) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-89 and National Aeronautics and Space Administration) AD 615439 Unclassified

The ASTRAC II plug-in diode function generator consists of a plug-in module which covers the patching area of 2 operational amplifiers on a standard analog-computer patchbay. The circuit utilizes both of the covered amplifiers to provide both positive and negative slopes. Six breakpoints are fixed at ± 1, ± 3, and ± 5.5 v. Slopes and a d-c adjustment are set by means of eight 10-turn wire-wound potentiometers. The input diodes reduce the input loading. Shunt diodes and low impedance levels improve the frequency response. The maximum current requirement is 18 ma with all slopes maximum, some positive and some negative. The error for a given frequency depends on the particular function generated. In general, however, the error is less than 0.5% of half scale for input frequencies less than 5 kc with slopes less than 2. The temperature drift is approximately 2 mv/°C.

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Arizona U., Tucson.

A FAST 10V DIODE QUARTER SQUARE MULTIPLIER, by R. H. Whigham. [1965] [7]p. incl. illus. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-89 and National Aeronautics and Space Administration) Unclassified

Published in Simulation, v. 5: 114-120, Aug. 1965.

This report describes the design and performance of a fast wideband quarter-square diode multiplier designed to work the ± 10-v low-impedance computing circuits of a high-speed iterative differential analyzer (ASTRAC II), or in other hybrid analog-digital computer systems. To reduce cost, the new multiplier employs absolute-value squaring circuits and does not require committed computer amplifiers. Improved combination shunt-series switching circuits and low resistance values ensure wide bandwidth (± 0.5% of half-scale dynamic error at 10 kc, < 1 degree phase shift below 70 kc). Temperature-compensating diodes in the bias networks reduce thermal drift below 0.7 mv/°C, so that the multiplier static accuracy of ± 0.20% of half-scale is maintained from 15 to 40°C. A number of useful design hints are listed. (Contractor's abstract)

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Arizona U., Tucson.

HYBRID COMPUTER MONTE CARLO TECHNIQUES, by G. A. Korn. [1965] [12]p. incl. illus. diagrs. refs. (Bound with its AFOSR-65-2313; AD 631635) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-89 and National Aeronautics and Space Administration) Unclassified

Published in Simulation, v. 5: 224-245, Oct. 1965.

This report introduces hybrid analog-digital computer systems suitable for high-speed Monte-Carlo studies and suggests methods for further reducing the computing time, such as sequential estimation and a number of variance-reducing techniques. Shift-register-generated pseudo-random-noise is especially convenient for many hybrid analog-digital computations. Applications to the solution of partial differential equations and to random-search optimization are outlined. (Contractor's abstract)

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Arizona U., Tucson.

HYBRID-COMPUTER TECHNIQUES FOR MEASURING STATISTICS FROM QUANTIZED DATA, by G. A. Korn. [1965] [10]p. incl. diagrs. table, refs. (Bound with its AFOSR-65-2313; AD 631635) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-89] and National Aeronautics and Space Administration) Unclassified

Published in Simulation, v. 4: 229-239, Apr. 1965.

Digital data processing necessarily involves quantization (roundoff) of input data. The statistical theory of amplitude quantization indicates that the effects of quantization on statistics are often negligible or can be approximately predicted and corrected, even with surprisingly coarse quantization. This tutorial paper reviews contributions to the theory made in England, the Netherlands, and Russia, as well as B. Widrow's original work in this country. Applications to remarkably inexpensive hybrid analog-digital averaging computers and correlators are also discussed. The theory can pay very handsome practical dividends; in many applications, 2- to 4-bit analog-to-digital converters and data-transmission channels can yield averages, mean squares, and correlation functions with 10- to 20-bit accuracy, and one-bit (polarity-coincidence) correlators are often practical. (Contractor's abstract)

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Arizona U. Dept. of Physics, Tucson.

EFFECT OF PRESSURE ON THE DIFFUSION RATE IN

METALS. by R. H. Dickerson, R. F. Bonanno, and C. T. Tomizuka. [1965] [7]p. incl. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)790 and Atomic Energy Commission) Unclassified

Published in Physics of Solids at High Pressures, Proc. First Internat'l. Conf., Tucson, Arizona (Apr. 20-23, 1965), ed. by C. T. Tomizuka and R. M. Emrick. New York, Academic Press, 1965, p. 329-335. (AFOSR-66-0131)

The molar activation volume ΔV in a diffusion process is defined as $(\delta \Delta G/\delta p)_T$, where ΔG is the molar Gibbs free energy for the self-diffusion process, p is pressure and T temperature. Using a gas pressure system up to 9 k bar at temperatures of about 1000°C, the effect of pressure on the self-diffusion rate in Au was determined, and ΔV evaluated from the results. ΔV amounts to about 70% of the molar volume; this estimate agrees with that obtained by summing the volume of a mol of vacancies at rest and the volume increase caused by a mol of vacancies moving to the activated state. The effect of pressure on the diffusion rates of In and Sb in Ag, and the self-diffusion rate of Ag itself are also determined. The difference between the ΔV's corresponding to self-diffusion and the diffusion of In and Sb respectively are compared with those calculated from the Lazarus-Le Claire and the Corless-March theories; the agreement with the latter theory is close.

73

Arizona U. Dept. of Physics, Tucson.

EFFECT OF HYDROSTATIC PRESSURE ON THE CURIE POINTS OF SEVERAL FERRITES, by C. L. Foiles and C. T. Tomizuka. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-65-1745) (AF AFOSR-63-105) AD 641494 Unclassified

Also published in Jour. Appl. Phys., v. 36: 3839-3843, Dec. 1965.

The effect of hydrostatic pressure on the Curie temperature T_c was measured for 4 members of a Ni-Zn ferrite series (30%, 50%, 80%, and 100% NiO) and for 2 members of a gadolinium-iron-garnet series ($Gd_3AlFe_4O_{12}$ and $Gd_{1.5}Y_{1.5}Al_{0.5}Fe_{4.5}O_{12}$). A transformer technique was used for the measurements with the maximum pressure available being 8 kbar. The Curie temperature showed a linear increase with pressure and the slopes ranged from 0.58 ± 0.05 to 1.16 ± 0.07°C/kbar. The approximate Curie points varied from 153°C ($Gd_3AlFe_4O_{12}$) to 616°C (100% NiO ferrite). The samples with T_c less than 400°C were measured in a liquid-pressure system and the others were measured in a gas-pressure system. (Contractor's abstract)

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Arizona U. Dept. of Physics, Tucson.

EFFECT OF HYDROSTATIC PRESSURE ON THE NÉEL TEMPERATURE IN CHROMIUM, by T. Mitsui and C. T. Tomizuka. [1965] [2]p. incl. diagrs. refs. (AF AFOSR-63-105) Unclassified

Published in Phys. Rev., v. 137: A564-A565, Jan. 18, 1965.

The electrical resistivity of high-purity chromium polycrystal was measured as a function of temperature in the range of hydrostatic pressure from atmospheric pressure to 8 kbar. The Néel temperature, which manifests itself as the resistivity minimum, was observed to decrease linearly with pressure at a rate of 5.1 ± 0.2°K/kbar. The relative resistivity anomaly in the neighborhood of the Néel temperature was found to be pressure-insensitive. Attempts have been made to interpret the results in terms of the spin-density-wave theory. (Contractor's abstract)

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Arizona U. Dept. of Physics, Tucson.

EFFECT OF HYDROSTATIC PRESSURE ON THE NÉEL TEMPERATURE AND ELECTRICAL RESISTIVITY ANOMALY IN CHROMIUM METAL, by T. Mitsui. [1965] [9]p. incl. diagrs. refs. (AF AFOSR-63-105) Unclassified

Published in Physics of Solids at High Pressures, Proc. First Internat'l. Conf., Tucson, Arizona (Apr. 20-23, 1965), ed. by C. T. Tomizuka and R. M. Emrick. New York, Academic Press, 1965, p. 213-221. (AFOSR-66-0131)

The electrical resistivity of high-purity polycrystalline chromium was measured as a function of temperature in the range of hydrostatic pressures from atmospheric pressure to 8 kbar. The Neel temperature, which manifests itself as a resistivity minimum, was observed to decrease linearly with pressure at a rate of -5.1 ± 0.2°C/kbar. This value is in agreement with the one estimated by the thermodynamical relation of the second order phase transition. The electrical resistivity anomaly, which is associated with magnetic energy gaps introduced by the periodicity of antiferromagnetic spin arrangement, was found to be pressure insensitive. (Contractor's abstract)

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Arizona U. [Dept. of Physics] Tucson.

PHYSICS OF SOLIDS AT HIGH PRESSURES, PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE, Tucson, Arizona, Apr. 20-23, 1965, ed. by C. T. Tomizuka and R. M. Emrick. New York, Academic Press, 1965, 595p. incl. illus. diagrs. tables, refs. (AFOSR-66-0131) (AF AFOSR-65-740) Unclassified

The purpose of this conference was to bring together workers in the field of solid state physics, employing high pressure techniques, and offer them an opportunity for free exchange of information. The development of excellent high-pressure facilities in many countries required that the conference be international. Nine countries were represented. A total of 44 papers and

discussions are presented, grouped under the following general headings (1) electronic properties, (2) magnetism, (3) lattice defects, (4) phase transformations, and (5) lattice properties.

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Arkansas U. Dept. of Physics, Fayetteville.

RADIATIVE LIFETIMES AND EXCITATION MECHANISMS IN HELIUM, by W. R. Pendleton, Jr and R. H. Hughes. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-2776) [AF AFOSR-62-159] AD 629540 Unclassified

Also published in Phys. Rev., v. 138 A683-A687, May 3, 1965.

The radiative decay rates of the $n^1S(n = 4,5)$, 3^1P, $n^1D(n = 3,4,5)$, $n^3S(n = 4,5)$, $n^3P(n = 3,4,5)$ and $n^3D(n = 3,4)$ states of helium have been measured using pulsed, variable-energy electron-impact excitation and a sampling method of detection. The results agree well with previously published measurements. Experimental evidence is presented for the mechanisms involved in the collisional-transfer reactions where atoms in ^1P states excite ^3D levels: nF levels ($n > 5$) are populated by collisional transfer from n^1P levels and in turn cascade to the ^3D levels. Possible laser action in the $3^1P - 3^1S$ and $5F - 3^3D$ transitions is suggested.

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Arkansas U. Dept. of Physics, Fayetteville.

SIMPLE NANOSECOND LIGHT PULSER, by W. R. Pendleton, Jr. [1965] [1]p. incl. diagrs (AFOSR-66-1568) [AF AFOSR-62-159] AD 640181 Unclassified

Also published in Rev Scient. Instr., v. 36 1645, Nov. 1965.

A voltage indicator tube, Amperex 6977, has been used as a nanosecond light pulser using a miniature hydrogen thyratron pulser. An analysis of the emission of the fast component of the two-component P-15 phosphor showed a decay to 10% of original light peak intensity in not more than 50 nanoseconds. Best light pulse shapes showed 3.5 ns rise to 90% of peak intensity and 7 ns width at the one-half intensity points.

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Astrosystems International, Inc., Fairfield, N. J.

AFOSR SIXTH ANNUAL CONTRACTORS' MEETING ON CHEMICAL KINETICS OF PROPULSION, New York, Sept. 20-21, 1965 [45]p. incl. refs. (AFOSR-65-2238) [AF 49(638)1400] AD 627978 Unclassified

Abstracts are presented which briefly describe the current status of research efforts contractually supported by AFOSR and other research programs in the field of chemical kinetics of propulsion.

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Astrosystems International, Inc., Fairfield, N. J.

COMBUSTION GAS EMITTED RADIATION AND CHEMILUMINESCENCE PHENOMENA (Abstract), by J. S. Gordon. [1965] [1]p. (Bound with its AFOSR-65-2238, AD 627978) (AF 49(638)1400) Unclassified

Spectral radiance-measurement discrete emission bands in combustion gases are being used to study and characterize chemiluminescence. A chemical kinetics interpretation of results is desired. A low pressure premix gas burner is being assembled for use with simple fuel oxidizer combinations (CHg O_2). Later experiments will use CHg NO, C_2H_2 N_2O and other systems (containing halogen, boron, etc.). This apparatus replaces the previous unsuccessful configuration in which the torch plume impinged on a nozzle section so as to exhaust selected portions of the flame gas (fast reaction zone) into a vacuum chamber Previous observation of strong chemiluminescence with O_2 isobutylene using this configuration could not be reproduced. The combustion gas will be optically scanned over the wavelength region of interest (2000 to 6000A) using a McPherson Model 235 grating monochromator and photomultiplier recorder system as functions of location within the flame. The objectives are to determine radiative lifetimes of selected species (CH, NO, OH, HCO, C_2 etc.) based on monochromator scan results, and departures from thermal equipartitions between rovibronic energy levels of selected species (interdepartures from the thermochemical equilibrium as defined by thermodynamic calculations as function of fuel oxidizer stoichiometry and location within the premix flame brush)

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Atlantic Research Corp., Alexandria, Va.

THE KINETICS OF THE HYDROGEN-FLUORINE REACTION. II. THE OXYGEN-INHIBITED REACTION, by J. B. Levy and B. K. W. Copeland. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-0692) (AF 49-(638)1131) AD 615181 Unclassified

Also published in Jour. Phys. Chem., v. 69 408-416, Feb. 1965.

The kinetics of the thermal, gaseous hydrogen-fluorine reaction have been investigated by a colorimetric technique. The reaction has been found to be inhibited by oxygen and the inhibited reaction was studied mainly at 132°, but also from 122 to 162 The experiments have been performed at a total pressure of about 645 mm, with oxygen varying from about 80 to 500 mm. Nitrogen and helium have been used to maintain the total pressure at the desired value. Hydrogen and fluorine pressures have been in the general range of 20-80 mm It has been found that the rate decreases with added oxygen but reaches a limiting value unaffected by further oxygen addition. The limiting rate obeys the expression $-d(F_2)/dt = k(F_2)(H_2)^{1/2}$ fairly well, but the curves of the integrated forms are linear only for about the first 50% of reaction, dropping off thereafter The Arrhenius plot for the rates from 132 to 162 C is linear, yielding

activation energy of 16.7 kcal/mol. The results are discussed in terms of a chain reaction involving the propagation steps, $H + F_2 \rightarrow HF + F$, $F + O_2 + M \rightarrow FOO + M$, and $FOO + H_2 \rightarrow HF + O_2 + H$. Evidence is presented for an activation energy of 5-7 kcal/mol for the reaction $F + H_2 \rightarrow HF + H$ and for a heat of formation for the FOO species of +3.5 kcal/mol. (Contractor's abstract)

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Atlantic Research Corp., Alexandria, Va.

THE KINETICS OF THE TETRAFLUOROHYDRAZIN FLUORINE REACTION, by J. B. Levy and B. K. W. Copeland. [1965] [5]p. incl. diagrs. tables, refs. (AF 49(638)1131) Unclassified

Published in Jour. Phys. Chem., v. 69, 3700-3704, Nov. 1965.

The reaction between fluorine and tetrafluorohydrazine has been investigated from 35 to 86°. Nitrogen trifluoride has been shown to be the only product. The kinetics have been measured by a colorimetric technique and have been shown to be homogeneous. It has been found that the kinetic data obey the expression $-d(F_2)/dt = k(F_2)(N_2F_4)^{\frac{1}{2}}$ and $k = 1.0 \times 10^{11.0 \pm 0.2} \exp(-200,400 \pm 400/RT)\ M^{-\frac{1}{2}}\ sec^{-1}$. It is proposed that $k = K^{\frac{1}{2}}k_2$ where K is the equilibrium constant for the dissociation of tetrafluorohydrazine and k_2 is the rate constant for the reaction $NF_2 + F_2 \rightarrow NF_3 + F$. (Contractor's abstract)

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Atlantic Research Corp. Kinetics and Combustion [Group] Alexandria, Va.

A NOVEL CHEMICAL SYSTEM FOR GENERATION OF ELECTRON RICH GASES, by R. Friedman and A. Macek. [1965] [26]p. incl. diagrs. tables, refs. (Also bound with its AFOSR-64-1291) (AF 49(638)651) Unclassified

Published in Tenth Symposium (Internat'l.) on Combustion, Cambridge (Gt. Brit.) (Aug. 17-21, 1964), Pittsburgh, Combustion Inst., 1965, p. 731-741.

A unique, self-oxidized combustion system, consisting initially of a solid mixture, is described which burns to yield an all-gas plasma containing over 10^{15} (measured) or 10^{16} (calculated) electrons cm^3 at atmospheric pressure. The ingredients are tetracyanoethylene, hexanitroethane, and cesium azide, formulated to be stoichometric to CO, N_2, and Cs. The mixture is compacted to 1.6 gm/cm^3 by pressing at 20,000 psi. The strand burning rate at 1 atm is 1.3 mm/sec and the pressure exponent is about 0.6. The flame temperature, calculated as 3660 K, was measured as 3520 K by the spectral-line-intensity method and 3000 -3100 K by the line-reversal method. In view of the radial nonuniformity of the plasma, the former value is considered more likely to be correct. Electron densities were determined both from measurements of individual spectral-line shapes (Stark-broadening) and by the Inglis-Teller series limit method. The two methods agreed with one another. Strands of 1.27-cm diam gave 3 or 4 times higher electron concentrations than strands of 0.79-cm diam; however, electron concentrations, while extremely high, were still below calculated values, even after the lowering of flame temperature below theoretical (because of heat loss) was considered. It is suggested that adequate time was available for cesium ionization, under the experimental conditions, but time was not adequate for complete oxidation of CN and CN^- to CO and N_2, so electrons were largely attacked as CN^- rather than free. Hence, longer residence times allowing a closer approach toward equilibrium should give even higher yields.

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Atlantic Research Corp. Kinetics and Combustion Group, Alexandria, Va.

RESEARCH ON THE DEFLAGRATION OF HIGH-ENERGY SOLID OXIDIZERS, by J. B. Levy, R. Friedman and others. Quarterly technical summary rept. no. 10, Sept. 1-Nov. 30, 1964. Jan. 19, 1965, 13p. incl. illus. diagrs. tables. (AFOSR-65-1278) (AF 49(638)1169) AD 465871 Unclassified

Further measurements of the rate of deflagration of pressed strands of hydrazine diperchlorate at elevated pressures have been made. The data are erratic. The effect of copper chromite catalyst on the deflagration of hydrazine diperchlorate at atmospheric pressure has been examined at a higher catalyst content. Flame temperatures have been calculated for 1, 10, and 100 atm pressure and are fairly constant at 1600°K. Attempts at measurement of the flame temperature by means of fine Pt-Pt, 10% Rh thermocouples have been unsuccessful—apparently because of catalysis by the metals of condensed phase reactions. Exploratory experiments have been performed with ammonium perchlorate, hydrazine perchlorate and hydrazine diperchlorate on the deflagration of spheres of these oxidizers at atmospheric pressure in fuel gas streams (Contractor's abstract)

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Atlantic Research Corp. Kinetics and Combustion Group, Alexandria, Va.

RESEARCH ON THE DEFLAGRATION OF HIGH-ENERGY SOLID OXIDIZERS, by J. B. Levy, G. von Elbe and others. Quarterly technical summary rept. no. 11, Dec. 1, 1946-Feb. 28, 1965. May 19, 1965 [18]p. incl. diagrs. tables. (AFOSR-65-1280) (AF 49(638)1169) AD 617272 Unclassified

Further experiments are performed in which the flame temperature above deflagrating hydrazine diperchlorate has been measured with fine thermocouples. Results are obtained with ceramic-coated Pt-Pt, 10% Rh thermocouples and with uncoated chromel-alumel thermocouples. A flame temperature of about 1350 K is indicated for an ambient pressure of about 20 atm. This is substantially below the theoretical flame temperature of about 1600 K. The thermal decomposition of hydrazine diperchlorate

has been investigated from 211-291 °C. Ammonium perchlorate has been found in the surface of a strand of hydrazine diperchlorate which had been ignited at an elevated pressure, allowed to deflagrate partially and extinguished by sudden pressure release. Deflagration rate measurements from 6-130 atm are reported for pressed hydrazine diperchlorate. (Contractor's abstract, modified)

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Atlantic Research Corp. Kinetics and Combustion Group, Alexandria, Va.

RESEARCH ON THE DEFLAGRATION OF HIGH-ENERGY SOLID OXIDIZERS, by J. B. Levy, G. von Elbe and others. Quarterly technical summary rept. no. 12, Mar. 1-May 31, 1965, 1965. Aug. 11, 1965, 10p. incl. diagrs. tables. (AFOSR-65-1615) (AF 49-(638)1169) AD 472633 Unclassified

The measurements of the flame temperature of deflagrating hydrazine diperchlorate using fine chromel-alumel thermocouples have been completed at 28 atm. A value of 1385 ± 35 °K was obtained. Experiments at 55 atm tentatively put the flame temperature at above 1500 °K at this pressure. Both temperatures are below the theoretical value of 1600 °K and indicate that thermodynamic equilibrium is not attained in the flame, although it may be at higher pressures. The temperature profile through the combustion wave was obtained for deflagration at 28 atm. The thickness of the preheat zone was measured as 550 ± 80 μ, and the thermal diffusivity was determined to be 0.0015 ± .0005 cm^2/sec, for HDP of 2.1 g/cc density. Further measurements of the deflagration rate were made as a function of pressure. (Contractor's abstract, modified)

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Atlantic Research Corp. Kinetics and Combustion Group, Alexandria, Va.

RESEARCH ON THE DEFLAGRATION OF HIGH-ENERGY SOLID OXIDIZERS, by J. B. Levy, G von Elbe,and others. Quarterly technical summary rept no. 13, June 1-Aug 31, 1965. Oct. 11, 1965, 10p. incl. diagrs. table. (AFOSR-65-2291) (AF 49(638)1169) AD 624533 Unclassified

The flame temperature of hydrazine diperchlorate was measured using fine chromel-alumel thermocouples. At 28 atm, the measured temperature was found to be ~ 200 °C below the calculated product gas temperature. The observed temperature increases with pressure, and at approximately 100 atm the theoretical value is attained The temperature profile through the preheat zone of the combustion wave was carefully measured at 18 atm. This was found to agree well with that predicted by theory if some variation of thermal diffusivity with temperature is assumed. The thermal profile at low pressure was found not to exhibit the character of that of a normal deflagration wave. This finding has shed considerable light on the nature of the process. Finally, quenching experiments were performed and these are discussed. (Contractor's abstract)

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Atlantic Research Corp. Kinetics and Combustion Group, Alexandria, Va.

RESEARCH ON THE DEFLAGRATION OF HIGH-ENERGY SOLID OXIDIZERS, by J. B. Levy, G. von Elbe and others. Final technical rept. June 1, 1962-Nov. 30, 1965, 55p. incl. diagrs. tables, refs. (AFOSR-66-0157) (AF 49(638)1169) AD 628035 Unclassified

The results of research on the deflagration of the solid-propellant oxidizers, hydrazine perchlorate (HP) and hydrazine diperchlorate (HDP), are reported and discussed. Each compound was found to be unique physically and chemically, in both its low-temperature thermal decomposition and its high-temperature deflagration behavior HP and HDP are white solids of crystal densities 1.939 and 2.21 g/cc, and melting points of 141 and 191 °C, respectively. The following aspects of the combustion process were studied: The deflagration rate as a function of pressure and the effects of catalysts; the flame temperature and the temperature profile through the combustion wave; quenching, thermal decomposition, and chemical behavior. In addition, vaporization rates of HP were measured.

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Austrian Atomic Energy Study Group. Dept. of Physics, Seibersdorf.

[DEFECT MODE IN A FACE CENTERED CUBIC LATTICE] Schwingungszustand eines Fremdatoms im kubisch flaechenzentrierten Gitter, by E. Balcar. [1965] [8]p. (AFOSR-66-1610) (AF 61(052)638) AD 638514 Unclassified

Also published in Acta Phys. Austriaca, v. 20: 325-331, 1965.

The substitution of an atom in a crystal by an atom which is lighter than the surrounding host atoms, gives rise to a localized defect mode of the lattice. To calculate the frequency of this mode a model of the crystal was assumed with general forces between nearest atoms and central forces between next nearest atoms. This model gives the dynamical matrix of the system which contains the symmetry of the face centered cubic crystal. A theoretical formula was developed to calculate the defect mode frequency by using the dynamical matrix. The resulting formula was applied to the calculation of the frequency of an isotope defect in a face centered cubic lattice (Ni in Pd) and compared with experimental results.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

CURRENT SHEET TILT IN A RADIAL MAGNETIC SHOCK TUBE, by R. B. Johansson. Sept. 1964 [20]p. incl. illus. diagrs. table. (Research rept. no. 189) (AF 49(638)659) AD 608147 Unclassified

Also published in Phys. Fluids, v 8· 866-871, May 1965.

This paper describes an experiment carried out in a radial (inverse pinch) shock tube with argon of 50-400 μ pressure and hydrogen of 100 μ pressure. The current sheet was found to be tilted so that the cathode side lagged the anode side. At the anode the shock has a tilt in the same direction as the current sheet. At the cathode the shock is normal. These phenomena can be correlated by physical models which assume that the current is predominantly carried by the ions. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

THE DIOCOTRON INSTABILITY IN A CYLINDRICAL GEOMETRY, by R. H. Levy. Dec. 1964 [21]p. incl. diagrs. table, refs. (Research rept. no. 202) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)659 and National Aeronautics and Space Administration) AD 609638 Unclassified

Also published in Phys. Fluids, v. 8 1288-1295, July 1965.

The diocotron (or slipping stream) instability of low density ($\omega_p \ll \omega_c$) electron beams in crossed fields is considered for a cylindrical geometry. For a simple density distribution, the normal modes of the electron beam correspond to a continuum of eigenvalues, plus 2 discrete eigenvalues. Work due to Case and Dikii appears to show that the continuous spectrum is not important in stability studies of this type. The condition for stability considering the discrete modes only is derived, under suitable geometrical and electrical conditions, it is shown that these modes can be stable. The analogy between the electromagnetic problem considered here and the problem of the stability of an ideal rotating fluid is discussed. It is shown that stability conditions derived for the latter problem depend on the possibility of axial perturbations, what this implies for the electron beam problem is briefly discussed. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

THE ELECTRON PLASMA EXPERIMENT THEORY AND APPLICATIONS, by R. H. Levy and G. S. Janes. June 1965 [18]p. incl. diagrs. refs. (Rept. no. AMP-160) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)659 and National Aeronautics and Space Administration) AD 473350 Unclassified

The basic concepts involved in the production and control of pure electron and electron rich plasmas are reviewed, with particular reference to the different geometries in which equilibrium may be achieved. An inductive method of establishing arbitrary equilibrium profiles is described. Recent theoretical work on the stability of some particularly simple equilibria is then discussed. Instabilities considered are the so-called diocotron (or slipping stream) instability, this instability (whose importance in magnetron work is well understood) is related to the Kelvin-Helmholtz instability in fluid mechanics and a new mode involving spontaneous coherent radiation into space as a result of bunching. This effect can be described as the flexible antenna instability. Both these instabilities are considered for low density electron beams. Two experiments are discussed. The object of the first is to produce a stable electron plasma in a simple geometry. The second is designed to test the practicability of the inductive charging scheme. A brief review of selected applications of the electron plasma is also given, these include space radiation shielding and certain high voltage laboratory devices. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab , Everett, Mass

OBSERVATIONS OF ANOMALOUS DIFFUSION IN EM-REGION PLASMA-ACCELERATION EXPERIMENTS (Abstract), by R. S. Lowder and G. S. Janes [1965] [1]p. [AF 49(638)659] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull Amer. Phys Soc , Series II, v. 10: 195, Feb. 25, 1965.

Anomalous electron diffusion has previously been reported in an annular geometry EM-region plasma accelerator, employing an axial electric field. In this device, the mean free path and ion gyro radius are large as compared to apparatus dimensions, while the Debye length and electron gyro radius are relatively small. The axial diffusion has been accounted for by observations of azimuthal density variations and measurements of phase-correlated azimuthal electric fields resulting from polarization along the density gradients. A broad, somewhat striated spoke rotating at 1 5 the E/B velocity in the E x B direction is observed. This nonuniformity may be due to an inherent nonuniform ionization of the neutral influx at the anode rather than to instabilities in the plasma itself. The spoke velocity also approximates the critical velocity commonly observed for ionization waves. Time fluctuations in density and in electric and magnetic fields can be correlated assuming adiabatic electron motions.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

PLASMA PROPULSION RESEARCH (Abstract), by G S. Janes. [1965] [2]p. (Bound with its AFOSR-65-1266, AD 622527) (AF 49(638)659) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

I. Collisionless Electron Heating Accompanying Anomalous Electron Diffusion in EM Region DC Accelerators. Electron diffusion can be accounted for by a

collisionless adiabatic transport process; however, neutral atoms leaving the anode are ionized by electron impact and the energy for this must be provided by some nonadiabatic electron heating process which must include both a source of energy and a means of conveying it to the electrons. The collisional ion-electron thermal relaxation process is very slow. However, ion acoustical waves have been observed, and the evidence suggests that this low frequency ion wave energy is transported to higher frequencies where it is absorbed by electrons at the electron cyclotron frequency. II. Single Component Plasma Research. The term "single component" is used to describe plasma conditions wherein the number density of electrons exceeds the number density of ions and neutrals to such an extent that the plasma motion is controlled by magnetic and collective electrostatic forces rather than by magnetic and collective inertial (or pressure) forces (i.e., $\epsilon_0 E^2/2 > nKT$ or ρv^2). DC experiments in cylindrical geometries indicate the possibility of producing these conditions inductively by injecting electrons tangentially into cylindrical (or torus) shaped systems with rising axial magnetic fields. If verified, this inductive pumping technique should result in the generation of large radial electrostatic fields.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

SINGLE-COMPONENT PLASMAS. I (Abstract), by R. H. Levy, G. S. Janes, and P. J. Gierasch. [1965] [1]p. [AF 49(638)659] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 238, Feb. 25, 1965.

It is possible to arrange, in special geometries, for a cloud of electrons not neutralized by the presence of ions to be confined in equilibrium under opposing magnetic and electric forces. The neutralizing positive charge is fixed on a single electrode external to the plasma. If the thermal pressure of the electron gas is less than the electrostatic pressure, the Debye length $(kT/4\pi n_e e^2)^{\frac{1}{2}}$ will be smaller than the over-all size of the cloud. Since collective effects are then possible, the cloud has some plasma properties even though it contains only a single component. The electric-field pressure is, in turn, smaller than the magnetic pressure by a factor that is roughly analogous to the β of a neutral plasma. An important feature of the single-component plasma is that the electric field, and hence also the E/B drift velocity, has strong spatial variations. The question of stability is considered for some simplified cases. An important distinction from neutral plasmas is that coherent radiation from the plasma will probably govern the over-all stability of any particular configuration.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

SINGLE-COMPONENT PLASMAS. II (Abstract), by G. S. Janes and R. H. Levy. [1965] [1]p. [AF 49(638)-659] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 238, Feb. 25, 1965

Single-component plasma conditions can be produced in magnetron or PIG-type apparatus operating under high-vacuum space-charge-limited conditions. The results of such experiments suggest that electron densities in excess of $10^{10}/cm^3$, containment times in excess of 10^{-5} sec, and values of $\omega\tau$ in excess of 10^4 have been obtained. These considerations suggest that it may also be possible to create single-component plasma conditions without the use of an initial dc high-voltage power supply by trapping electrons on magnetic-field lines and changing the total magnetic flux in the system, provided that the local electron-diffusion velocities do not exceed the magnetic compression rate. This inductive-pumping technique appears to have useful applications to radiation shielding in space and to plasma generation.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

EXPERIMENTAL AND THEORETICAL STUDY OF MAGNETOHYDRODYNAMIC IONIZING FRONTS, by R. M. Patrick and E. R. Pugh. [1965] [9]p. incl. illus. diagrs. refs. (AF 49(638)1129) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 195, Feb. 25, 1965.

Published in Phys. Fluids, v. 8: 636-655, Apr. 1965.

An experimental and theoretical description of ionization fronts propagating into hydrogen with a bias magnetic field in the plane of the front is presented. The experimental evidence showed that the absolute light intensity behind the front corresponds to a fully ionized plasma. The density ratio was obtained by measuring the magnitude of the current in the front, the front speed, and using the equation of mass and momentum. The front speeds are small compared to the Alfven velocity and are characterized by a critical velocity U_c, where U_c is the velocity a molecule must have so the kinetic energy equals the energy necessary to ionize it. A theory for the ionization front was developed which neglects the plasma pressure and abandons the condition $E = V \times B$ both ahead and behind the front. The theory predicts the front velocity and the rather unusual variation of the density ratio across the fronts with the front speed. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

PROPERTIES OF COLLISIONLESS PLASMAS (Abstract), by R. M. Patrick. [1965] [1]p. (Bound with its AFOSR-65-1266; AD 622527) (AF 49(638)1129) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

An experimental and theoretical description of ionization fronts propagating into hydrogen with a bias magnetic field in the plane of the front was carried out. Measurements of the absolute light intensity behind the front showed that the plasma was fully ionized. The front speeds were small compared to the Alfven speed ahead of the front, and were characterized by a critical velocity U_c, where U_c is the velocity a molecule must have so its kinetic energy equals the energy necessary to ionize it. A semi-empirical theory was developed for these fronts and predicted the front speed and the rather unusual variation of the density ratio across the fronts with front speed. Calculations based on work by Salpeter of the spectrum of Thomson scattering of a laser beam from typical laboratory plasmas were completed. Thomson scattering of a ruby laser beam by plasma electrons produced by strong magnetohydrodynamic shock waves in a MAST was observed. The intensity of the scattered radiation was equal to or greater than the radiation emitted by the shock heated hydrogen, and sufficient for time resolution of 10^{-8} seconds. The scattering results gave the velocity distributions of electrons and corroborated the previous measurements of shock speed, shock thickness, and plasma density.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

THOMSON-SCATTERING OBSERVATIONS FROM MHD SHOCK-HEATED PLASMAS (Abstract), by R. M. Patrick and E. T. Gerry. [1965] [1]p. [AF 49(638)-1129] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10-226, Feb. 25, 1965.

Thomson scattering of a ruby-laser beam by plasma electrons produced by strong MHD shock waves in a MAST has been observed. The laser beam was aligned parallel to the axis of the MAST; the 90° scattering was observed perpendicular to the direction of the shock propagation. The power of the "Q"-switched laser beam was between 3 and 30 mw, with pulse durations between 2×10^{-6} and 10^{-7} sec. The magnitude of the scattered radiation was equal to or greater than the radiation emitted by the shock-heated hydrogen and sufficient for time resolution of 10^{-8} sec. The scattering results gave the velocity distribution of the electrons, and corroborated the previous measurements of shock speed, shock thickness, and plasma density. The initial conditions ahead of the MHD shocks were hydrogen pressure between 40 and 100 μ Hg, B filed 3800 G; the conditions behind: plasma density $4\text{-}10 \times 10^{15}$ ions/cm^3, B filed 8000 G. Oscillograms showing both plasma radiation and Thomson scattering are shown. The measured velocity distribution for the plasma electrons is discussed.

100

Avco Corp. Avco-Everett Research Lab., Everett, Mass.

LABORATORY SIMULATION OF SOLAR WIND PHENOMENA, by R. M. Patrick and E. R. Pugh. Oct. 1965, 28p. incl. illus. diagrs. tables, refs. (Research rept. no. 234) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1483 and National Aeronautics and Space Administration) AD 622725 Unclassified

The IMP Satellite magnetic field measurements in the vicinity of the earth's magnetopause have shown that there is a standing shock between the earth's magnetic field and the solar wind, and a flow between the shock and the magnetosphere which is like a continuum flow. A theory which describes the boundary between this flow and the magnetosphere has been developed which shows that the diffusion of the magnetic field lines associated with the solar wind into the earth's magnetosphere can be much larger than previously expected. This has generated an interest in this Laboratory to build a facility which produces a steady flow of high conductivity, collision-free plasma with a characteristic flow dimension large compared to the ion gyro radii. A description of this facility and the design criteria will be given. The results of the calculation of the plasma flow in the field annihilation region between the solar wind and the magnetopause will be briefly reviewed, and the most recent experimental results obtained in the plasma wind tunnel facility will be given.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

ON A NEW TYPE OF ACCELERATOR FOR HEAVY IONS, by G. S. Janes, R. H. Levy and others. [1965] [101]p. incl illus. diagrs. refs. (Rept no. RR-235) (AF 49(638)1553) AD 475149 Unclassified

A new device (called HIPAC - Heavy Ion Plasma Accelerator) which may be capable of accelerating ions of any atomic number to energies sufficient to overcome the nuclear Coulomb barrier is described. A closed potential well is created by filling a toroidal vacuum chamber with electrons; the electrons are contained by a magnetic field whose intensity is so low that its effect on the ions can be neglected. Ions are both accelerated and trapped in the well, the trapping effect allows sufficient time for the ions to become highly stripped by electron impact. The very large ion energies that can be achieved in this way would allow a wide variety of nuclear

reactions to be studied, including inverse fission. The present primitive state of development of the HIPAC is described, and the future prospects assessed.

102

Avco Corp., Avco-Everett Research Lab., Everett, Mass.

PLASMA RADIATION SHIELDING, by R. H. Levy and S. Janes. Dec. 1965 [22]p. incl. diagrs table, illus (Rept. no. AMP-179) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1553 and National Aeronautics and Space Administration)
AD 476154 Unclassified

The principles of operation of the Plasma Radiation Shield are explained. The relationship between this device and others using crossed field electron beams (such as the microwave magnetron) is indicated.

103

Battelle Memorial Inst., Columbus, Ohio.

OSCILLATORY MAGNETIC PROPERTIES OF NEARLY FREE ELECTRONS, by M. L. Glasser. [1965] [2]p. incl. refs. (AFOSR-65-1372) (AF AFOSR-63-260) AD 621407 Unclassified

Also published in Phys. Ltrs., v. 15: 17-18, Mar. 1, 1965.

Theory interpreting oscillatory magnetic properties of metals is considered. It is suggested that a proper way to investigate the problem would be to calculate the oscillatory part of the free energy of a gas of Bloch electrons in a magnetic field, but this is a mathematically intractable problem. This investigation presents a simple model formulated on the basis of some approximations which permit a relatively straight forward analytic solution. The principal assumption is that the metal to be described is amenable to the weak pseudopotential approximation. The oscillatory free energy can be evaluated analytically if the potential is constant normal to and periodic along the uniform magnetic field.

104

Battelle Memorial Inst., Columbus, Ohio.

ENUMERATING NEAR NEIGHBORS, by V. E. Wood. [1965] [3]p. incl. diagrs. tables. (AFOSR-65-2568) (AF AFOSR-63-260) AD 626802 Unclassified

Also published in Amer. Jour. Phys., v. 33: 632-634, Aug. 1965.

An elementary method is described for enumerating near neighbors of an ion in a composite lattice where the ion positions are determined by symmetry. The method is illustrated by examples. (Contractor's abstract)

105

Battelle Memorial Inst., Columbus, Ohio.

ION-PAIRING BETWEEN LITHIUM AND THE RESIDUAL ACCEPTORS IN GaSb, by R. D. Baxter, R. T. Bate, and F. J. Reid. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-1186) (AF AFOSR-64-525) AD 620689 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 41-48, 1965.

The electrical properties of p-type GaSb containing lithium have been measured over the temperature range 20-400°K. It was found that introduction of lithium by diffusion at temperatures below 500° C results in reduced hole concentrations and increased Hall mobilities. In addition, the residual acceptor level at approx. 0.03 ev characteristic of pure material, apparently disappears and is replaced by a shallow acceptor level. This behavior is taken as evidence for the formation of ion pairs between lithium donors and doubly charged residual acceptors. Introduction of lithium by diffusion at 600° C and subsequent heat treatment at lower temperature results in the formation of a large density of holes ($>1 \times 10^{18}$ cm^{-3}) associated with a shallow level, suggesting the presence of substitutional lithium.

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Battelle Memorial Inst., Columbus, Ohio.

CONDUCTION ELECTRON SCATTERING BY IONIZED DONORS IN InSb AT 80°K, by R. T. Bate, R. D. Baxter and others. [1965] [10]p. incl. diagrs. refs. (AFOSR-65-2105) (AF AFOSR-64-525) AD 628437 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1205-1214, Aug. 1965.

Electron mobility data obtained from Hall effect and resistivity measurements at 80°K on samples of InSb containing 1×10^{15} to 3×10^{17} ionized donors per cc are reported and analyzed. The dominant scattering mechanism is that by ionized impurities, and theoretical results are corrected for electron-electron collisions and band nonparabolicity. The Kane model for the conduction band is employed, neglecting perturbations from bands other than the conduction and valence bands. The non-parabolic band shape is found to have a strong influence on the mobility at higher carrier concentrations. Approximate calculations are also made of the contribution of polar scattering as modified by the electron-electron collisions. Combination of the 2 mechanisms accounts fairly well for the observations measured as a function of impurity concentration.

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Battelle Memorial Inst., Columbus, Ohio

HIGH-MOBILITY LOW-MELTING-POINT GROUP III-V COMPOUND SEMICONDUCTORS, by A. C. Beer, R. D. Baxter, and F. J. Reid. Final technical rept. Oct. 31, 1965, 19p. incl. diagr. table, refs. (AFOSR-65-2531) (AF AFOSR-64-525) AD 624562 Unclassified

Research accomplishments summarized in the report include: (1) the reasonably conclusive identification of the residual defect in GaSb as a type of antistructure, e.g., Ga atoms in Sb sites, (2) the development of special techniques which enabled preparation of GaSb crystals having an order of magnitude lower concentration of the residual acceptors, with large increases in the hole mobility, (3) the achievement of relatively uncompensated n-type crystals of GaSb exhibiting a room-temperature mobility of 6300 cm^2/volt-sec—a value substantially larger than has been reported elsewhere, (4) the elucidation of scattering mechanisms in the above n-type material, which illustrated the importance of effects arising from the subsidiary conduction band, including screening of the Coulomb interaction; and (5) the analysis of electron scattering in moderately-doped InSb, which revealed the influence of electron-electron interactions and the nonparabolicity of the conduction band.

108

Battelle Memorial Inst., Columbus, Ohio.

SOLUBILITY AND ELECTRICAL BEHAVIOR OF Li IN N-TYPE GaSb (Abstract), by R. D. Baxter and F. J. Reid [1965] [1]p. [AF AFOSR-64-525]
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, June 23-24, 1965.

Published in Bull. Amer. Phys. Soc. Series II, v. 10 599, June 1965.

When diffused into n-type GaSb containing Te donors, lithium enters the lattice both interstitially and substitutionally, the dominant species being determined by the diffusion temperature. Diffusion of Li at 400°C results in increased electron concentrations and in Hall mobilities, which at 77°K are more than 50% higher than for samples with comparable electron concentrations but without added lithium. Diffusion at temperatures above 500 C, however, produces p-type GaSb characterized by a shallow acceptor level. The 400°C results are discussed in terms of a lithium-donor/residual-acceptor interaction, which was postulated to describe results of previous investigations into effects of lithium on electrical properties of p-type GaSb. Results of the higher-temperature diffusions are identical to those obtained on p-type GaSb and similar to those described by Fuller for Li in GaAs, in which the shallow acceptors are identified as Li^+Li^- self-pairs. Spectrographic determinations of total lithium solubility as functions of temperature and initial carrier concentration are presented and compared with electrical data.

109

Battelle Memorial Inst , Columbus, Ohio.

LASER-INDUCED THERMIONIC EMISSION AND FROM TANTALUM, by C. M. Verber and A. H. Adelman. [1965] [4]p. incl. diagrs. (AF AFOSR-64-640)
Unclassified

Published in Jour. Appl. Phys., v. 36 1522-1525, May 1965

The induced thermionic emission of electrons from tantalum as the result of bombardment with laser beams of up to 10^5-W/cm^2 peak power density as a function of the tantalum temperature has been measured. It is shown that within the power range investigated, the results can be described in detail as thermionic emission resulting from a temperature increase which is calculable from classical heat-transfer theory.

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Battelle Memorial Inst., Columbus, Ohio.

ON THE POTENTIAL OF IONIZED IMPURITIES IN SOLIDS (Abstract), by I. Adawi. [1965] [1]p. [AF AFOSR-64-640]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 302, Mar. 24, 1965.

A self-consistent approach is used to discuss the potential of ionized impurities in solids in which the conduction electrons are treated as a free electron gas of arbitrary degeneracy. A perturbation series is written down explicitly to all orders in the potential Φ. The linear term in Φ— which gives the same results obtained by Takimoto, Langer, and Vosko and by March and Murray—can be obtained from the dielectric treatment of Lindhard, and hence one can include the polarization of the core electrons. The screening charge density in metals and the Friedel oscillations are discussed. For a slowly varying potential, the perturbation series can be summed and one obtains the Thomas-Fermi equation. Corrections to the linearized Thomas-Fermi equation are discussed. These terms improve only the asymptotic behavior of the potential and lead to difficulties if extended to the origin. However, the first correction to the mobility is quite small in general, as can be established in the Born approximation.

111

Bell Aerosystems Corp., Buffalo, N. Y.

THERMAL RADIATION OF HIGH-TEMPERATURE COMBUSTION PRODUCTS, by T. G. Rossmann and L. M. Wood. Final technical rept. Dec. 2, 1963-Dec. 31, 1964. Feb. 1965, 40p. incl. illus. diagrs. (Rept. no. 9139-933002) (AFOSR-65-0431) (AF 49(638)1287) AD 612698
Unclassified

The purpose of this program is to amplify the scarce existing information concerning those physical properties of gases which determine their thermal radiation, especially at high temperatures and pressures. The experimental approach consists in determining directly, by means of emission radiometry and spectroradiometry, the magnitude and spectral distribution of the thermal radiation. These measurements will be conducted on gases which appear as or at least are contained in the combustion products of actual combustors, e.g. rocket combustion chambers, and will extend over ranges of temperature, pressure and radiating path lengths as close as possible to the ranges encountered in practice in such combustors. This information will enable the designer to predict, with greatly improved accuracy, the radiant heat flux from the combustion gases to the walls of the combustor.

112

Bell Aerosystems Corp., Buffalo, N. Y.

A UNIFYING MATHEMATICAL THEORY FOR TRAINING LEARNING NETS, by J. G. Goerner, L. A. Gerhardt, and F. D. Powell. Oct. 29, 1965, 97p. incl. diagrs. tables, refs. (Rept. no. 9500-920032) (AFOSR-65-2710) (AF 49(638)1449) AD 627908
Unclassified

This report analyzes the deterministic approaches which have been applied to the description of neural net configurations and their training algorithms which employ a single layer of trainable gain elements and partition the input space by hyperplanes. The nets are described by n-dimensional geometric vector methods. A general algorithm is developed based on gradient or steepest-descent methods for optimizing a system given a quadratic index of performance. Reductions of this algorithm to the two basic classes of (a) error correcting and (b) forced learning algorithms as special cases are considered. Effects are discussed of component imperfections such as saturation, nonlinear adaption rates, hysteresis, and component failure. Examination of advantages and disadvantages of the various algorithms indicate that the error correcting algorithm and its modified forms have the following areas of superiority: (1) capability in separating separable classes, (2) ability to form least-mean-square error for non-separable classes, (3) minimum magnitude gain vector, and (4) relative insensitivity to component imperfections. The forced learning algorithms respond to the relative frequency of the input classes. Where this sensitivity is important, the forced learning algorithm may be superior.

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Bell Aerosystems Corp., Buffalo, N. Y.

THE APPLICATION OF ERROR CORRECTING LEARNING MACHINES TO LINEAR DYNAMIC SYSTEMS, by J. G. Goerner, L. A. Gerhardt, and F. D. Powell. [1965] [6]p. incl. diagrs. (AFOSR-66-0012) (AF 49(638)-1449) AD 632184 Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill., Oct. 25-27, 1965.

Also published in Proc. Nat'l. Electronics Conf., v. 21, 541-546, 1965.

It is shown that a learning machine with orderly structure and deterministic training can model an unknown linear plant and/or find the plant's inverse to the extent physically realizable with least-mean-squared-error performance. Use of these properties to solve problems involving complex least-mean-square performance indices is demonstrated and a general algorithm for deterministic search for LMSE performance is described. (Contractor's abstract)

114

Biot, M. A., New York.

MECHANICS OF INCREMENTAL DEFORMATIONS, by M. A. Biot. New York, Wiley and Sons. 1965, 504p. incl. diagrs. refs. (AFOSR-65-0551) (AF 49(638)1329) Unclassified

A new approach to non-linear elasticity and viscoelasticity is presented which is characterized by the use of cartesian concepts and elementary mathematical methods and by the explicit introduction of a local rotation field in the 3-dimensional equations. The theory provides general and rigorous equations governing the dynamics and stability of solids and fluids under initial stress. It does not require that the medium be elastic or isotropic, and it is applicable to anisotropic, plastic, and viscoelastic media.

115

Birmingham U., Dept. of Chemistry (Gt. Brit.).

MICROWAVE SPECTROSCOPIC STUDIES OF MOLECULES, by J. Sheridan. Jan. 31, 1965, 11p. incl. tables. (Scientific rept. no. 3) (AFOSR-65-1687) (AF EOAR-62-1) AD 625407 Unclassified

Detailed spectroscopic studies are summarized for acetyl acetylene and trifluoroethylene. For the first of these, assignments and barrier-heights were found for 3 isotopic forms and very consistent results derived. For trifluoroethylene, an exhaustive study of vibrationally excited molecules was made, leading to identification of spectra for carbon-13 species in natural concentration. When these were combined with data for the deuterated species, all possible microwave structural information for the molecule was derived. Dipole moment studies of these substances are also reported with preliminary work on other molecules. Computational procedures in spectral analysis were developed.

116

Birmingham U. Dept. of Chemistry (Gt. Brit.).

PREPARATION OF THIAZYL FLUORIDES, by B. Cohen, T. R. Hooper and others. [1965] [2]p. (AFOSR-65-2184) [AF EOAR-63-96] AD 627198 Unclassified

Also published in Nature, v. 207 748-749, Aug. 14, 1965.

Observations were made of the action of several liquid and gaseous fluorides on sulphur nitride, and also the reaction of sulphur tetrafluoride with ammonia. The fluorides examined were: selenium tetrafluoride, iodine pentafluoride, sulphur tetrafluoride, antimony pentafluoride, and vanadium pentafluoride. The temperatures at which the reactions occur and the products formed (particularly thiazyl fluoride) are given. It is noted that sulphur tetrafluoride reacts with ammonia at -95°C to yield sulphur tetranitride and at 25°C to yield thiazyl fluoride.

117

Bolt, Beranek and Newman, Inc., Cambridge, Mass.

EVOKED POTENTIALS IN AUDITORY CORTEX AFTER BILATERAL TRANSECTION OF THE BRACHIUM OF THE INFERIOR COLLICULUS IN THE CAT, by P. C Nieder and N. L. Strominger. [1965] [10]p. incl illus refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1142 and Office of Naval Research) Unclassified

Published in Jour. Neurophysiol., v 28 1185-1194, Nov. 1965.

In a series of 6 cats, transcortical electrodes were chronically implanted in auditory cortex. The effects of sectioning the brachium of the inferior colliculus upon cortical potentials elicited by acoustic stimuli were studied in unanesthetized animals and in animals anesthetized with barbiturates. Complete transection of the brachium of the inferior colliculus abolished evoked potentials in auditory cortex under both of these conditions.

118

Boston U. Dept. of Physics, Mass.

SMALL-PARAMETER EXPANSIONS OF LINEAR BOLTZMANN COLLISION OPERATORS, by H. Akama and A. Siegel. [1965] [27]p. incl. diagrs. refs. (AFOSR-66-1587) (AF AFOSR-62-177) AD 640227 Unclassified

Also published in Physica, v. 31 1493-1519, 1965.

An important problem in the study of irreversible processes is the approximation of the linear Boltzmann operator by the Fokker-Planck operator or, when this is insufficient, by still further terms. The first attempt at a solution of this problem was the Kramers-Moyal expansion. Van Kampen and Siegel have reformulated this expansion with the aim of systematizing terms according to order of magnitude. Very few studies have been made of this problem in the multidimensional case, particularly collision processes. The present paper derives a new and greatly simplified formula for the coefficients of the Kramers-Moyal series in collision processes. This is applied to Siegel's order-of-magnitude rearrangement ("CD expansion"), which is found to have the required property at least in the case of power-law molecular interactions. Finally, a new stochastic model, related to the theory of collision processes is presented for the sake of its mathematical interest and simplicity. (Contractor's abstract)

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Boston U. Dept. of Physics, Mass.

COVARIANT MERGING OF SPIN AND UNITARY SPIN, by P. Roman and J. J. Aghassi. [1965] [3]p. incl. table, refs. (AFOSR-65-0824) (AF AFOSR-63-385) AD 616207 Unclassified

Also published in Phys. Ltrs., v. 14: 68-70, Jan. 1, 1965.

Previous progress toward the unification of internal and external symmetries is considered, and it is pointed out that the lack of covariance is the main difficulty in the scheme. A possible covariant generalization is proposed which is based on the observation that the inhomogeneous Lorentz group, including reflections, I_4, can be be considered as the limit of a deSitter group whose group space is embedded in a flat 5-dimensional space-time, becoming the 4-surface of a sphere with $R \to \infty$. The Lie ring of this O_5 group can be constructed by considering its fundamental 4-component spinor representation, the generators of which are composed of 2 independent sets of 2 x 2 Pauli matrices

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Boston U. Dept. of Physics, Mass.

A NOTE ON FIELD THEORIES WITHOUT MASS RENORMALIZATION, by W. S. Hellman and P. Roman. [1965] [3]p. (AFOSR-65-1813) (AF AFOSR-63-385) AD 625559 Unclassified

Also published in Nuovo Cimento, Series X, v. 37: 779-781, May 16, 1965.

It has been formerly conjectured by Olesen that a field theory in which no mass renormalization is necessary yields an S-matrix equal to unity. In this paper a counter-example is presented to the field theory constructed to illustrate the above conjecture. The model considered is that of a neutral pseudoscalar boson gradiently coupled to the Dirac field. It is found that the theory is not constrained to be equivalent to a free-field theory. The results indicate that a spinless pseudoscalar boson with zero bare mass must be excluded from the domain of Olesen's theorem. One of the conditions of the field theory can, however, be restated to take in account the example.

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Boston U. Dept. of Physics, Mass.

MASS FORMULA IN THE COVARIANT SPIN-UNITARY SPIN SCHEME, by P. Roman and J. J. Aghassi. [1965] [4]p. incl. tables. (AFOSR-65-1814) (AF AFOSR-63-385) AD 625561 Unclassified

Also published in Nuovo Cimento, Series X, v. 36: 1062-1065, Apr. 1, 1965.

A mass formula is developed to give insight into the covariant spin-unitary spin scheme. The full symmetry group $SV_{12} \otimes U_1^B$, where U_1^B is the baryon gauge group, is decomposed to relinquish $m^2 = (A_1 + B_1 s_2) + (A_2 + B_2 s_2) \mathcal{A}_2 + (A_3 + B_3 s_2)[T(T+1) - Y^2/4] + (A_4 + B_4 s_2)BY$. This formula is applied for the baryon supermultiplet 364 and the meson supermultiplet 143 to obtain the baryon and boson masses.

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Boston U. Dept. of Physics, Mass.

D F RATIOS AND BARYON MAGNETIC MOMENTS IN THE SV_{12} SCHEME, by P Roman and J. J Aghassi. [1965] [4]p incl table (AFOSR-65-1869) (AF AFOSR-63-385) AD 626513 Unclassified

Also published in Nuovo Cimento, Series X, v 38 1092-1095, July 16, 1965

Some dynamical predictions are calculated for the baryon meson vertices in the SV_{12} symmetry scheme Breaking down SV_{12} into $SU_3 \times O_5$ and noting that the algebra of O_5 is locally isomorphic with that of SP_4, the

equation for the (8, 4) baryon current is formulated. Solving this equation, the D/F ratio for the $\bar{B}NM$ vertex is determined to be 4:2. The baryon magnetic moments are calculated and, invoking the usual SU_3 identifications, are presented in arbitrary units. The results are compared to SU_6 theory, and though there is considerable agreement, a value of -1.62 is obtained for $\mu(p)/\mu(n)$ which disagrees with both the SU_6 prediction and the even smaller experimental values. Thus it is concluded that though the scheme yields an excellent classification of states and an accurate mass formula, it probably is not accurate for grasping intricate features of dynamics at high energy.

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Boston U. Dept. of Physics, Mass.

ELECTROMAGNETIC MASS CORRECTIONS IN THE COVARIANT SV_{12} SCHEME, by P. Roman and J. J. Aghassi. [1965] [4]p. incl. tables. (AFOSR-65-1870) (AF AFOSR-63-385) AD 626512 Unclassified

Also published in Nuovo Cimento, Series X, v. 37: 354-357, May 1, 1965.

Electromagnetic effects are considered in the SV_{12} symmetry scheme, a covariant merging of space-time and SU_3 symmetries within a framework which uses the deSitter group for a background. The electromagnetic mass-splitting operator is taken, to transform as the charge operator Q and it is convenient to evaluate this by using the U-spin formalism. The complete mass formula is obtained and its constants determined for the 143 and 364 baryon supermultiplets. Electromagnetic sum rules are discussed. The principal result is that electromagnetic mass splittings can be related in different spin submultiplets.

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Boston U. Dept. of Physics, Mass.

MACH'S PRINCIPLE, BARYON CONSERVATION AND BARYON MASS, by P. Roman. [1965] [17]p. incl. refs. (AFOSR-65-1871) (AF AFOSR-63-385) AD 626780 Unclassified

Also published in Nuovo Cimento, Series X, v. 37: 396-412, May 16, 1965.

Mach's principle is viewed as being incorporated into relativity by means of Dicke's scalar field theory. The assumption is made, however, that the scalar field interacts only with baryonic matter. It follows that the baryon current obeys an equation of continuity. By adopting the steady-state model of the universe, the baryon mass becomes determined by the scalar field. Thus, both baryon conservation and the origin of the baryon mass can be regarded as a consequence of Mach's principle. In order to ensure the unrestricted validity of the equivalence principle, one must allow for a pressure in the matter fields. Various cosmological consequences are discussed. (Contractor's abstract)

125

Boston U. Dept. of Physics, Mass.

A SHARPENING OF O'RAIFEARTAIGH'S THEOREM, by P. Roman and C. J. Koh. [1965] [2]p. (AFOSR-65-2800) (AF AFOSR-63-385) AD 627623 Unclassified

Also published in Nuovo Cimento, Series X, v. 39: 1015-1016, Oct. 1, 1965.

Proof is given of the theorem that: In any irreducible representation of a group G, the operator p^2 cannot have more than 1 eigenvalue.

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Boston U. [Dept. of Physics] Mass.

COVARIANT UNIFICATION OF SPACE-TIME AND SU_3 SYMMETRY (Abstract), by P. Roman and J. J. Aghassi. [1965] [1]p. [AF AFOSR-63-385] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 430, Apr. 26, 1965.

Three quarks spanning the fundamental spinor representation of the deSitter group are taken to define the noncompact SV_{12} group. Mesons and baryons are constructed as 2- and 3-fold products. Reducing these according to $L_5 \times SU_3$, one obtains for mesons the 0^- and 1^- octets and the 0^- and 1^- singlet; for baryons, one gets the $1/2^+$ octet, $3/2^+$ decuplet, $1/2^+$ singlet, and the $3/2^-$ octet. A mass formula, including also electromagnetic effects is derived. It gives interesting intermultiplet relations and good numerical fits. Further dynamical consequences of the scheme are discussed.

127

Boston U. [Dept. of Physics] Mass.

SYMBOLIC CALCULUS OF THE WIENER PROCESS AND WIENER-HERMITE FUNCTIONALS, by T. Imamura, W. C. Meecham, and A. Siegel. [1965] [12]p. incl. refs. (AFOSR-65-2121) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-557] and Office of Naval Research) AD 622659 Unclassified

Also published in Jour. Math. Phys., v. 6: 695-706, May 1965.

A new definition is given for the 'ideal random function' (derivative of the Wiener function), which separates out infinite factors by fullest exploitation of the possibilities of the Dirac delta function. By allowing all integrals to be written formally as sums, this facilitates the definition and manipulation of the Wiener-Hermite functionals, especially for vector random processes of

multiple argument. Expansion of a random function in Wiener-Hermite functionals is discussed. An expression is derived for the expectation value of the product of any number of Wiener-Hermite functionals; this is all that is needed in principle to obtain full statistical information from the Wiener-Hermite functional expansion of a random function. The method is illustrated by the calculation of the first correction to the flatness factor (measure of Gaussianity) of a nearly-Gaussian random function. (Contractor's abstract)

128

Boston U. [Dept. of Physics] Mass.

WIENER-HERMITE EXPANSION IN MODEL TURBULENCE IN THE LATE DECAY STAGE, by A. Siegel, T. Imamura, and W. C. Meecham. [1965] [15]p. incl. tables, refs. (AFOSR-65-2122) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-557] and Office of Naval Research) AD 622660 Unclassified

Also published in Jour. Math. Phys., v. 6: 707-721, May 1965.

The Wiener-Hermite functional expansion, which is the expansion of a random function about a Gaussian function, is substituted into the Burgers 1-dimensional model equation of turbulence. The result is a hierarchy of equations which (along with initial conditions) determine the kernel functions which play the role of expansion coefficients in the series. Initial conditions are postulated, based on physical reasoning, criteria of simplicity, and the assumption that the series is to represent the late decay stage (in which the Gaussian correction is small and also decreasing with time). These are shown to justify an iterative solution to the equations. The first correction to the Gaussian approximation is calculated. This is then tested by evaluating the correction to the flatness factor, which for an exactly Gaussian function has the value 3, but which has been found by experiment (in real 3-dimensional fluids, of course) to have a value which deviates from the Gaussian value increasingly rapidly with the order of the derivative. This effect is utilized as a test of the inherent ability of the Wiener-Hermite expansion to bring to realization the physical properties implicit in the Navier-Stokes or Burgers equations. The various contributions to the flatness-factor deviation, when computed, do show a potential capability of providing a theoretical basis for the effect. (Contractor's abstract)

129

Boston U., Dept. of Physics, Mass.

PARAMETER OF DISCONTINUITY AND DIFFERENTIAL-OPERATOR EXPANSION OF THE LINEAR BOLTZMANN OR MASTER OPERATOR, by A. Siegel and H. Akama. [1965] [19]p. incl. diagrs. refs. (AFOSR-66-0385) (AF AFOSR-64-557) AD 629805 Unclassified

Also published in Phys. Fluids, v. 8: 1218-1236, July 1965.

The ratio of the average microscopic agitation interval to the macroscopic relaxation time is proposed as the expansion parameter of linear Boltzmann or master operators. This parameter is interpretable physically both as a measure of the discontinuity of the random process, and as an inverse measure of the size of the fluctuating system. In the limit when the expansion parameter is zero, the process becomes continuous and is described by the Fokker-Planck equation. When the parameter is nonvanishing, the expansion of the master operator in terms of it is, in three representative cases, a 'CD expansion' in products of creation and destruction operators for Hermite functions; the dominant term is usually the Fokker-Planck operator. These results are considered in relation to van Kampen's hypothesis for small-parameter expansions of the same operators. It is found that the CD expansion fits the available model processes exactly, and that these processes do not satisfy van Kampen's hypothesis. As a new application, the explicit CD series is given for the density fluctuation model. Special cases of the model include the density fluctuations studied by van Kampen and the Ehrenfest urn model. (Contractor's abstract)

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Boston U. [Dept. of Physics] Mass.

PROPAGATOR EXPANSIONS OF THE LINEAR BOLTZMANN OR MASTER OPERATOR (Abstract), by I. Kohlberg and A. Siegel. [1965] [1]p. [AF AFOSR-64-557] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 530, Apr. 26, 1965.

The linear Boltzmann or Master operator can usually be expanded as the sum of the Fokker-Planck operator—CD/Λ and the series $(\lambda/\Lambda)^s \sum_{l=1}^{s} b_{sl} C^{s-l+1} D^l$, where λ/Λ is the ratio of the microscopic fluctuation time to the macroscopic relaxation time and C and D are creation and destruction operators on the distributed variable y. Introducing $\Lambda = (t/\lambda)$ = number of collisions and $T = (t/\Lambda)$ = dimensionless relaxation time leads to the following propagator expansion of the linear Boltzmann operator: $P(y, T, N) = \exp(-x^2/2)/\{2\pi[1-\exp(-2T)]\}^{1/2} + \Sigma (1/N)^m P_m(x)$ where $x = [y - y_0 \exp(-T)]/[1-\exp(-2T)]^{1/2}$. It has been proved that every $P_m(x)$ can be written in closed form, expressed as a finite sum of hermite functions of x. The expression for P(y, T, N) then embodies a theorem of central-limit type but for nonindependent increments, because we observe that the Gaussian Uhlenbeck-Ornstein function is achieved as the number of collisions becomes infinite. The result is a generalization of the additive-process Edgeworth series to this nonadditive case.

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Brandeis U. [Dept. of Biochemistry] Waltham, Mass.

EFFECT OF PHOSPHORYLATED COMPOUNDS AND INHIBITORS ON CO_2 FIXATION BY INTACT SPINACH CHLOROPLASTS, by E. S. Bamberger and M. Gibbs. [1965] [7]p. (AFOSR-65-2959) (AF 49(638)798) AD 628270 Unclassified

Also published in Plant Physiol., v. 40: 919-926. Sept. 1965.

The effect of some phosphorylated compounds principally sugar phosphates and the inhibitors, arsenite and iodoacetamide, upon CO_2 fixation by intact spinach chloroplasts under anaerobic conditions was studied. Ribulose-1,5-diphospnate, fructose-1,6-diphosphate, ribose-5-phosphate, glyceraldehyde-3-phosphate, dihydroxyacetone phosphate and glycerate-3-phosphate enhance the rate, sedoheptulose-7-phosphate and -1,7-diphosphate inhibit, erythrose-4-phosphate, glycolaldehyde phosphate, L-α-glycerol phosphate and phosphoenolpyruvate have no effect while fructose-6-phosphate and glucose-6-phosphate yield inconclusive results. The phosphorylated compounds affect CO_2 fixation by filling up the pools of the photosynthetic carbon cycle depleted during isolation of the chloroplast. Inhibition of CO_2 fixation by iodoacetamide and arsenite is relieved by the compounds which enhance fixation. Light also protects against inhibition of CO_2 fixation by iodoacetamide and arsenite. (Contractor's abstract)

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Brandeis U. Dept. of Biochemistry, Waltham, Mass.

CREATINE KINASE: EVIDENCE FOR A DIMERIC STRUCTURE, by D. M. Dawson, H. M. Eppenberger, and N. O. Kaplan. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-1128) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-732, American Cancer Society, and National Institutes of Health) AD 641142 Unclassified

Also published in Biochem. and Biophys. Research Commun., v. 21: 346-353, Nov. 22, 1965.

The findings presented here indicate that creatine kinase is an enzyme whose structure is that of a dimer, as suggested by Eppenberger et al (1964) and Thomson et al (1964). The muscle enzyme may be composed of two identical subunits (M-M), the brain enzyme of two identical but different subunits (B-B), and the hybrid molecule of two subunits, one of either kind (M-B). The hybrid enzyme, whether it occurs naturally or is formed in vitro, is intermediate in kinetic qualities and in electrophoretic mobility between the two parental or unmixed forms. Hence, the nature of the multiple forms of creatine kinase resembles that found with the lactic dehydrogenases in that a hybrid enzyme occurs in vivo.

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Brandeis U., Dept. of Chemistry, Waltham, Mass.

PHOTOINITIATION OF UNIMOLECULAR REACTIONS. THE PHOTOLYSIS OF 2,3-DIAZABICYCLO [2.2.1] HEPT-2-ENE, by T. F. Thomas and C. Steel. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-66-0592) (AF AFOSR-64-583) AD 632738 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87. 5290-5293, Dec. 5, 1965.

The gas-phase photolysis of [2,3-diazabicyclo [2.2.1] hept-2-ene (I) with 337 mμ light has been investigated in the pressure range 10-1000μ. The variation in the yields of hydrocarbon products, bicyclo [2.1.0] pentane (II), cyclopentene (III), and 1,3-cyclopentadiene (IV), with pressure is consistent with the initial formation of "hot" II which can either be deactivated or isomerized to "hot" III. The latter can either undergo unimolecular decomposition to yield IV or be deactivated. Changing the wave length of irradiation from 313 to 334 mμ changed the relative yields of the products in a manner consistent with this "hot" molecule mechanism. (Contractor's abstract)

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Brandeis U. Dept. of Chemistry, Waltham, Mass.

PHOTOCHEMISTRY OF AZO COMPOUND AND STUDIES IN UNIMOLECULAR REACTIONS, by C. Steel. Final scientific rept. Jan. 1, 1964-Dec. 31, 1965 [34]p. incl. diagrs. tables, refs. (AFOSR-66-0930) (AF AFOSR-64-583) AD 633969 Unclassified

The photochemistry of cyclic azo compounds has been investigated. The effects of pressure and of wavelength on the unimolecular rate constants for the reactions of the various vibrationally excited molecules formed as a result of photodissociation have been determined and the results compared with theoretical models. The efficiencies of various molecules in transferring energy from the vibrationally excited molecules have also been studied. Fluorescence emission and excitation spectra of 2,3-diazobicyclo(2,2,1)-2 heptene and 2,3-diazobicyclo(2,2,2)-2 octene are reported and the fluorescence and decomposition quantum yields given.

135

Brandeis U. [Dept. of Physics] Waltham, Mass.

SPATIALLY INHOMOGENEOUS STATES OF MANY-BODY SYSTEMS, by M. Eger and E. P. Gross. [1965] [1]p. (AF AFOSR-63-176) Unclassified

Published in Jour. Math. Phys., v. 6: 891-901, June 1965.

To treat many-body systems in the presence of a static potential or problems of highly collective spatially inhomogeneous motions such as vortex lines, wavefunctions of a type $\Psi = \prod_{i}^{N} g(X_i)\Phi(X_1, \cdots, X_N)$ have been

proposed. Here Φ is the exact ground state of the homogeneous system and g(x) is a 1-particle state introduced to describe the effect of the spatial inhomogeneity. However, to determine g(x) by the variation principle, one needs to know the spatial correlation functions of all orders for the homogeneous many-body system. It is shown that the method of point transformations allows one to work with qualitatively similar but different states. The description of the system in the presence of a static impurity or of a state representing a vortex line in liquid helium requires a knowledge of only the average kinetic energy and x-ray scattering factor for homogeneous liquid helium. Both of these are available from experiments. The treatment of a recoiling impurity atom, strictly speaking, requires a knowledge of the current correlation tensor for the ground state of the homogeneous many-body system. This term vanishes in the Hartree limit of the theory for bosons. (Contractor's abstract)

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Brandeis U. [Dept. of Physics] Waltham, Mass.

IGNORABLE COORDINATES AND STEADY MOTION IN CLASSICAL MECHANICS, by C. W. Kilmister and F. A. E. Pirani. [1965] [12]p. (AFOSR-65-0821) (AF AFOSR-63-368) AD 616200 Unclassified

Also published in Proc. Cambridge Philos. Soc., v. 61: 211-222, 1965.

It is shown, for a classical dynamical system with a Lagrangian that the existence of an ignorable coordinate is equivalent to the vanishing of a certain Lie derivative. On this covariant description is based a new definition of steady motion. A definition given earlier by Synge is criticized. (Contractor's abstract)

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Brandeis U. Dept. of Physics, Waltham, Mass.

SPONTANEOUS SYMMETRY BREAKDOWN AND THE μ-e-γ INTERACTION, by R. Arnowitt and S. Deser. [1965] [12]p. incl. refs. (AFOSR-65-1787) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-368] and National Science Foundation) AD 625563 Unclassified

Also published in Phys. Rev., v. 138: B712-B723, May 10, 1965.

Spontaneous breakdowns of symmetries are examined for the electromagnetic interactions of the muon-electron system. Upon arranging the 2 fields into an isotopic doublet the Lagrangian is seen to possess SU(2) symmetry. Three possibilities are available: (a) no spontaneous breakdown of the SU(2) symmetry is allowed and the muon-electron system remains a degenerate doublet; (b) a partial breakdown occurs in which a mass splitting develops but the heavier muon remains stable, (c) a complete breakdown occurs in which the muon decays into an electron plus a photon. Using the high-energy scheme of Baker, Johnson, and Willey, approximate solutions for the one-fermion Green's function and vertex function are examined. The solutions obtained permit case (b) to occur but not case (c), provided improper Lorentz invariance is imposed. It is shown, at least for the one-fermion Green's function, that no solutions breaking P, C, or T invariance can arise.

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Brandeis U. Dept. of Physics, Waltham, Mass.

MINIMUM SIZE OF DENSE SOURCE DISTRIBUTIONS IN GENERAL RELATIVITY, by R. Arnowitt, S. Deser, and C. W. Misner. [1965] [20]p. incl. diagrs. (AFOSR-66-0437) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-368 and National Science Foundation) AD 630322 Unclassified

Also published in Ann. Phys., v. 33. 88-107, June 1965.

The properties of very dense sources of the gravitational field are examined. The sources are spherically symmetric initially static distributions of neutral or charged dust, treated as dynamical systems with no phenomenological pressure term. The exterior Schwarzschild solution is analyzed from this point of view as generated by a realistic 'bare' matter stress-tensor with appropriate initial Cauchy data. A coordinate frame is introduced in which the radial coordinate coincides with the invariant distance, and the initial value equations are solved in this frame. The systems considered become, in the limit, models for neutral and charged particles, and so provide solutions for the problems of interaction between 'point' particles and the gravitational field. It is shown that, at the instant of time symmetry, there is a minimum invariant extension for a particle, below which no solution of the field equations exists; this fact emerges especially clearly in the invariant radial frame used. The clothed (or exterior) mass and invariant properties of the interacting systems as a function of the bare mass charge, and extension are given. The results are in agreement with those obtained previously in another frame, in terms of whose radial coordinate the particle had vanishing extension in the limit. (Contractor's abstract)

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Brandeis U. Dept. of Physics, Waltham, Mass.

SOME PROPERTIES OF THE QUANTUM LINEARIZED EINSTEIN FIELD, by S. Deser, J. Trubatch, and S. Trubatch. [1965] [7]p. (AFOSR-66-0431) (AF AFOSR-65-368) AD 630210 Unclassified

Also published in Nuovo Cimento, Series X, v. 39: 1159-1165, Oct. 16, 1965.

Some aspects of the quantized linear approximation to Einstein theory are examined, in view of their relevance to the full theory's quantization. In contrast to the otherwise similar Maxwell field case, it is seen that the Lorentz-invariance requirements on the time-translation and Lorentz-rotation generators P^0, J^{0i} are not expressible in terms of simple local commutation relations for the energy density with itself. This is in

agreement with the expectation that such local relations apply only to fields of spin one or lower. It is also shown that the physical requirement $-P_\mu P_\mu \cdot 0$ is fulfilled in the linearized theory.

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Brandeis U. Dept. of Physics, Waltham, Mass.

CRITIQUE OF A NEW THEORY OF GRAVITATION, by S. Deser and F. A. E. Pirani. [1965] [13]p. incl. refs. (AFOSR-66-0448) (In cooperation with Northeastern U.) (AF AFOSR-65-368) AD 630311 Unclassified

Also published in Proc. Roy. Soc. (London), v. 288A· 133-145, Oct. 1965.

Hoyle and Narlikar have developed a new theory of gravitation, for which they claim that it is a direct inter-particle action theory, that it 'is equivalent to that of Einstein in the description of macroscopic phenomena, and hence the situation is the same so far as the classical tests of general relativity are concerned', that the sign of the gravitational constant is correctly determined, and that it has other advantages over Einstein's theory such as implying the absence of solutions representing an empty universe. In the present paper, it is shown that these claims are largely unsubstantiated. (Contractor's abstract)

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Brandeis U. [Dept. of Physics] Waltham, Mass.

PROBLEMS AND PROSPECTS IN QUANTIZATION OF RELATIVITY, by S. Deser. [1965] [6]p. incl. refs. (AFOSR-66-0802) (AF AFOSR-65-368) AD 641066 Unclassified

Also published in Proc. Nat'l. Committee for the Celebration of the Fourth Centenary of the Birth of Galileo Galilei, 1965.

Some current aspects of the quantization problem in general rel- together with closely related classical questio discussed. The viewpoint is that of Lorentz covariant quantum field theory, as employed in the joint work with R. Arnowitt and C. W. Misner.

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Brandeis U. Dept. of Physics, Waltham, Mass.

A NOTE ON BOUNCING PHOTONS, by F. A. Pirani. [1965] [4]p. incl. diagr. (AFOSR-66-1313) (AF AFOSR-65-368) AD 641065 Unclassified

Also published in Bull. Acad Polon. Sci. Ser. Sci. Math. Astronom. et Phys., v. 13. 239-242, 1965.

J. L. Synge proposed a method of characterizing Fermi transport by a simple thought experiment with photons. However, his verification of the characterization is rather long and complicated. The purpose of this note is to give Synge's experiment an intrinsic geometrical description and a simple verification. This description makes manifest the conformal invariance of Fermi transport of directions. (Contractor's abstract)

143

Brigham Young U. Dept. of Physics, Provo, Utah.

DIFFUSION IN METALS AT ULTRA-HIGH PRESSURES, by D. L. Decker and H. B. Vanfleet. Final rept Mar. 1, 1965, 56p. incl. illus. diagrs. tables, refs. (AFOSR-65-0580) (AF AFOSR-63-201) AD 614839 Unclassified

Silver wires 3 mm in diam have been quenched from temperatures between 500 and 1000 C to room temperatures for pressures up to 30 kbar. Upon quenching, an increase in room temperature resistance was measured, but 90% of this increase was permanent and remained even after high temperature anneals. The diffusion of silver into lead has been investigated using radioactive tracer techniques in a temperature range within 200 C of the melting point of lead for 6 pressures between zero and 40 kbar. The activation energy was found to increase from 15.2 to 21 9 ± .3 kcal mol as the pressure increased from atmospheric to 39.2 kbar. The activation volume for pressures below 11.9 kbar ranged from .54 ± .06 to .48 ± .05 atomic volumes as the temperature decreased from 769 to 556 K. Above 11.9 kbar the activation volume was nearly constant at 38 ± .03 atomic volumes over the same temperature interval. As a result of the large decrease in the activation volume that occurs between zero and 11.9 kbar it is suggested that the diffusion process for silver into lead changes from a composite of interstitial plus vacancy to an interstitial mechanism. Therefore the measured activation volume of .38 ± .03 atomic volumes as measured for pressure above 11.9 kbar is ΔV_m the activation volume of motion which characterizes the interstitial mechanism. (Contractor's abstract)

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Brigham Young U. [Dept. of Physics] Provo, Utah.

MELTING AND HIGH-TEMPERATURE ELECTRICAL RESISTANCE OF GOLD UNDER PRESSURE, by D. L. Decker and H. B. Vanfleet. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-1373) (AF AFOSR-63-201) AD 622632 Unclassified

Also published in Phys. Rev., v. 138: A129-A133, Apr. 5, 1965.

The electrical resistance of gold was measured over the temperature range 30 C to the melting point and over a pressure range 0-70 kbar. At constant pressure, a sudden twofold increase in resistance sharply indicated the melting point and was used to determine the solid-liquid phase line to 70 kbar. The experimental melting curve has an initial slope, 5.91 C/kbar, in very good agreement with Clapeyron's equation, and has a form satisfying a Simon's equation with a coefficient c 2.2 ± 0.1. The electrical resistance data show a

decrease in the temperature coefficient of resistivity at higher pressures, while the resistance at the melting point appears to be a constant independent of pressure. (Contractor's abstract)

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Brigham Young U. [Dept. of Physics] Provo, Utah.

EQUATION OF STATE OF NaCl AND ITS USE AS A PRESSURE GAUGE IN HIGH-PRESSURE RESEARCH, by D. L. Decker. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-65-1374) [AF AFOSR-63-201] AD 621257 Unclassified

Also published in Jour. Appl. Phys., v. 36: 157-161, Jan. 1965.

The pressure as a function of lattice parameter and temperature has been calculated for NaCl over a pressure range of 0 to 500 kbar for temperatures between 0 and 1500°C. The calculation used the Mie-Gruneisen equation of state with Born-Mayer type repulsion terms between first and second nearest neighbors. The Gruneisen constant was expanded about its value at room temperature and atmospheric pressure; the first coefficient in the expansion being evaluated by forcing the calculated thermal expansion at atmospheric pressure to fit the experimental results of Enck. The 2 empirical parameters in the repulsion terms were evaluated using the experimental lattice parameter and isothermal compressibility at atmospheric pressure. The calculated pressure vs volume agrees with Bridgman's room-temperature measurements in NaCl below 100 kbar to within 3% and with high-pressure high-temperature shock data to better than 2%. It is proposed to use the numerical results to calibrate the pressure in high-pressure high-temperature apparatus. (Contractor's abstract)

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Brigham Young U. [Dept. of Physics] Provo, Utah.

EFFECT OF PRESSURE ON THE INTERMETALLIC DIFFUSION OF SILVER IN LEAD, by H. R. Curtin, D. L. Decker, and H. B. Vanfleet. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-2588) (AF AFOSR-63-201) AD 627751 Unclassified

Also published in Phys. Rev., v. 139: A1552-A1557, Aug. 30, 1965.

The diffusion of silver-110 into lead has been investigated using radioactive-tracer techniques in a temperature range within 200°C of the melting point of lead for 6 pressures between 0 and 40 kbar. The activation energy was found to increase from 15.2 to 21.9 + 0.3 kcal/mol as the pressure increased from atmospheric to 39.2 kbar. The activation volume for pressures below 11.9 kbar ranged from 0.54 ± 0.06 to 0.48 ± 0.05 atomic volumes as the temperature decreased from 769 to 556°K. Above 11.9 kbar the activation volume was nearly constant at 0.38 ± 0.03 atomic volumes over the same temperature interval. As a result of the large decrease in the activation volume that occurs between 0 and 11.9 kbar it is suggested that the diffusion process for silver into lead changes from a composite of interstitial plus vacancy to an interstitial mechanism. Therefore the activation volume of 0.38 ± 0.03 atomic volumes as measured for pressures above 11.9 kbar represents the activation volume of motion ΔV_m characterizing the interstitial mechanism. Within the accuracy of the experimental data for lnD vs T_m/T the results suggest that $\Delta H(P)/T_m(P)$ is independent of pressure to 40 kbar.

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British Columbia U. Dept. of Chemistry, Vancouver (Canada).

THE RED EMISSION BANDS OF MOLECULAR OXYGEN, by J. S. Arnold, R. J. Browne, and E. A. Ogryzlo. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-66-1019) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-158, and Defence Research Board of Canada) AD 631814 Unclassified

Also published in Photochem. and Photobiol., v. 4: 963-969, 1965.

The temperature dependence and the absolute emission intensity of the 6340 A band of molecular oxygen have been measured. The results indicate that the emitting pair of molecules is not bound and possesses a radiative half life of about 25 msec. The implication of these results on some chemiluminescent reactions are discussed.

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British Columbia U. Dept. of Chemistry, Vancouver (Canada).

THE YIELD OF SINGLET OXYGEN IN THE REACTION OF CHLORINE WITH HYDROGEN PEROXIDE, by R. J. Browne and E. A. Ogryzlo. [1965] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-158, and Defence Research Board of Canada) AD 632910 Unclassified

Also published in Canad. Jour. Chem., v. 43: 2915-2916, Oct. 1965.

In these gas phase studies it was shown that the visible emission at 6 340 A arises from a simultaneous electronic transition in 2 colliding O_2 ($^1\Delta_g$) molecules and that the emission intensity in this band is proportional to the square of the O_2 ($^1\Delta_g$) concentration. Using an f/4.5 Hilger-Watts glass-prism spectrometer with a slit of 500 μ combined with an RCA 7102 photomultiplier the following results were obtained when O_2 ($^1\Delta_g$) was measured in the products of an electrical discharge: $[O_2 (^1\Delta_g)] = 1.5 \times 10^{-5}$ mol/1; R = 36; k = 2.4×10^3 1/mol.] When the emission from the chlorine-hydrogen peroxide reaction was observed with the same optical system, the maximum ratio R measured was 1.8×10^3. The concentration of O_2 ($^1\Delta_g$) is 7.5×10^{-4} mol/1. Assuming that the bubble temperature is 300°K this corresponds to a partial pressure of 14 mm Hg. Since

the total oxygen pressure in the bubbles is about 750 mm Hg, this corresponds to a minimum yield of 2% O_2 ($^1\Delta_g$) in the reaction. There are a number of reasons for believing that the yield of O_2 ($^1\Delta_g$) is actually greater than this.

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[British Columbia U., Dept. of Mathematics, Vancouver (Canada)]

SOME INEQUALITIES FOR SYMMETRIC MEANS, by P. S. Bullen. [1965] [8]p. (AFOSR-65-2606) [AF AFOSR-62-261] AD 629135 Unclassified

Also published in Pacific Jour. Math., v. 15 47-54, Mar. 1965.

Let $(a) = (a_1, \cdots, a_m)$, $(w) = (w_1, \cdots, w_m)$ be m-tuples of positive numbers, $E_0 = 1$, $E_r = E_r(a)$ the rth elementary symmetric function of (a), $P_r = \binom{m}{r}^{-1} E_r$, A_m [respectively, G_m] the arithmetic [geometric] mean of (a) with weights (w), $W_m = w_1 + \cdots + w_m$, $(wa) = (w_1a_1, \cdots, w_ma_m)$, $F_r(a) = E_r(wa)\, E_r(w)$, $m = n + q$. Let $(\bar{a}) = (a_1 \cdots, a_n)$, $(\tilde{a}) = (a_{n+1} \cdots, a_m)$, $\bar{E}_r = E_r(\bar{a})$ and $\tilde{E}_r$, etc., be analogously defined. Results of the author and M. Marcus (Proc. Amer. Math. Soc., v. 12, 285-290, 1961) and others are generalized as follows. Theorem 2: Let $1 \le r \le k \le m$, $u = \max(r-n, 0)$, $v = \min(r, q)$, $w = \max(k-n, 0)$, $x = \min(k, q)$, $v \le w$. Then (1) if $r-u \le k-x$, $\dfrac{P_r^{k/r}}{P_k} \ge \dfrac{\bar{P}_{r-u}^{(k-x)/(r-u)} P_v^{w/v}}{\bar{P}_{k-x} \tilde{P}_w}$ with equality if and only if $r = k$ or $a_1 = \cdots = a_m$, or $r = 1$, $k = m$ and $\bar{P}_1 = \tilde{P}_1$}, (2) $P_r^{k/r}/P_k \ge P_v^{w/v}/\tilde{P}_w$ with equality if and only if $r = k$ or $a_1 = \cdots = a_m$, or $r = 1$, $k = m$ and $a_1 = \cdots = a_n = \tilde{P}_1$}. Theorem 7: $W_m(A_m - G_m) \ge \bar{W}_n(\bar{A}_n - \bar{G}_n) + \tilde{W}_q(\tilde{A}_q - \tilde{G}_q)$ with equality if and only if $\bar{G}_n = \tilde{G}_q$}; $(A_m/G_m)^{W_m} \ge (\bar{A}_n/\bar{G}_n)^{\bar{W}_n} (\tilde{A}_q/\tilde{G}_q)^{\tilde{W}_q}$ with equality if and only if $\bar{A}_n = \tilde{A}_q$}. Theorem 8. If (a), (w) are similarly ordered, (1) $s < t$ implies $F_s^t \ge F_t^s$ with equality if and only if $a_1 = \cdots = a_m$, or $s = 0$}, (2) an analogue of Theorem 2 holds with P replaced by F. The following analogue of inequalities for $\bar{A}_n - \bar{G}_n$ is obtained and a generalization of Hölder's inequality derived: Let $\bar{W}_n = 1$, $R_n = \bar{A}_n/\bar{G}_n$, $w = \min(\bar{w})$, $W = \max(\bar{w})$, $L_n = \prod_{i,j=1}^{n} (\frac{1}{2}a_i^{1/2}a_j^{-1/2} + \frac{1}{2}a_i^{-1/2}a_j^{1/2})$, $\Lambda_n = \prod_{i,j=1}^{n} (\frac{1}{2}a_i^{1/2}a_j^{-1/2} + \frac{1}{2}a_i^{-1/2}a_j^{1/2})^{w_iw_j}$. Then $L_n^{w(n-1)} \le R_n \le L_n^{W}$, $\Lambda_n^{1/(1-w)} \le R_n \le \Lambda_n^{1/w}$ with equalities if and only if $a_1 = \cdots = a_n$. (Math. Rev. abstract, modified)

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British Columbia U., [Dept. of Mathematics] Vancouver (Canada).

A GENERAL PERRON INTEGRAL, by P. S. Bullen. [1965] [14]p. incl. refs. (AFOSR-65-2607) [AF AFOSR-62-261] AD 629134 Unclassified

Also published in Canad. Jour. Math., v. 17: 17-30, 1965.

Integrals are considered from the point of view of inverting differential operators. For this purpose it is necessary to introduce integrals more general than the Lebesque integral. For the second section of the article a generalized second order derivative is introduced and it is used to obtain conditions for a function to be hyperharmonic. Later in the article the general Perron integral that inverts the derivative in question is defined. In the final section examples are given of the above theory.

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British Columbia U., [Dept. of Mathematics] Vancouver (Canada).

DOMAIN PERTURBATIONS OF THE BIHARMONIC OPERATOR, by C. A. Swanson. [1965] [11]p. (AFOSR-66-0030) (AF AFOSR-63-379) AD 641528 Unclassified

Also published in Canad. Jour. Math., v. 17: 1053-1063, 1965.

The purpose of the work is to obtain asymptotic variational formulae for eigenvalues and eigenfunctions under the deformation of removing an E-disk and adjoining additional boundary conditions on the new boundary component thereby introduced, valid on a positive interval $0 < E < E_0$.

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British Columbia U. [Dept. of Mathematics] Vancouver (Canada).

COMPARISON THEOREMS FOR ELLIPTIC DIFFERENTIAL EQUATIONS, by C. [W.] Clark and C. A. Swanson. [1965] [5]p. (AFOSR-66-0210) (AF AFOSR-63-379) AD 641529 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 886-890, Oct. 1965.

In recent years the classical Sturm-Picone comparison theorem for a pair of second order ordinary differential equations has been generalized in 2 directions. First, Hartman and Wintner have extended the theorem to

self-adjoint elliptic equations in n dimensions. On the other hand, Leighton has shown in the case n = 1 that the usual pointwise inequalities for the coefficients can be replaced by a more general inequality. The purpose of this note is to extend Leighton's result to self-adjoint elliptic equations. The Hartman-Wintner result is a corollary of the main theorem. An example is given to show that the result is actually stronger. An interesting feature is the simplicity of the proof as compared to that of Hartman and Wintner or the recent proof of Kreith.

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British Columbia U. Dept. of Mathematics, Vancouver (Canada).

THE GENERAL PROBLEM OF THE MOTION OF COUPLED RIGID BODIES ABOUT A FIXED POINT, by E. Leimanis. VOL. 7. SPRINGER TRACTS IN NATURAL PHILOSOPHY, ed. by C. Truesdell, L. Collatz and others. Berlin, Springer-Verlag, 1965, 337p. incl. diagrs. tables, refs. (AFOSR-66-0261) (AF AFOSR-64-483) Unclassified

This attempt to account for the present state of the field and its growth during the last two hundred years of the theory of motion of several coupled rigid bodies about a fixed point is concerned first with particular cases of integrability of the equations of motion and with their geometrical interpretation. Next the motion of a symmetric as well as an asymmetric self-excited rigid body is considered because of its importance in various devices with internal reaction commonly used today to influence rotational motions; for example, devices for the steering of space vehicles. Finally consideration is given to the motion of an externally excited rigid body, especially a rigid body subject to periodic torque vectors which are of interest in astronomy and atomic physics. In the former the main concern is the perturbation of the Earth's rotation about its axis under the influence of forces arising from the planetary system. In atomic physics electrons and nuclei in high frequency magnetic fields represent atomic gyroscopes subject to periodic torques. Later chapters survey the problems, the separation of the general motion of mutually attracting rigid bodies into translations of their mass centers and rotations about the latter, rotation of an artificial satellite about its mass center and the motion of a rigid body about a fixed point in a central Newtonian force field.

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[Brown U. Div. of Applied Mathematics, Providence, R. I.]

ON THE STOCHASTIC MAXIMUM PRINCIPLE WITH "AVERAGE" CONSTRAINTS, by H. J. Kushner. [1965] [14]p. incl. diagrs. (AFOSR-66-0559) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1206 and National Aeronautics and Space Administration) AD 639019 Unclassified

Also published in Jour. Math. Anal. and Appl., v 12: 13-26, Aug. 1965.

Under certain assumptions a necessary condition, a stochastic form of the Euler equations, or the maximum principle for deterministic systems, is obtained for the stochastic system dx(w,t) = f(x(w,t), u(w,t)) + dz(w,t), where u(·,·) is the control, and z(·,·) is a stochastic process. It is required that E(c(x(w, T))) be minimized subject to the constraint that E(x(w, T)) is in a closed convex set, the control u(·,·) depending on the observed data concerning the values z(w,t) and x(w,t). (Math. Rev. abstract)

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Brown U. [Div. of Applied Mathematics] Providence, R. I.

DUAL DYNAMICAL SYSTEMS AND THEIR REPRESENTATION BY SYSTEM FUNCTIONS, by L. Weiss. [1965] [11]p. (AFOSR-65-2127) (AF AFOSR-64-693) AD 628704 Unclassified

Presented at Second Allerton Conf. on Circuit and System Theory, Illinois U., Urbana, Sept, 1964.

Also published in Internat'l. Jour. Control, v. 1: 475-485, May 1965.

The system function concept is an extension of the usual application of the transform method to linear systems. In this paper it is shown that there are 2 system functions which can be naturally associated with a given system and that each one can be interpreted in 2 ways. These alternate interpretations are used to show that the same system function provides a means for calculating the time-domain output of a given system and the transform-domain output of the dual system (defined as the adjoint of the given system with reversal of the time scale ordering). (Contractor's abstract)

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Brown U. Div. of Applied Mathematics, Providence, R. I.

SOME PROBLEMS AND SOME RECENT RESULTS IN STOCHASTIC CONTROL, by H. J. Kushner. [1965] [9]p. incl. refs. (AFOSR-65-2128) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-693 and National Aeronautics and Space Administration) AD 628700 Unclassified

Also published in IEEE Internat'l. Convention Record, v. 16. 108-116, 1965.

This paper is divided into 2 major sections. The first section is of the nature of both a review of work in stochastic optimal control in the past 2 yr, and a brief discussion of a few of the important remaining problems. There are some remarks on noise sources and their mathematical description, a discussion of the partial differential equation obtained by the application of dynamic programming to a class of continuous time models and a list of references to a few other problems and approaches. The second section is more specific and discusses the application of some recent results of the author (in the theory of stochastic stability) to the design of controllers for linear and non-linear stochastic systems. The latter material giving techniques for obtaining optimal controls to a number of stochastic problems, rounds out the first part, and is of interest since,

via some perhaps small (if any) changes in problem statements a number of solutions can be obtained. In fact there are stochastic analogies to almost all of the suggested applications of Liapunov theory to the choice of feedback controls in deterministic systems. (Contractor's abstract)

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Brown U. [Div. of Applied Mathematics] Providence, R. I.

ON THE STABILITY OF SYSTEMS DEFINED OVER A FINITE TIME INTERVAL, by L. Weiss and E. F. Infante. [1965] [5]p. (AFOSR-65-2129) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-693 and National Aeronautics and Space Administration) AD 628699 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 54: 44-48, July 1965.

Consider the system of n first-order real differential equations represented in vector form by $dx/dt = f(x,t)$ defined over a finite interval of time. The function f is assumed to be smooth enough in x and t (over T) to assure existence and uniqueness of solutions over T as well as the continuous dependence of the solutions on initial conditions at t_0. It is not required that $f(0,t) = 0$ The purpose of this note is to present some results toward the establishment of a comprehensive qualitative theory of stability for such systems.

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Brown U. [Div. of Applied Mathematics] Providence, R. I.

ON SYSTEM FUNCTIONS WITH THE PROPERTY OF SEPARABILITY, by L. Weiss. [1965] [10]p. incl. diagrs. refs. (AFOSR-65-2130) (AF AFOSR-64-693) AD 628696 Unclassified

Presented at Second Allerton Conf. on Circuit and System Theory, Illinois U., Urbana, Sept. 1964.

Also published in Internat'l. Jour. Control, v. 1, 487-496, May 1965.

This paper considers linear differential (time-varying) systems which may be described by either of 2 system functions based on a specified integral transform. In particular, those systems are discussed for which at least one of the aforementioned system functions is separable in its 2 arguments. Physical interpretations of separable system functions are given and 2 theorems are proved which yield sufficient conditions for the presence of this property. It is also proved that the so-called 'bi-frequency' function of Zadeh must be separable for linear differential systems. Finally, the problem of approximately representing a given system by a separable system function based on the Laplace transform is discussed. (Contractor's abstract)

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[Brown U. Div. of Applied Mathematics, Providence, R. I.]

STOCHASTIC STABILITY AND THE DESIGN OF FEEDBACK CONTROLS, by H. Kushner. May 1965, 34p. (Technical rept. no. 65-5) (AFOSR-65-2317) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-693 and National Aeronautics and Space Administration) AD 628274 Unclassified

The paper describes the stochastic extensions of the various techniques for using the second method of Lyapunov to aid the construction and analysis of feedback control.

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Brown U. [Div. of Applied Mathematics] Providence, R. I.

PLANAR GRAPHS AND RELATED TOPICS, by S. Lefschetz. [1965] [3]p. (AFOSR-66-0386) (In cooperation with Princeton U., N. J.) (AF AFOSR-64-693) AD 633535 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 54: 1763-1765, Dec. 1965.

The paper gives a short and accessible proof of MacLane's formulation of necessary and sufficient conditions for a graph to be topologically imbeddable in the plane. (Math. Rev. abstract)

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Brown U. [Div. of Applied Mathematics] Providence, R. I.

ON THE CONSTRUCTION OF STOCHASTIC LIAPUNOV FUNCTIONS, by H. J. Kushner. [1965] [2]p. incl. refs. (AFOSR-66-0387) (AF AFOSR-64-693) AD 641078 Unclassified

Also published in IEEE Trans. Automatic Control, v. 10: 477-478, Oct. 1965.

The object of this correspondence is to present the stochastic analog of the deterministic method of partial integration for computing Liapunov functions and to give some examples. In the deterministic method, a suitable negative definite or semidefinite function $\dot{V}(x) = dV(x)/dt$ is chosen. There is an attempt to compute V(x) via a sequence of partial integrations, and use of the system equations. Finally, the computed V(x) is checked for positive definiteness in a suitable region. The method is interesting since $\dot{V}(x)$ is easier to choose than V(x). Concepts of stochastic stability are discussed only indirectly The system under investigation is represented by the stochastic vector differential equation $dx = f(x)dt + \sigma(x)dz$. f and σ are a vector and matrix respectively with components f_i, σ_{ij}, each of which satisfies a local Lipshitz condition.

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Brown U. Div. of Applied Mathematics, Providence, R. I.

SUFFICIENT CONDITIONS FOR STABILITY AND INSTABILITY OF AUTONOMOUS FUNCTIONAL-DIFFERENTIAL EQUATIONS, by J. K. Hale. [1965] [31]p. incl. diagrs. refs. (AFOSR-66-0560) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-633, Army Research Office (Durham), and National Aeronautics and Space Administration) AD 629446
Unclassified

Also published in Jour. Differential Equations, v. 1: 452-482, Oct. 1965.

The author proves several sufficient conditions for stability and instability of autonomous functional differential equations of the form (1) $\dot{x}(t) = f(x_t)$, $t \geq 0$, where $f(\Phi)$ is a function on C_H, the open ball $\{\Phi: \|\Phi\| < H\}$ in the space $C[-r, 0]$, and applies these to several interesting examples. The theorems depend on concepts of invariant set and Liapunov functional, and in part represent generalizations of similar theorems for ordinary differential equations given by LaSalle (Proc. Nat'l. Acad. Sci., v. 46: 363-365, 1960). With a suitable definition of "derivative" $\dot{V}_{(1)}(\Phi)$ for a functional V, the first theorem has the following form. Theorem 1: Let V be a continuous scalar function on C_H. Let U_1 designate the region where $V(\Phi) < 1$ and suppose there exists a nonnegative constant K such that $|\Phi(0)| \leq K$, $V(\Phi) \geq 0$, and $\dot{V}_{(1)}(\Phi) \leq 0$ for all Φ in U_1. If R is the set of all points in U_1 where $\dot{V}_{(1)}(\Phi) = 0$ and M is the largest invariant set in R, then every solution of (1) with initial values in U_1 approaches M as $t \to \infty$. A large part of the paper is devoted to a detailed stability analysis of 8 examples, with the aid of suitable Liapunov functionals and the theorems of the paper. In the first example, extensions of results of Levin and Nohel (Jour. Math. Anal. Appl., v. 8: 31-44, 1964) are obtained. Among the other examples are a system of equations used by Volterra (Lecons sur la théorie mathématique de la lutte pour la vie, Gauthier-Villars, Paris, 1931) as a model for the interaction of 2 species and a Rayleigh equation with retardation. In the last section of the paper, it is indicated how the stability theorems may be extended to the case of infinite lag. (Math. Rev., abstract)

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Brown U., Div. of Applied Mathematics, Providence, R. I.

LIAPUNOV FUNCTIONS FOR THE PROBLEM OF LUR'E, by K. R. Meyer. [1965] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-693, Army Research Office, Durham, and National Aeronautics and Space Administration)
Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 53: 501-503, Mar. 1965.

Consider the differential equation (') $dx/dt = Ax - \Phi(\sigma)b$, $\sigma = c'x$, where t is a real variable, x, b and c are real n-vectors, c' is the transpose of c, A is a real n-by-n matrix and $\Phi(\sigma)$ is a real continuous scalar function of σ such that $\sigma\Phi(\sigma) > 0$ for $\sigma \neq 0$ and such that through each point $x^0 \in E^n$ there passes a unique trajectory of ('). Define $P(z) = (\alpha + \beta z)c'(Iz - A)^{-1}b$, a function of the complex variable z, with $\alpha \geq 0$, $\beta \geq 0$, $\alpha + \beta > 0$ and I, the identity n-by-n matrix. A criterion for the asymptotic stability of (') in terms of P(z), well known as "Popov's criterion", is satisfied if (') has a Liapunov function of the form $V = x'Bx + \beta \int_0^\sigma \Phi(\tau)d\tau$, B a symmetric matrix. Yakubovich and Kalman tried to change into "if and only if" the "if" in the preceding statement, but they succeeded only under additional assumptions. This note is to announce that the converse holds true without the above restrictions. Further results are also announced. (Math. Rev. abstract)

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Brown U. [Div. of Applied Mathematics] Providence, R. I.

ON THE STABILITY OF STOCHASTIC DYNAMICAL SYSTEMS, by H. J. Kushner. [1965] [5]p. (AF AFOSR-64-693)
Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 53: 9-12, Jan. 1965.

Theorems pertaining to the stability of the stochastic discrete-time system $x_{n+1} = f(x_n, y_n)$, $f(0, y) = 0$, where y_n is a Markov process, are given using Liapunov functions. The various definitions of stability are too long for complete reproduction here. The following is a sample: "The origin is stable with probability one if and only if for any $\rho > 0$, $\epsilon > 0$, there is a $\delta(\rho, \epsilon) > 0$ such that if $x_0 \leq \delta(\rho, \epsilon)$, $P[\sup_n x_n \geq \epsilon] \leq \rho$." By requiring the stochastic Liapunov function $V(x_n, y_n)$ to have the supermartingale property in a neighborhood, some useful estimates as well as stability theorems are derived. (Math. Rev. abstract)

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Brown U., Div. of Applied Mathematics, Providence, R. I.

THE STABILITY OF NONLINEAR DYNAMICAL SYSTEMS, by J. P. La Salle. [1965] [10]p. incl. refs. [AF AFOSR-64-693]
Unclassified

Published in Science in the Sixties; Tenth Anniversary AFOSR Scientific Seminar, Cloudcroft, N. Mex. (June 1965), ed. by D. L. Arm. Albuquerque, Mexico U. Office of Publications, 1965, p. 124-133. (AFOSR-68-2384; AD 678056)

After an introduction dealing with the history of linear stability analysis and its use in the design of control devices, Liapunov's nonlinear analysis of stability and the theory of optimal control is discussed. The Liapunov method is the only general method available today for analyzing stability and taking into account the nonlinearities of the system, the best that has been accomplished is the solution of a fairly large number of specialized problems. It is not yet known how to use

computers as an aid in applying Liapunov's method. The significant stability problems require methods that are nonnumerical and the nonnumerical use of computers is not yet highly developed. The Liapunov theory of stability for autonomous systems has been unified and extended and appears to be fairly complete. Further developments of theory for nonautonomous systems seem possible. For the study of the stability of nonautonomous linear systems, new methods have been found but there are no new ideas in sight other than those generated by Liapunov's method for carrying out nonlinear stability analyses. The study of more "practical' types of stability is promising. Two relatively new areas of mathematical research are the theory of functional differential equations and the theory of stochastic differential equations. Developments in these areas could have a profound effect on the theory of control systems and the theory of systems in general.

Brussels U. (Belgium). see
Free U. of Brussels (Belgium).

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[Buenos Aires U.] Inst. de Anatomía General y Embriologia (Argentina).

ULTRASTRUCTURE AND PHARMACOLOGICAL STUDIES OF NERVE ENDINGS IN THE PINEAL ORGAN, by A. Pellegrino de Iraldi, L. M. Zieher, and E. de Robertis. [1965] [34]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2836) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-314 and Consejo Nacional de Investigaciones Cientificas y Technicas) AD 628435 Unclassified

Also published in Prog. Brain Research, v. 10: 389-422, 1965.

The work was initiated to investigate the origin of the nerve fibers innervating the pineal gland and particularly the nature of the granular vesicles present in these nerve endings. For this purpose 2 principal approaches were used: Some rats were submitted to the bilateral extirpation of the superior cervical ganglia, and others were submitted to the action of drugs that may alter the metabolism of catechol and indolamines. In both cases the glands were fixed and studied under the electron microscope, and the changes occurring in the nerve fibers and endings were specially recorded. Preliminary determinations of 5-HT content were also carried out in normal and denervated glands and in some of the rats treated with some of the agents that may change in this indolamine. (Contractor's abstract)

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Buenos Aires U. Inst. de Anatomía General y Embriologia (Argentina).

FUNCTIONAL IMPLICATIONS OF STRUCTURAL FINDINGS IN RETINAL GLIAL CELLS, by A. Lasansky. [1965] [25]p. incl. illus. diagr. refs. (AFOSR-65-1941) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-656 and Consejo Nacional de Investigaciones Cientificas y Tecnicas) Unclassified

Also published in Prog. Brain Research, v. 15: 48-72, 1965.

When the outer surface of the retina is placed in a solution containing ferrocyanide and after ferric ions are added, it is possible to detect with the optic microscope within the retina Prussian blue deposits. When retinae are examined with the electron microscope it is found that the terminal bars attaching 2 membranes of glial cells (Muller cells) are similar to those known, but the terminal bars relating the membranes of visual and Muller cells present only a zonula adherens. It is concluded that the intercellular spaces between visual and Muller cells are freely open and it seems rather difficult that Muller cells may control the flow of water, ions and metabolites through the neural retina.

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[Buenos Aires U.] Inst. de Anatomía General y Embriologia (Argentina).

5-HYDROXYTRYPTAMINE RECEPTORS AND SYNAPTIC TRANSMISSION IN MOLLUSCAN NEURONS, by H. M. Gerschenfeld and E. Stefani. [1965] [6]p. incl. illus. diagrs. refs. (AFOSR-65-1943) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-656 and Consejo Nacional de Investigaciones Cientificas y tecnicas) AD 623367 Unclassified

Also published in Nature, v. 205: 1216-1218, Mar. 20, 1965.

5-HT was iontophoretically injected on the somatic membrane of central neurons of the snail Cryptomphallus aspersa. Only a limited number of cells called CILDA are sensitive to 5-HT and show a peculiar inhibitory input called Inhibition of Long Duration. 5-HT microinjections depolarize and excite CILDA neurons. Repeated microinjections cause intense desensitization of 5-HT receptors, an interval of 40 sec being necessary to obtain the same effect in 2 successive injections. 5-HT receptors may be blocked by LSD 25, BOL 148, morphine, chorpromazine and atropine. All these drugs block 5-HT receptors reversibly. Dibenamine, tryptamine and cyproheptadine block the receptor irreversibly. SKF trans-385 and ipronaizaid also block the receptors. 5-HT reduces the membrane conductance of CILDA neurons. This effect was not observed in other types of neurons. Recent findings show that BOL 148 blocks excitatory postsynaptic potential in CILDA neurons. From the present results it may be discussed that 5-HT may be the natural excitatory transmitter to CILDA neurons in mollusea.

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[Buenos Aires U.] Inst. de Anatomía General y Embriologia (Argentina).

[CALCIUM DEPENDENCE OF 5-HT RECEPTORS OF CENTRAL NEURONS OF CRYPTOMPHALLUS ASPERSA] Ca^{++}-Dependencia de los receptores a la 5-hidroxitriptamiana (5th) en neuronas centrales de cryptomphallus aspersa (Abstract), by E. Stefani and H. M.

Gerschenfeld. [1965] [2]p. (AFOSR-65-1947) (AF AFOSR-64-656) Unclassified

Also published in Proc. Scient. Meeting Biologists, Rosario (Chile), Apr. 12-14, 1965, p. 149-150.

Some central cells (CILDA neurons) present in the nervous system of Cryptomphalus aspersa have an inhibitory input called "inhibition of long duration" and respond to the iontophoretic injection of 5-HT. It is known that changes in the calcium concentration of the environment modify the response of the 5-HT receptors. In multicellular preparations it is difficult to understand this relationship but combining intracellular recording with iontophoretic microinjections it is possible to analyze this problem at a cellular level. When CILDA neurons are bathed with a Ca-free saline solution, there is an increase of 8% in the membrane conductance. In this ionic condition 5-HT response is transiently blocked. The same concentration of Na EDTA but added to a Ca-free saline solution blocks completely and reversibly the response to the 5-HT injection. The effects of Na EDTA on membrane conductance are unspecific and similar effects have been observed in cholinergic receptors of snail neurons.

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[Buenos Aires U.] Inst. de Anatomía General y Embriologia (Argentina).

STUDIES ON THE FUNCTION OF THE PIGMENT EPITHELIUM IN RELATION TO IONIC MOVEMENT BETWEEN RETINA AND CHORIOID (Abstract), by A. Lasansky and F. Fisch. [1965] [1]p. (AFOSR-65-1949) (AF AFOSR-64-656) Unclassified

Presented at Symposium on the Structure of the Eye, Weisbaden (Germany), 1965.

Electrophysiological and pharmacological findings in mammalian retina suggested the possibility that the pigment epithelium might be the main source of the resting potential across the eye and the principal diffusion barrier between retina and choriodal vessels. In order to investigate these points the ionic movements across the isolated toad pigment epithelium and chorioid were studied in a flux chamber. A steady potential of about 20-30 mv, epithelial side positive and a short circuit current of approx 40 μ amp cm^{-2} can be recorded for many hours under these conditions. Determinations of unidirectional radioisotope fluxes in the absence of an electrochemical gradient evidenced a net transfer of chloride (.92 μ eq cm^{-2} hr^{-1}) from epithelial to choriodal surface which accounts for a major part of the short circuit current (1.44 μ eq cm^{-2} hr^{-1}). The discrepancy between short circuit current and net chloride transfer is not explained by the measurements of cation fluxes, since no net transfer of sodium or potassium was found in the short-circuited condition. These findings support the view that the pigment epithelium has an important role in influencing the ionic environment within the neural retina.

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[Buenos Aires U.] Inst. de Anatomía General y Embriologia (Argentina).

IONIC MECHANISM ASSOCIATED WITH NON-CHOLINERGIC SYNAPTIC INHIBITION IN MOLLUSCAN NEURONS, by H. M. Gerschenfeld and D. J. Chiarandini. [1965] [14]p. incl. illus. tables, refs. (AFOSR-66-1124) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-656 and Consejo Nacional de Investigaciones Cientificas y Tecnicas, Argentina) AD 641885 Unclassified

Also published in Jour. Neurophysiol., v. 28: 710-723, July 1965.

The ionic basis of the non-cholinergic inhibitory postsynaptic potential (IPSP) in D neurons with inhibition (D Inhi) neurons of the snail Cryptomphalus aspersa was analyzed by intracellular recording. It has been found that the increase in the intracellular concentration of Cl^- does not modify either the IPSP or its equilibrium potential. When the external concentration of K was zero, an increase in both the IPST's amplitude and equilibrium potential value was observed. It is concluded that the non-cholinergic IPST's are due to an increase of the subsynaptic membrane permeability that allows a selective efflux of K^+ down its electrochemical gradient. (Contractor's abstract)

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Bureau of Social Science Research, Inc., Washington, D. C.

THE QUEST FOR SELF-CONTROL: CLASSICAL PHILOSOPHIES AND SCIENTIFIC RESEARCH, ed. by S. Z. Klausner. New York, Free Press, 1965, 400p. incl. tables, refs. (AFOSR-65-0719) (AF 49(638)992) AD 621135 Unclassified

Revised drafts are given of papers presented at a Conference on Self-Control under Stressful Conditions, held in Washington, D. C., on Sept. 10-12, 1962. Titles of the papers are as follows. Part One on Self-Control in the perceptive of history: Collocation of concepts of self-control, Self-images and systems of spiritual direction in the history of European civilization. Self-control: the Greek paradigm. Part Two on Self-Control in a sociological perspective. Popular psychology: a content analysis of contemporary inspirational nonreligious books. Social identity and self-control, the routinization of love: Structure and process in primary relations. Part Three on Self-Control in psychological perspective: Psychodynamic aspects of stress tolerance. Some psychological determinants of stress behavior. Experimental analysis of stress and individual self-control in animal behavior. Part Four on Self-control in psychiatric perspective: Psychological factors maximizing resistance to stress, with special reference to hypnosis. Behavioral approach to the problem of self-control, Stress and the concept of selfrealization. Part Five on Scientific hermeneutics.

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Bureau of Social Science Research, Inc., Washington, D. C.

NECESSARY, PERMISSIBLE, AND OBLIGATORY DISCOURSE WITH CAPTOR PERSONNEL, by A. D. Biderman. May 4, 1965, 10p. (AFOSR-65-0750) (AF 49(638)992) AD 467873 Unclassified

This report discusses circumstances under which discourse other than name, rank and serial number between prisoners of war and captor personnel may be necessary, permissible, or obligatory. Several examples are given in which this has been proven true because of requirements of international law, the maintenance of health, life and welfare of prisoners of war in an organized camp, for exploiting potential "friendlies" or defectors, for self-defense against false accusation, and in various special circumstances of cold or hot war. It is concluded that the "name, rank, service number, date of birth, only" rule relates to an abstract conception of interrogation that is only sometimes congruent with actual confrontations with captor personnel that are experienced by prisoners of war. The considerations advanced here are independent of the issue of duress and "loss of self-control," except that there are dangers of confusing rational and moral action with rationalization of weakness.

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Bureau of Social Science Research, Inc., Washington, D. C.

SOME NOTES ON THE PRODUCTION OF PSYCHIATRIC AND PSYCHOLOGICAL KNOWLEDGE, by S. Z. Klausner. [1965] [10]p. incl. tables. (AFOSR-66-1154) (AF 49(638)992) AD 639868 Unclassified

Also published in Jour. Consulting Psychol., v. 29: 405-415, 1965.

The polemic about the relative competencies of psychiatrists and psychologists has, by and large, concerned their clinical roles. Members of these 2 professions differ in types of knowledge they produce in their research roles for application in clinical situations. A list of 1,226 concepts was selected from the literature reporting studies of behavior under stress. An analysis of these research concepts shows that psychiatrists use concepts of personality almost exclusively when studying stressful situations, whereas psychologists are more flexible in combining concepts of personality with those of society and culture. Differences among members of these professions in modes of research conceptualization and in problem selection tend to be more closely related to such factors as the institutional setting in which they work, their religious affiliation, and their self-perception as "tender" or "tough" minded, than they are to differences in professional training.

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Bureau of Social Science Research, Inc., Washington, D. C.

FEAR AND ENTHUSIASM IN SPORT PARACHUTING, by S. Z. Klausner. May 1965 [33]p. incl. diagrs. tables. (AFOSR-65-1329) (AF 49(638)992) AD 619389 Unclassified

Also published in Motivations in Sports, ed. by R. Slovenko and J. A. Knight, Springfield, Charles C. Thomas, 1965, p. 670-694.

A study is presented on the relation between the experience of fear and the experience of enthusiasm. Fear is assessed by a self-report of fear and by an inference from a projective test about predispositions to fear. Replies to a mail questionnaire by 825 sport parachutists affiliated with 103 parachute clubs constitute the data of this study. Only the jump experience, an analysis of the stories told about one picture in the draw-a-person test, and a few social characteristics are reported.

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Bureau of Social Science Research, Inc., Washington, D. C.

CHINESE "THOUGHT REFORM" AS A SOURCE OF PERSPECTIVES TOWARD WESTERN CORRECTIONAL PRACTICE, by A. D. Biderman. May 20, 1965, 7p. incl. refs. (AFOSR-65-1205) (AF 49(638)1344) AD 623172 Unclassified

Presented at First Internat'l. Cong. of Social Psychiatry, London (Gt. Brit.), Aug. 17-22, 1964.

Studies of Chinese Communist 'brainwashing' practices proceeded with little reference to Western literature on phenology and correction. When serious comparative consideration of Western and Chinese reform efforts did take place, however, the normative outlook from which Westerners had viewed Chinese 'thought reform' gave uniquely valuable perspectives on Western practices. Several illustrations are given of how the examination of deplored reform practices can provide valuable, chastening insights regarding the meaning and effectiveness of reform efforts that one values positively. The sympathetic regard of Western observers for those they considered victims of the Chinese practices contrasts with difficulties practitioners have in identifying with the subjects of their own correctional procedures. The explicity positive valuation which was placed on the efforts of subjects to resist 'brainwashing' contrasts with the tendency of practitioners to regard resistance as obduracy. The literature on 'brainwashing' emphasizes the malleability of attitudes and behavior as contrasted with the emphasis on the intractability of inmates or patients typical of Western correctional literature. Despite great difference in theories applied by practitioners, similar emotional reactions are experienced by their subjects. (Contractor's abstract)

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Bureau of Social Science Research, Inc., Washington, D. C.

THE SOCIAL SCIENCES IN INTERNATIONAL AND MILITARY POLICY; AN ANALYTIC BIBLIOGRAPHY, by E. T. Crawford. Oct. 1965 [91]p. incl. refs. (AFOSR-65-1899) (AF 49(638)1344) AD 623841 Unclassified

The bibliography presents selective materials pertaining to the role of social science research in international and military policy and operations since the beginning of World War II. The bibliography lists 150 references to books, articles and reports, all of which are part of the open literature. The references are annotated. The report also contains an introduction which discusses the purpose of the bibliography, its scope, the sources from which the works cited are drawn and some limitations of the available literature. The bibliography is divided into 5 parts. Part I lists general works discussing the role of social science research in public policy. Part II lists work which show the trends in the relationship of government and the social science community in the area of international and military affairs since the beginning of World War II. Parts III and IV list literature which suggests some analytic categories to be used in studying social science research and international and military policy. Part V, finally, contains writings which give a theoretical perspective on the roles of applied social science. (Contractor's abstract)

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Bureau of Social Science Research, Inc., Washington, D. C.

WORSHIP AND THE DANGEROUS LIFE: A STUDY OF CHURCH ATTENDANCE AMONG SPORT PARACHUTES, by S. Z. Klausner. Dec. 1965, 48p. incl. diagrs. tables, refs. (AFOSR-66-0124) (AF 49(638)1510) AD 630793 Unclassified

The data for this study were drawn from 825 questionnaires returned by members of American sport parachuting clubs. Among Protestant parachutists, the emotionally volatile are more frequent church attenders than the relatively calm. Among Catholics the reverse is true; the calmer types go to church while the more volatile tend to stay away. Skydivers who avoid thinking about their fear of jumping are, especially among Protestants, more frequent church attenders than those skydivers who express their fear. Catholics who express the feeling of free fall in sensory and esthetic terms are more frequent church attenders than the Catholics who confront this experience in a simple, descriptive, matter-of-fact way. Protestants who grasp the free fall experience in a matter-of-fact way were more frequent worshippers in their churches than those Protestants for whom free fall is an esthetic or sensory experience. Protestants who felt that harm befalling a skydiver was due to fate-that is, predestined or determined, rather than a result of the jumper's irresponsible behavior, are more frequent church attenders. Catholics for whom skydiver injury is due to his own responsibility are more likely than fatalistic Catholics to be frequent attenders at Mass. (Contractor's abstract)

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Bureau of Social Science Research, Inc., Washington, D. C.

PLAN FOR AN ARID ZONE SOCIAL SCIENCE RESEARCH AND INFORMATION CENTER, by L. Krader. Final rept. Mar. 1965, 11p. (AFOSR-65-0596) (AF AFOSR-64-494) Unclassified

A plan is presented for a proposed center of social science research in the arid zones. Its purpose may be summarized as follows: (1) It should compiement and support activities of social scientists already underway, (2) It should focus on complex issues which the individual social science field worker normally does not undertake, and (3) It should supply supportive services to all research, primary service being science information program.

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California Inst. of Tech., Pasadena.

REPORT ON INSECT VISION, by D. M. Vowels. Final rept. June 1965 [87]p. incl. diagrs. tables, refs. (AFOSR-65-1226) (AF AFOSR-63-458) AD 621280
Unclassified

The properties of a model describing optomotor responses in the housefly are listed. Some of these theoretical properties may be found empirically by histological and electrophysiological techniques. The parameters required are the interommatidial angle, the diameter of the receptive field of an ommatidium or retinula cell, and the relationship between the generator potential and light intensity. The interommatidial angle was measured histologically. This is variable over the whole eye, the most uniform region lying between 20 and 60° in the horizontal plane (anterior = 0°) and 30° above and 10° below horizontal in the vertical. The mean interommatidial angle in the horizontal plane is 3.9° and 2.5° in the vertical. The role of screening pigment is examined. This is most dense in the upper part of the eye. During dark adaptation the pigment migrates, moving inwards away from the lenses and contracting outwards towards the pseudocone from deeper parts of the retina. This is discussed in relation to the optical system of the ommatia, and it is suggested that the pigment migration will lead to a widening of the receptive field.

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California Inst. of Tech. Antenna Lab., Pasadena.

ANTENNA RADIATION IN A MOVING DISPERSION MEDIUM, by K. S. H. Lee and C. H. Papas. Feb. 1965 [21]p. incl. diagrs. (Technical rept. no. 34) (AFOSR-65-0653) (AF 49(638)1266) AD 614275
Unclassified

Also published in IEEE Trans. Antennas and Propagation, v. AP-13: 799-804, Sept. 1965.

The general problem of calculating the radiation field of an antenna immersed in a moving dispersive medium is formulated as an algebraic equation in wave-vector frequency space for the potential 4-vector in the rest frame of the antenna, and is solved in terms of a Green's function having the form of a one-dimensional integral. The special case where the moving medium is a homogeneous ionized gas and the antenna is an oscillating dipole is studied in detail. It is found that the far-zone field is not transverse and the Poynting vector is not purely radial.

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California Inst. of Tech. Antenna Lab., Pasadena.

RADIATION RESISTANCE OF AN OSCILLATING DIPOLE IN A MOVING MEDIUM, by P. Daly, K. S. H. Lee, and C. H. Papas. [1965] [5]p. (AFOSR-66-0545) [AF 49-(638)1266] AD 644573 Unclassified

Also published in IEEE Trans. Antennas and Propagation, v. AP-13: 583-587, July 1965.

The radiation resistance of an oscillating electric dipole immersed in a moving medium is calculated by Brillouin's "EMF method." Two cases are studied in detail: (1) the moving medium is simple, and (2) the moving medium is an ionized gas (plasma). It is found that in case 1, the motion of the medium tends to increase the radiation resistance, whereas in case 2, the motion of the medium tends to decrease the radiation resistance. A comparison is made between Frank's well-known theory of the radiation from an oscillating dipole moving through a material medium and the results obtained in this paper. (Contractor's abstract)

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California Inst. of Tech. [Antenna Lab.] Pasadena.

ON THE ATTENUATION OF TRANSIENT FIELDS BY IMPERFECTLY CONDUCTING SPHERICAL SHELLS, by C. W. Harrison, Jr. and C. H. Papas. [1965] [7]p. incl. diagrs. (In cooperation with Sandia Corp., Albuquerque, N. M.) [AF 49(638)1266]
Unclassified

Published in IEEE Trans. Antennas and Propagation, v. AP-13: 960-966, Nov. 1965.

Exact formulas for the electric and magnetic fields at any arbitrary point within a cavity region completely enclosed by a conducting spherical shell of arbitrary size are derived under the assumption that the exciting electromagnetic field is a linearly polarized monochromatic, plane wave falling on the external surface of the shell. It is shown that the polarization of the electromagnetic field at the center of the cavity is the same as the polarization of the incident wave. From a knowledge of this steady-state solution, the time history of the electromagnetic field at the center of the cavity is calculated for the case where the incident wave is a Gaussian pulse. Numerical information on the effectiveness of the aluminum and copper shields under steady-state and transient conditions is provided for several pulse durations, shield sizes and wall thicknesses. (Contractor's abstract)

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[California Inst. of Tech. Antenna Lab., Pasadena]

PERTURBATION THEORY OF MICROWAVE INTERACTION WITH GYROELECTRIC PLASMAS, by E. R. Nagelberg. [1965] [7]p. incl. diagrs. refs. [AF 49-(638)1266] Unclassified

Published in Jour. Math. Phys., v. 6: 44-50, Jan. 1965.

As a means of determining the effects of a uniform but arbitrarily directed magnetic field on cylindrical and spherical wave propagation in a cold, homogeneous plasma, the magnetic field is regarded as a small perturbation. Assuming an expansion for the electric and magnetic fields in powers of the parameter $i\omega_g/\omega$,

where ω_g is the static gyrofrequency of the electron, the linear terms are solved. This solution is carried out under the assumption that the fields are known for the limit of vanishing static magnetic field. The first-order theory is then applied to cylindrical and spherical systems. When the approximate solution for the axially magnetized column is compared with the exact result, agreement is obtained provided that the static magnetic field is weak, as expected. (Contractor's abstract)

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California Inst. of Tech. [Dept.] of Biology, Pasadena.

THE DEMONSTRATION AND MANIPULATION OF A CIRCADIAN RHYTHM IN A SINGLE NEURON, by F. Strumwasser. [1965] [21]p. incl. illus. diagrs. refs. (AFOSR-65-2751) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1447 and Army Medical Research and Development Command) AD 628727 Unclassified

Also published in Circadian Clocks, ed. by J. Aschoff. Amsterdam, North-Holland Publishing Co., 1965, p. 442-462.

It is demonstrated that a circadian and fortnight lunar rhythm exist in one of the nerve cells of an isolated ganglion from the sea hare, Aplysia californica. The circadian rhythm can be conditioned by exposure of the intact organism to controlled cycles of light followed by darkness. Furthermore, it can be phase shifted by temperature pulses applied to the isolated ganglion and by the intracellular injection of such agents as actinomycin D which are known to block messenger RNA synthesis and hence protein synthesis.

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California Inst. of Tech. [Dept.] of Biology, Pasadena.

NERVOUS FUNCTION AT THE CELLULAR LEVEL, by F. Strumwasser. [1965] [26]p. incl. table, refs. (Sponsored jointly by [Air Force Office of Scientific Research under AF 49(638)1447] and Army Medical Research and Development Command) Unclassified

Published in Ann. Rev. Physiol., v. 27: 451-476, 1965.

Certain aspects of nervous function at the cellular level, with emphasis on the current themes available from a survey of the literature through Sept. 1964 are reviewed. The topics covered are: the mechanisms of synaptic transmission, comparative aspects of chemically and electrically excitable membranes, investigations on glia in the nervous system, and the nature of intercellular and intracellular events related to developmmental and long-term processes in nervous systems.

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California Inst. of Tech. [Dept. of Electrical Engineering] Pasadena.

AN EXPERIMENTAL STUDY OF THE HYDROMAGNETIC WAVEGUIDE, by R. H. Hertel. Jan. 1965, 123p. incl. illus. diagrs. refs. (Technical rept. no. 3) (AFOSR-65-0726) (AF 49(638)1462) AD 615630 Unclassified

The hydromagnetic waveguide consists of a cylindrical metal tube filled with a longitudinally magnetized plasma. Among the classes of waves which propagate in this system are the compressional hydromagnetic modes, characterized by a waveguide cutoff at low frequencies and by a resonance at the electron cyclotron frequency. This paper presents the results of observations of the propagation of such waves in a decaying hydrogen plasma at frequencies from 0.8 to 3.4 times the ion cyclotron frequency. The phase shift and attenuation of the waves are interpreted in terms of the ion density and the temperature by applying a theory based on a three-fluid description of the plasma. Spectroscopic measurements of the H_β line profile and absolute intensity are used to check the density and temperature inferred from the wave measurements. The results of this study indicate that a simple approximate relationship between the phase factor and density obtained by neglecting dissipation gives densities which agree well with the spectroscopic measurements. A journal publication, Experimental Study of Compressional Hydromagnetic Waves, by D. G. Swanson, R. W. Gould, and R. H. Hertel (Phys. Fluids, v. 7: 269-277, Feb. 1964) is appended to this report.

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California Inst. of Tech. [Div. of Chemistry and Chemical Engineering] Pasadena.

APPARATUS FOR X-RAY DIFFRACTION STUDIES OF LIQUIDS, by S. E. Rodriguez, R. W. Caputi, and C. J. Pings. [1965] [5]p. incl. illus. diagrs. (AFOSR-65-1242) (AF 49(638)1273) AD 618428 Unclassified

Also published in Rev. Scient. Instr., v. 36: 449-453, Apr. 1965.

A sample enclosure compatible with the Norelco goniometer permits x-ray diffraction measurements on liquids confined under their own vapor pressure or an inert gas. Diffraction is in reflection-type geometry using a free liquid surface. The prototype, made of plastic, has been operated between 0 and 50°C on samples of liquid gallium, liquid mercury, and mercury-gallium mixtures. (Contractor's abstract)

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California Inst. of Tech. Div. of Chemistry and Chemical Engineering, Pasadena.

X-RAY DIFFRACTION STUDIES OF STABLE AND SUPERCOOLED LIQUID GALLIUM, by S. E. Rodriguez and C. J. Pings. [1965] [3]p. incl. diagrs. table, refs. (AFOSR-65-1366) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1273 and Office of Naval Research) AD 618429 Unclassified

Also published in Jour. Chem. Phys., v. 42: 2435-2437, Apr. 1, 1965.

X-ray diffraction studies of stable and supercooled liquid gallium (mp 29.8C) between 0 and 50°C show no important dependence of internal structure on temperature. Atomic radial-distribution functions were determined for 0, 10, 20, 29.5, 30, and 40 and 50°C, from diffraction data to S = 11/A-1. Diffraction measurements were made in reflection geometry with silver Kα radiation, scintillation counter, and pulse-height analyzer. The density distribution indicates 11 near neighbors. A Ga-Ga complex is also indicated.

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California Inst. of Tech. Div. of Chemistry and Chemical Engineering, Pasadena.

ABSORPTION OF SOUND IN CRITICAL MIXTURES, by C. J. Pings and A. V. Anantaraman. [1965] [2]p. incl. diagr. (AFOSR-65-1636) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-1273 and Office of Naval Research) Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 781-782, May 10, 1965.

The Fixman theory for sound absorption in fluids in the vicinity of gas-liquid and liquid-liquid critical points is investigated experimentally. Results are obtained for the nitrobenzene-iso-octane system which include measurements over the full composition range for frequencies between 4.5 and 16.5 mc/sec and for temperatures of 30.5, 34.8, and 44.8°C. The experimental data lend substantial credence to the functional dependence of sound absorption upon temperature and frequency as predicted by Fixman.

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California Inst. of Tech. Div. of Chemistry and Chemical Engineering, Pasadena.

X-RAY ABSORPTION FACTORS FOR CYLINDRICAL SAMPLES IN ANNULAR SAMPLE CELLS EXPOSED TO INCIDENT BEAMS OF LIMITED WIDTH, by A. P. Kendig and C. J. Pings. [1965] [7]p. incl. diagrs. tables. (AFOSR-65-1637) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1273 and Office of Naval Research) AD 624002 Unclassified

Also published in Jour. Appl. Phys., v. 36: 1692-1698, May 1965.

Expressions are derived for x-ray absorption factors for a liquid or amorphous sample confined within a cylindrical sample cell. Sufficient geometrical parameters are included in the formulation to cover many experimental cases of practical interest. Various integrals involved are formulated in numerical calculus formulas adaptable to digital computer procedures. The statistical error caused by subtracting the cell background from the scattering of a cell and sample can be reduced substantially by limiting the volume of the cell material irradiated. The absorption factors calculated apply to uniform beams only; the approximation of absorption factors for nonuniform beams is discussed. (Contractor's abstract)

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California Inst. of Tech. Div. of Chemistry and Chemical Engineering, Pasadena.

SATURATED LIQUID DENSITY OF CARBON TETRAFLUORIDE FROM 90° TO 150°K, by C. M. Knobler and C. J. Pings. [1965] [2]p. incl diagr. table. (AFOSR-65-1638) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1273 and Office of Naval Research) AD 623996 Unclassified

Also published in Jour. Chem. and Eng. Data, v. 10: 129-130, Apr. 1965.

Because of a discrepancy in available data, measurements were made of the saturated liquid density of carbon tetrafluoride at 16 temperatures between 90° and 150°K. The experimental density values determined are compared with those calculated from the equation $d(g/cm^3) = 2.254 - 3.64 \times 10^{-3}T - 5.40 \times 10^{-6}T^2$ and with those from other investigations. The value reported for the coefficient of thermal expansion in the temperature range 94° to 107°K is in good agreement with Croll and Scott's value of $2.59 \pm 0.04 \times 10^{-3}$/°K. The standard deviation of the measured points from the smooth curve in the range 94° to 150° is 7.1×10^{-4} g/cm^3.

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California Inst. of Tech. Div. of Chemistry and Chemical Engineering, Pasadena.

IMPROVED APPROXIMATION FOR INCOHERENT X-RAY SCATTERING, by S. E. Rodriguez and C. J. Pings. [1965] [2]p. incl. table. (AFOSR-65-1639) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1273 and Office of Naval Research) AD 617876 Unclassified

Also published in Acta Cryst., v. 18: 979-980, May 1965.

In the approximation for incoherent x-ray scattering presented, the entire decrease in atomic factor f is assigned to outer orbitals. The equation then becomes $I_{inc} = Z - f$. This approximation has special attraction for cases where exchange terms are important. Oxygen and germanium are used as examples and the values determined are compared to values obtained by quantum-mechanical means and James' equation $I_{inc} = Z - f^2/Z$. The new approximation appears superior for both elements.

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California Inst. of Tech. [Div. of Chemistry and Chemical Engineering] Pasadena.

DIAPHRAGM PRESSURE TRANSDUCER, by W. I. Honeywell and C. J. Pings. [1965] [3]p. incl diagrs.

(AFOSR-65-1640) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1273 and Office of Naval Research) AD 623998 Unclassified

Also published in Rev. Scient. Instr., v. 36: 754-756, June 1965.

A diaphragm pressure transducer has been developed for the purpose of separating a sample fluid from a hydraulic oil used in a dead weight tester. The diaphragm null position is determined by a commercially available magnetic sensing unit. The null position shifts systematically with a absolute pressure, but the shift is reproducible and may be calibrated. With the output scheme utilized, the unit has a sensitivity of 0.00007 atm and a reproducibility of 0.0003 atm. The equipment has been used extensively at pressures up to 70 atm, but as designed should be operable to much higher pressures. The equipment described includes a small injector for refined pressure adjustments. (Contractor's abstract)

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California Inst. of Tech. Div. of Chemistry and Chemical Engineering, Pasadena.

THE CONTINUOUS ABSORPTION SPECTRUM OF IODINE MONOCHLORIDE, by E. B. Nebeker and C. J. Pings. [1965] [1]p. incl. diagr. (AFOSR-65-2368) (AF 49(638)1273) AD 629253 Unclassified

Also published in Jour. Phys. Chem., v. 69: 2483, July 1965.

Quantitative extinction coefficients are measured for iodine monochloride between 220 and 600 mu and compared with the data of Seery and Britton (Jour. Phys. Chem., v. 68: 2263, 1964), Binder (Phys. Rev., v. 54: 114, 1938), and Gibson and Ramsperger (Phys. Rev., v. 30: 598, 1927).

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California Inst. of Tech. Div. of Chemistry and Chemical Engineering, Pasadena.

REFRACTIVE INDEX AND LORENTZ-LORENZ FUNCTION FOR SATURATED ARGON, METHANE, AND CARBON TETRAFLUORIDE, by C. P. Abbiss, C. M. Knobler and others. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-2369) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-1273 and Office of Naval Research) AD 629252 Unclassified

Also published in Jour. Chem. Phys., v. 42: 4145-4148, June 15, 1965.

By means of the principle of minimum deviation, the refractive index was determined for argon, methane, and carbon tetrafluoride as saturated liquids from the triple point to the critical point. For argon, some measurements were also made on the saturated gas. For argon and methane, known values of the densities were used to compute the Lorentz-Lorenz function over the entire range of the saturation curve. For carbon tetrafluoride these computations were made only up to 0.7 of the critical temperature due to the lack of density data at higher values. The Lorentz-Lorenz function varies little with density and temperature for the three liquid phases. The argon measurements indicate definite increases in the Lorentz-Lorenz function on isothermal condensation. (Contractor's abstract)

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California Inst. of Tech. [Div. of Chemistry and Chemical Engineering] Pasadena.

THERMODYNAMICS OF CHEMICAL COUPLING, by C. J. Pings and E. B. Nebeker. [1965] [6]p. incl. diagr. refs. (AFOSR-66-0302) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)1273 and Research Corporation) AD 629249 Unclassified

Also published in I and EC Fundamentals, v. 4: 376-381, Nov. 1965.

The applicability of irreversible thermodynamics to coupled chemical reactions is discussed. Coupling is distinguished from the common phenomenon of interference, and a sufficient condition for the existence of nontrivial chemical coupling is given. The phenomenological coupling coefficients are identified for a particular example of a reacting system near equilibrium. Linear transformations which destroy the Onsager relations, or which eliminate the coupling of chemical reactions, are shown to be not generally applicable; any such given transformation can be used only for a particular initial state of the system. Also, the physical significance of the stoichiometry of such transformed reactions is questionable. (Contractor's abstract)

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California Inst. of Tech. Div. of Chemistry and Chemical Engineering, Pasadena.

DIRECT EXPERIMENTAL TEST OF THE PY AND CHNC INTEGRAL EQUATIONS, by P. G. Mikolaj and C. J. Pings. [1965] [4]p. incl. diagrs. refs. (AFOSR-66-0340) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1273 and Office of Naval Research) AD 629250 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 849-852, Nov. 29, 1965.

Radial distribution function and direct correlation function data for liquid argon were used to test fundamental hypotheses underlying the derivations of the Percus-Yevick and convoluted hypernetted chain integral equations, with the conclusion that these equations have systematic density-dependent defects.

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California Inst. of Tech. Gates and Crellin Labs. of Chemistry, Pasadena.

MECHANISMS OF PHOTOCHEMICAL REACTIONS IN SOLUTION. XXXII. ASYMMETRIC INDUCTION DURING ENERGY TRANSFER, by G. S. Hammond and R. S. Cole. [1965] [2]p. incl. diagr. refs. (Contribution no. 3246) (AFOSR-66-0883) (AF 49(638)1479) AD 635425 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 3256-3257, July 20, 1965.

The generalized energy transfer reaction considered is $D^* + A \rightarrow D + A^*$. There is considerable evidence that transfer of triplet excitation requires molecular contact between donor and acceptor. Under such circumstances stereochemical factors may be of importance in determining the efficiency of transfer, and one might anticipate that an optically active donor would show selection between the d and l isomers of a racemic substrate. Studies are reported that verify these expectations.

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California Inst. of Tech. Gates and Crellin Labs. of Chemistry, Pasadena.

NITROGEN-15 MAGNETIC RESONANCE SPECTROSCOPY. VI. PYRIMIDINE DERIVATIVES, by B. W. Roberts, J. B. Lambert, and J. D. Roberts. [1965] [3]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)-1479], National Science Foundation, and Public Health Service) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 5439-5441, Dec. 5, 1965.

Proton and nitrogen-15 magnetic resonance spectra of several derivatives of pyrimidine have been studied. Long-range ^{15}N-H couplings were observed in uracil-$^{15}N_2$, 2,4-dichloropyrimidine,$^{15}N_2$, 2,4-dimethoxypyrimidine-$^{15}N_2$, 1-methyl-4-methoxy-2-pyrimidone-$^{15}N_2$, and 1-methylcytosine-$^{15}N_3$. A particularly large $^{15}N_{(1)}$-C-H coupling (12.5 cps) has been observed in 2,4-dichloropyrimidine-$^{15}N_2$. 1-Methylcytosine-$^{15}N_3$ has been shown to protonate at $N_{(3)}$ in agreement with previously reported work on 1-methylcytosine labeled only in the amino group. (Contractor's abstract)

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California Inst. of Tech. [Graduate Aeronautical Labs.] Pasadena.

THEORY OF LAMINAR NEAR WAKE OF BLUNT BODIES IN HYPERSONIC FLOW, by B. L. Reeves and L. Lees. [1965] [14]p. incl. diagrs. refs. (Publ. no. 617) (AF 49(638)1298) AD 626810 Unclassified

Presented at Second AIAA Aerospace Sciences meeting, New York, Jan. 25-27, 1965.

Also published in AIAA Jour., v. 3: 2061-2074, Nov. 1965.

The problem of laminar flow in the near wake of blunt bodies is discussed. A theoretical model is employed which emphasizes 2 essential regions. In the first region, fluid is entrained by the shear layer from an irrotational external stream, and, simultaneously, fluid is scavenged by the shear layer from the recirculating viscous flow at the base. In the second region, which always commences upstream of the rear stagnation point, the turning of the flow in the inner viscous wake produces a strong viscous-inviscid interaction and generates a series of compression waves that eventually coalesce into a neck or wake shock. By means of this model, the near-wake solution is determined by a set of joining conditions for the 2 regions and also by a singular point in the neck which is shown to be analogous to the critical point of the Crocco-Lees theory. The viscous interaction solution is obtained by means of a moment-integral method and follows the previous work by the authors on separated and reattaching laminar flows. Results of the present theory are in good agreement with the near-wake experiments of Dewey for adiabatic flow over a circular cylinder. (Contractor's abstract)

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[California Inst. of Tech. Graduate Aeronautical Labs., Pasadena].

THE ELECTRICAL CONDUCTIVITY OF SEEDED GASES, by T.-F. Zien. [Final rept.] pt. 2 [1965] [24]p. incl. diagrs. refs. (AFOSR-65-2018) [AF 49(638)1348] AD 627900 Unclassified

A crude but simple method of evaluating the electrical conductivity of seeded-plasma, applicable to both equilibrium and non-equilibrium cases is presented. A simplified method, that of the mean-free-path, is used in which the force acting on an electron due to the externally applied electric field is considered the only force that causes collision between the electron and the neutral atom or molecule. This method does not consider the effect of the ions; however, in the ordinary practice of seeding, the seeding fraction is usually less than 1% and the temperature rarely exceeds 3000°K. Under these circumstances the effect of ions is believed to be negligible. Satisfactory results are obtained in the temperature range of practical interest, but serious error may occur when applying this method to higher temperature regions where the ionization becomes so significant that Coulomb interaction is important.

203

[California Inst. of Tech. Graduate Aeronautical Labs., Pasadena]

BIBLIOGRAPHY ON MHD CHANNEL FLOW, by K. Harstad. [Final rept.] pt. 3 [1965] [17]p. incl refs (AFOSR-65-2019) [AF 49(638)1348] AD 627901 Unclassified

A bibliography of one hundred and seventy references is presented on magnetohydrodynamic channel flow. The references are arranged alphabetically by author, generally with brief annotations.

204

[California Inst. of Tech. Graduate Aeronautical Labs., Pasadena].

SOME PROBLEMS IN MHD PIPE FLOW, by J. D. Cole and P. Caseau. [Final rept.] pt. 4 [1965] [24]p. (AFOSR-65-2020) [AF 49(638)1348] AD 627902 Unclassified

The methods of boundary layer theory are systematically applied in order to obtain information about the distribution of flow in a cross section. Although the work is based on incompressible flow it is believed that the essential differences found between insulator and electrode boundary-layers is a general feature of all magnetohydrodynamic channel flows.

205

California Inst. of Tech. Graduate Aeronautical Labs., Pasadena.

SOME EXPERIMENTAL OBSERVATIONS ON THE NONLINEAR VIBRATION OF CYLINDRICAL SHELLS, by M. D. Olson. [1965] [3]p. incl. diagrs. [AF 49(638)-1364] Unclassified

Published in AIAA Jour., v. 3: 1775-1777, Sept. 1965.

In preparing for flutter experiments, vibration tests were performed on several cylindrical shells. Qualitatively, when any mode of the shell was forced into resonance and the pickup was positioned at a longitudinal nodal line, the Lissajous figure for the vibration was a horizontal figure 8 of relatively small height. It was also observed, that as any mode was driven to increasing amplitudes by increasing the driver voltage, at some critical amplitude the vibration would become unstable. Although no quantitative data were obtained, it was observed that this critical amplitude depended on the circumferential wave number n. It is suspected that this is evidence of the occurrence of the companion mode instability observed in the ring vibrations. The experimental results presented support the thesis that the nonlinear vibrations of thin cylindrical shells in mode shapes with long axial wavelengths exhibit many of the phenomena previously observed for thin cylindrical rings. In particular, for amplitudes of the order of the shell thickness, the vibrations exhibit a slight nonlinearity of the "softening" type.

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California Inst. of Tech. Graduate Aeronautical Labs., Pasadena.

SUPERSONIC FLUTTER OF CIRCULAR CYLINDRICAL SHELLS SUBJECTED TO INTERNAL PRESSURE AND AXIAL COMPRESSION, by M. D. Olson. Apr. 1965, 98p. incl. illus. diagrs. tables, refs. (Aeroelasticity and Structural Dynamics rept. no. SM 65-7) (AFOSR-65-0599) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1364 and National Aeronautics and Space Administration) AD 619729 Unclassified

Results of recent experiments on the flutter of circular cylindrical shells in the Mach number range 2.5-3.5 are presented. Three shells with radius-to-thickness ratios of 2000 were subjected to radial external pressure loadings and to combinations of axial compressive loading and internal pressurization while in the presence of an external axially-directed supersonic flow. Small amounts of internal pressurization were very stabilizing with respect to flutter, but moderate amounts reduced stability to the unpressurized level. However, high internal pressures completely stabilized the shells. The axial compressive loading was slightly destabilizing for moderate amounts of internal pressurization. There was no apparent danger of destruction of models even for the most violent flutter conditions which occurred just prior to buckling under radial external pressure loading and just after buckling under axial compressive loading. Buckled portions of a shell did not flutter. It appears that the large local curvatures encountered in the buckling of a cylindrical shell have a marked stabilizing effect on the shell locally. However, it also appears that the localized buckling usually encountered in practice significantly reduces the stability of any unbuckled regions of the shell.

207

California Inst. of Tech. Graduate Aeronautical Labs.] Pasadena.

ERROR ESTIMATES FOR LUKE'S APPROXIMATION FORMULAS FOR BESSEL AND HANKEL FUNCTIONS, by H. Krumhaar. [1965] [11]p. incl. refs. (AFOSR-66-2627) [AF 49(638)1364] AD 639772 Unclassified

Also published in Zeitschr. Angew Math. und Mech., v. 45: 245-255, 1965.

Error estimates are presented for approximation formulas for Bessel functions $J_n(z)$ and for the Hankel functions $H_0^{(1)}(z)$ and $H_1^{(2)}(z)$. These approximation formulas are obtained by means of the trapezoidal rule according to Luke. The error estimates are valid in the case of Bessel functions for arbitrary real or complex argument z, they hold in the case of the Hankel functions for arguments z with a positive imaginary part. Use is made of Luke's results, some of them are repeated in order to make this paper self-contained. In order to derive the error estimates for the Hankel functions some inequalities are engaged for the Gamma function with certain complex arguments and for Bessel functions of certain complex orders. (Contractor's abstract)

208

California Inst. of Tech. [Graduate Aeronautical Labs.] Pasadena.

STABILITY OF SPINNING SPACE STATIONS DUE TO CREW MOTION, by W. T. Thomson and Y. C. Fung. [1965] [6]p. incl. diagrs. (AFOSR-65-2472) [AF AFOSR-63-352] AD 621861 Unclassified

Also published in AIAA Jour., v. 3: 1082-1087, June 1965.

The stability of a spinning space station due to periodic motions of the crew is considered. It is shown by a few examples that instability may occur if the period of an astronaut's motion bears certain ratios to the half-period of the spin of the satellite. For example, if he moves back and forth along a radius of a circular, planar satellite, instability will occur when the period of his motion is approximately an integral multiple of the half-period of the satellite spin. A similar conclusion holds if the astronauts move with constant speed or oscillate periodically in circumferential direction. The heavier the moving masses are, relative to the satellite, or the larger their amplitude of motion, the wider will be the regions of instability. General equations are given which are useful for analyzing other modes of crew motion or for other problems such as passive damping of a spinning satellite. (Contractor's abstract)

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California Inst. of Tech. [Guggenheim Jet Propulsion Center] Pasadena.

RECOMBINATION RATES AND NON-EQUILIBRIUM ELECTRICAL CONDUCTIVITY IN A SEEDED PLASMA (Abstract), by E. E. Zukoski. [1965] [1]p. (Bound with its AFOSR-65-1286; AD 622527) (AF 49(638)1285) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Experimentally determined values of electrical conductivity and electron temperature have been measured in a non-equilibrium seeded plasma. These results are in good agreement over a wide range of parameters with values calculated from a two-temperature model of the plasma. There is no doubt that the two-temperature model is valid over a wide range of gas temperatures, seed concentrations, and current densities for the argon-potassium and helium-potassium plasmas. However, the model does not give an accurate description of the plasma when the current density is below about 0.4 amp/cm^2; in this range the omission of the influence of atom-atom excitation and the influence of non-equilibrium excited state populations may explain the discrepancy between experiment and theory. In addition, the electron-electron-ion collisional recombination rate for potassium has been measured in the argon-potassium system. The range of electron temperatures investigated was between 1900°K and 3000°K with electron densities between 3×10^{13} and $4 \times 10^{14}/cm^3$. The measured values show a scatter of 60% about theoretical values calculated from present recombination rate theory employing the Gryzinski classical collision cross sections.

210

California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

ABSOLUTE INTENSITY MEASUREMENTS FOR THE 2.7 μ BAND OF WATER VAPOR IN A SHOCK TUBE, by R. W. Patch. [1965] [30]p. incl. illus, diagrs. tables, refs. (AFOSR-65-2488) (AF AFOSR-63-71) AD 629612 Unclassified

Also published in Jour. Quant. Spectros. and Radiative Transfer, v. 5: 137-164, 1965.

The apparent spectral absorption coefficients of the H_2O infrared bands in the vicinity of 2.7 μ were measured in a shock tube behind reflected shock waves in an Ar-H_2O mixture. By interrupting an infrared beam at a 60 kc rate and projecting this beam across the shock tube to a monochromator, it was possible to measure simultaneously both emission and absorption of H_2O at 1000°K. The spectral absorption coefficients obtained from emission measurements averaged 9.8% higher than absorption measurements, probably due to experimental errors (smaller than usually encountered in shock tube measurements). At 1933°K experimental difficulties precluded simultaneous measurement of infrared emission and absorption, so measurements were restricted to emission. The apparent absorption coefficients were integrated to give the integrated absorption coefficients for the collection of bands near 2.7 μ. Integrated absorption coefficients were 49.8 cm^2 atm^{-1}, 54.7 cm^2 atm^{-1} and 31.6 cm^2 atm^{-1} for absorption at 1000°K, emission at 1000°K, and emission at 1933°K, respectively. The 2 values at 1000°K were in good agreement with those of Goldstein, who made no measurements above this temperature. (Contractor's abstract)

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California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

NONEQUILIBRIUM ELECTRICAL CONDUCTIVITY MEASUREMENTS IN ARGON AND HELIUM SEEDED PLASMAS, by E. E. Zukoski and T. A. Cool. [1965] [2]p. incl. diagrs. (Publication no. 165) (AFOSR-65-1419) (AF AFOSR-63-160) AD 622740 Unclassified

Also published in AIAA Jour., v. 3: 370-371, Feb. 1965.

Experimental and calculated conductivity measurements are presented as a function of current density for the argon-potassium system with neutral gas temperatures of 1500°K ± 30°K and 2000°K ± 100°K at 1 atm pressure. Measurements were also made for helium-potassium conductivity and relaxation times at 2000° ± 100°K. Conductivity values were calculated as in a similar but less extended study by Zukoski, Cool, and

Gibson (AIAA Jour., v. 2: 1410-1417, 1964). Good agreement exists between experimental and calculated values of conductivity for both systems.

212

California Inst. of Tech. Palomar Observatory, Pasadena.

A SEARCH FOR INTERSTELLAR ICE ABSORPTION IN THE INFRARED SPECTRUM OF MU CEPHEI, by R. E. Danielson, N. J. Woolf, and J. E. Gaustad. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-1080) (In cooperation with Mount Wilson Observatory, Pasade a, Calif.) (AF 49(638)1323) AD 619133 Unclassified

Also published in Astrophys. Jour., v. 141: 116-125, Jan. 1, 1965.

The infrared spectra of μ Cephei and α Orionis obtained in the second flight of Stratoscope II are compared in an attempt to detect an absorption band at 3.1 μ due to interstellar ice particles. The absence of the band suggests that no more than 1/4 of the interstellar reddening is due to ice. The water-vapor bands in the spectra of these 2 supergiants are surprisingly strong, and no satisfactory explanation for this phenomenon is known. (Contractor's abstract)

213

California Inst. of Tech. Palomar Observatory, Pasadena.

OBSERVATIONS OF PROPER-MOTION STARS. II, by O. J. Eggen and J. L. Greenstein. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-1252) (i cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)1323) AD 638864 Unclassified

Also published in Astrophys. Jour., v. 142: 925-933, Oct. 1, 1965.

In the course of an observational program on white dwarfs, results of which have been reported earlier in Astrophys. Jour., v. 141: 83, 1965, colors and spectra of many non-white dwarfs were obtained. A few wide binaries are found to be optical pairs only and the data for these pairs are given. New physical pairs containing white dwarfs were established, and new single white dwarfs were discovered spectroscopically and are listed. This paper lists 12 newly observed white dwarfs of spectral types DA and DF and gives further observations on 2 stars from our earlier work. The RR Lyr variable, AP Ser, is also a visual binary. Photometric ovservations of the faint, physical companion give δ (U-B) = $+0.12^m$ and lead to a luminosity of $M_v = +1.6^m$ at median light of the variable. Stars found not to be white dwarfs during the earlier survey of proper-motion stars are listed. Lowell survey colors were also studied statistically and found to be moderately reliable. Proper-motion stars of color class -1 and most of those of color class 0 are almost certainly white dwarfs. Also, some interesting subdwarf M stars were found, with weak TiO and strong MgH bands.

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California Inst. of Tech. Palomar Observatory, Pasadena.

THE EARLY A STARS. I. ROTATION AND METALLICISM, by P. S. Conti. [1965] [12]p. incl. illus. diagr. table, refs. (AFOSR-66-1255) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49-(638)1323) AD 639013 Unclassified

Also published in Astrophys. Jour., v. 142: 1594-1603, Nov. 15, 1965.

The problem of classifying main-sequence stars near type A0 is reviewed. Attention is drawn to a similar difficulty with regard to Am (metallic-line) stars previously found only as early as A5. Recent detail analysis, using model atmospheres of 2 early A stars, Sirius and 68 τ, have shown abundance anomalies similar to those in Am stars. Since these stars had been classified as normal, it is suggested that other Am stars of early type can be found by improved methods, one of which is discussed here. The line strength of the strong line of ionized scandium at λ 4246 relative to the line of ionized strontium at λ 4215, indicates the presence of an Am star. In normal stars these two lines have the same strength, but in Am stars as well as in Sirius and 68 τ the scandium line is considerably weaker. This criterion, which is useful for detection of Am stars over a wide range of effective temperature, is clearly discernible only for sharp-line stars and in spectra of relatively high dispersion. A diagram of rotation as a function of B-V color for the brightest stars in the sky indicates many sharp-line stars near type A0, which have formerly been classified as normal. High-dispersion spectra of most of them show that about one-half have anomalous Sc/Sr line strength. It is probable that they are the heretofore hidden analogues of the later-type Am stars and that the metallic-line phenomena extend into the early A stars. (Contractor's abstract)

215

California Inst. of Tech. Palomar Observatory, Pasadena.

THE COMPOSITION OF MAIN-SEQUENCE STARS OF TYPES A-K IN THE HYADES CLUSTER, by P. S. Conti, G. Wallerstein, and R. F. Wing. [1965] [25]p. incl. diagrs. tables, refs. (AFOSR-66-1256) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1323 and National Science Foundation) AD 639991 Unclassified

Also published in Astrophys. Jour., v. 142: 999-1023, Oct. 1, 1965.

The investigation is designed to test the common assumption that all main-sequence stars in a cluster have the same chemical composition. The chemical composition of main-sequence Hyades stars with B-V colors between 0.0 and +0.9 (spectral types A0V and K2V) were derived. HD 28344 (type G IV) was chosen as the standard star because it has previously been compared to the sun. The compositions of the other stars are identical to that of HD 28344 with the following exceptions. (1) 68 τ displays the abundance anomalies of a

metallic-line star, and (2) there are wide fluctuations in the lithium content of the Hyades stars. To derive a similar composition for the hottest star (HD 73666 of Praesepe) it is necessary to assume that Praesepe is reddened by at least 0.03 mag in B-V. For the coolest stars it appears to be necessary to modify the models by including the contribution of line blanketing to the opacity. Departures from local thermodynamic equilibrium indicated by the low excitation temperatures found for the A stars, apparently have no effect upon the derived abundances. Why HD 73666 and 68 ? lie above the turnoff point of the color-magnitude diagrams of thier clusters is not explained. (Contractor's abstract)

216

California Inst. of Tech. [Palomar Observatory] Pasadena.

ON THE INTERNAL EVOLUTION OF HELIUM STARS, by G. Wallerstein. [1965] [3]p. incl. tables. (AFOSR-66-1276) (AF 49(638)1323) AD 639988 Unclassified

Also published in Astrophys. Jour., v. 142: 1260-1262, Oct. 1, 1965.

A possible sequence of thermonuclear reactions leads to the observed surface composition of helium-rich stars. The O^{18}, N^{14}, and C^{12} abundances are affected by the mixing of He to the surface.

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California Inst. of Tech. Palomar Observatory, Pasadena.

EFFECTIVE TEMPERATURES AND GRAVITIES OF AP, AM, AND NORMAL A-TYPE STARS, by B. Baschek and J. B. Oke. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2773) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)1323) AD 629378 Unclassified

Also published in Astrophys. Jour., v. 141: 1404-1410, May 15, 1965.

Effective temperatures and gravities are determined for selected Ap, Am, and normal A-type stars and it is found that the colors are modified substantially by the presence of abnormally strong metallic lines. The gravities of all stars, with one exception, are those expected of main-sequence stars. The Am stars in the Hyades are systematically hotter than the corresponding normal stars. (Contractor's abstract)

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California Inst. of Tech. Palomar Observatory, Pasadena.

SPECTRA, COLORS, LUMINOSITIES, AND MOTIONS OF THE WHITE DWARFS, by O. J. Eggen and J. L. Greenstein. [1965] [26]p. incl. diagrs. tables, refs. [AF 49(638)1323] Unclassified

Published in Astrophys. Jour., v. 141: 83-107, Jan. 1965.

Spectroscopic and photometric data, most of which are new, are given for 166 white dwarfs together with the available astrometric data. The white dwarfs are divided into 2 groups, each with its specific characteristics in relation to dispersion and absorption. Several stars of individual interest were studied extensively with regard to color, departure from black bodies and motion.

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California Inst. of Tech. Quantum Electronics Labs., Pasadena.

ROTATIONAL MODES IN SPHERICAL-MIRROR RESONATORS, by W. A. Specht, Jr. June 1964, 46p. incl. diagrs. refs. (Scientific rept. no. 2) (AFOSR-64-1311) (AF 49(638)1322) AD 604690 Unclassified

Also published in Jour. Appl. Phys., v. 36: 1306-1313, Apr. 1965. (Title varies)

This work is the examination of a cavity mode approach to the mode structure of a laser. Solutions of the vector wave equation for electromagnetic fields in and between perfectly conducting oblate spheroidal cavities are examined for the case of wavelengths much less than cavity dimensions. These solutions are the field modes in Fabry-Perot type resonators with equal-radius concave spherical mirrors, or with concave-convex spherical mirrors, when the parameters of the oblate spheroids are chosen so that the radii of curvature and spacing on the axis of rotation match those of the resonator mirrors. Expressions for the transverse and longitudinal mode structures are derived. The eigenvalue equations are written, and are solved for the case of the two lowest-order modes.

220

California Inst. of Tech. [Quantum Electronics Labs.] Pasadena.

NONLINEAR EFFECTS IN TRAVELING WAVE LASER AMPLIFIERS, by D. H. Close. May 1965, 214p. (Scientific rept. no. 5) (AFOSR-65-0999) (AF 49(638)1322) AD 621320 Unclassified

Using semiclassical radiation theory, a formalism similar to that used by Lamb in his "Theory of an Optical Maser" is developed for studying the amplification of vector traveling waves in a laser-type medium. The effect of the medium on the waves is given in terms of space (or time) dependent field amplitudes and phases and a nonlinear index of refraction. With particular emphasis on typical gaseous media, the effects of Doppler broadening are treated in detail for arbitrary ratios of natural to Doppler line widths. Lowest order nonlinear effects (due to a polarization cubic in the field amplitudes) are studied extensively, and the frequency dependence of several of these processes is presented in graphical form. The characteristics of these nonlinear processes peculiar to Doppler broadened lines are discussed, and the processes are interpreted in terms of saturation and coherent modulation of the population inversion density.

221

California Inst. of Tech. Quantum Electronics Labs., Pasadena.

SPONTANEOUS RADIATING ATOM IN CAVITY FIELDS, by C. J. Buczek. Apr. 1965, 148p. incl. diagrs. refs. (Scientific rept. no. 4) (AFOSR-65-1000) (AF 49(638)-1322) AD 621319 Unclassified

The characteristics of spontaneous emission from an atom which interacts with a coherent light wave are determined. The competition between coherent photons and spontaneous photons is treated in detail for a system consisting of a stationary atom, an open cavity and spatial fields. It is found that the interaction with the coherent field modifies the spectral distribution of spontaneous radiation from the atom. For spontaneous transitions involving an atomic state which interacts with the coherent field, the spectral distributions can no longer be described by Lorentzian functions. The new distributions exhibit a broadening and splitting for strong interactions between the atom and the coherent field. It is shown that the qualitative features of these new distributions can be predicted from the energy-level diagram of the atom-cavity system. The net probability of the system gaining a coherent or cavity photon is calculated by integrating over the emitted spontaneous frequencies. The equivalence of this approach to the method of computing probabilities by integrating over time is demonstrated by using Parseval's theorem.

222

California Inst. of Tech. Seismological Lab., Pasadena.

SEISMIC RESULTS FOR GNOME AS OBSERVED BY THE CALTECH NETWORK, by G. Dewart. [1965] [5]p. incl. diagr. tables, refs. (AFOSR-66-2254) (AF 49(638)910) AD 624547 Unclassified

The underground nuclear explosion Gnome was recorded at several stations of the Caltech network with P amplitudes as large as or smaller than reported by Romney for Logan and Blanca. Since large amplitudes were reported for propagation to the east the hypothesis is advanced that a more severe shadow zone effect exists for propagation to the west due to different structure of the mantle in the low velocity layer. (Contractor's abstract)

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California Inst. of Tech. Seismological Lab., Pasadena.

A PROCEDURE FOR SOURCE STUDIES FROM SPECTRUMS OF LONG-PERIOD SEISMIC BODY WAVES, by A. Ben-Menahem, S. W. Smith, and T.-L. Teng. [1965] [33]p. incl. diagrs. tables, refs. (AFOSR-65-2913) (AF 49(638)1337) AD 617039 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 203-235, Apr. 1965.

The well-known first motion method of Nakano and Byerly is extended, generalized and combined with recent new ideas in body wave theory in order to set up a routine procedure for extracting source parameters from spectral analysis of isolated P and S pulses recorded at a net of standardized stations around a nonshallow source. The method consists of compensating the observed spectrums for instrumental and propagational effects. A combined study of the resulting radiation patterns, initial phases, and the initial amplitudes will render information regarding the spatial and temporal nature of deep and intermediate earthquake sources as seen through the spectral window of 10-100 sec. The shorter periods can be used for source studies only if an accurate station correction is available. (Contractor's abstract)

224

California Inst. of Tech. Seismological Lab., Pasadena.

RELATIONSHIP BETWEEN SEISMICITY AND GEOLOGIC STRUCTURE IN THE SOUTHERN CALIFORNIA REGION, by C. R. Allen, P. St. Amand and others. [1965] [45]p. incl. diagrs. tables, refs. (AFOSR-65-2914) (In cooperation with Naval Ordnance Test Station, China Lake, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1337 and National Science Foundation) AD 621721 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 753-797, Aug. 1965.

Data from 10,126 earthquakes that occurred in the southern California region between 1934 and 1963 have been synthesized in the attempt to understand better their relationship to regional geologic structure, which is here dominated by a system of faults related mainly to the San Andreas system. Most of these faults have been considered 'active' from physiographic evidence, but both geologic and short-term seismic criteria for 'active' versus 'inactive' faults are generally inadequate.

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California Inst. of Tech. Seismological Lab., Pasadena.

SURFACE WAVE RADIATION PATTERN AND SOURCE MECHANISM OF THE SEPTEMBER 1, 1962, IRAN EARTHQUAKE, by F. T. Wu and A. Ben-Menahem. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2915) (AF 49(638)1337) AD 621761 Unclassified

Also published in Jour. Geophys. Research, v. 70: 3943-3949, Aug. 1965.

Surface waves recorded at stations surrounding the Iran earthquake of Sept. 1, 1962, were Fourier-analyzed; the amplitudes were corrected for instrumental response, geometric spreading, and absorption and are presented as a function of azimuth and frequency. The patterns thus derived are compared with theoretical radiation patterns for different source types, orientation of motion vectors, and other parameters. It is found that the source of the Iran earthquake can be represented as a double couple equivalent to a sinistral reverse shear fault with strike N 80° W, dip 78° to the southwest,

slip angle 63° and a depth of 11 km. This solution agrees well with the conclusion obtained from a first motion study. It is remarkable that solutions obtained over such a wide frequency range conform to each other. (Contractor's abstract)

226

California Inst. of Tech. Seismological Lab., Pasadena.

ATTENUATION OF SEISMIC ENERGY IN THE UPPER MANTLE, by D. L. Anderson, A. Ben-Menahem, and C. B. Archambeau. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-2916) (AF 49(638)1337) AD 616476 Unclassified

Also published in Jour. Geophys. Research, v. 70: 1441-1448, Mar. 15, 1965

The amplitude attenuation and phase dispersion for Love and Rayleigh waves in the period range 50 to 300 sec is determined from 2 earthquakes by digital techniques. A distribution of Q, or anelasticity, is determined for the upper mantle which satisfies the amplitude decay data for Love and Rayleigh waves and which is consistent with available body wave data. An argument is made for a longitudinal wave Q of about 2.4 to 2.6 times the Q for shear waves. This implies that very small losses are involved in pure compression compared to the losses in shear. This is an argument against the importance of certain mechanisms, such as thermoelastic losses, in the mantle. The Q for shear waves in the upper 400 km of the mantle seems to vary from about 50 to about 150. The Q for mantle Rayleigh waves is greater than the Q for mantle Love waves, both theoretically and experimentally. However, it is predicted that QR becomes less than QL at some period shorter than 50 sec, the crossover period being diagnostic of the thickness of the 'Q crust' or lithosphere. (Contractor's abstract)

227

California Inst. of Tech. Seismological Lab., Pasadena.

SEISMIC DIGITAL DATA ACQUISITION SYSTEMS, by S. W. Smith. [1965] [6]p. incl. diagrs. (AFOSR-65-2918) (AF 49(638)1337) AD 618780 Unclassified

Presented at Symposium on Theory and Computers, Moscow and Leningrad (USSR), May 15-21, 1964.

Also published in Rev. Geophys., v. 3. 151-156, Feb. 1965.

Two digital seismograph systems in current operation are described. Together they provide high quality data for experimental studies of earth tides, free oscillations, surface waves, and teleseismic body waves. A broad-band system sampling 3 components 10 times per sec covers the frequency range between 0.003 and 3.0 cps, and a long-period system sampling each of 10 channels every 15 sec covers the range between 0.0 and 0.01 cps. The broad-band system can be used to simulate any desired standard seismograph and provides greater dynamic range and more flexibility than most existing seismographs. The long-period system is currently being used for a free oscillation experiment in which strain and pendulum seismographs record together. (Contractor's abstract)

228

California Inst. of Tech. Seismological Lab., Pasadena.

DETERMINATION OF SOURCE PARAMETERS BY AMPLITUDE EQUALIZATION OF SEISMIC SURFACE WAVES. 2. RELEASE OF TECTONIC STRAIN BY UNDERGROUND NUCLEAR EXPLOSIONS AND MECHANISMS OF EARTHQUAKES, by M. N. Toksöz, D. G. Harkrider, and A. Ben-Menahem. [1965] [16]p. incl. diagrs. tables, refs. (AFOSR-65-2921) (AF 49(638)-1337) AD 613864 Unclassified

Also published in Jour. Geophys. Research, v. 70: 907-922, Feb. 15, 1965.

The radiation patterns of Love and Rayleigh waves from 3-nuclear explosions are studied to determine the nature of the asymmetry of radiation and the mechanism of Love wave generation. From a comparative study of different explosions it is reasoned that the Love waves are generated at the source of the explosion The source function, represented as the superimposition of an isotropic dilatational component due to the explosion and a multipolar component due to the release of tectonic strain energy, is consistent with the observed radiation patterns and the amplitude spectrums The amount of seismic energy due to the strain release is computed. In some cases it is found that this energy may be due to the relaxation of the pre-stressed medium by the explosion-formed cavity. It has been concluded that the explosion must have triggered some other strain release mechanism, such as an earthquake. The amplitude equalization method is applied to surface waves from an earthquake to determine the source parameters.

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California Inst. of Tech. Seismological Lab., Pasadena.

UPPER MANTLE STRUCTURE OF WESTERN NORTH AMERICA FROM APPARENT VELOCITIES OF P WAVES, by M Niazi and D. L. Anderson. May 1965, 33p. incl. diagrs. tables, refs (Contribution no. 1346) (AFOSR-66-0117) (AF 49(638)1337) AD 616298 Unclassified

Also published in Jour. Geophys. Research, v. 70. 4633-4640, Sept. 15, 1965.

Variation of the compressional velocity with depth in the C-region of the upper mantle in Western North America is studied. Apparent velocities of first arrivals across the Tonto Forest Array in Arizona were determined for about 70 shallow focus earthquakes. The epicenters range from 10° to 30° in distance and are mostly south of the array The method gives the slope of the travel time curve directly, the parameter required for a velocity-depth determination. For this distance range it is found that although the slope of the P travel time curve decreases substantially with distance, i.e.,

increasing apparent velocity, the variation is not uniform. Two relatively abrupt changes are observed at distances of about 17° and 24°. These are most readily interpreted as two second order discontinuities in the region of the mantle above 1000 km. Assuming an average crustal structure as derived from seismic refraction measurements and taking the uppermost 200 km of the mantle given by Gutenberg or Jeffreys, various possibilities are explored for the form of variation of the P wave velocity with depth. The discontinuities in the rate of change of velocity with depth which cause the observed breaks in the apparent velocity curve are found to be at depths of about 320 and 640 km. Although no absolute times are required in the method the travel times for the various derived models are computed and compared with standard tables. (Contractor's abstract)

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California Inst. of Tech., Seismological Lab., Pasadena.

A NOTE ON THE EXISTENCE OF RELATIVE MAXIMA AND MINIMA ON PHASE VELOCITY CURVES, by E. N. Thrower and D. G. Harkrider. [1965] [4]p. incl. diagrs. (AFOSR-66-0425) (AF 49(638)1337) AD 627169 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 971-974, Dec. 1965.

Phase and group velocity dispersion curves for fundamental Rayleigh waves have been computed with more precision than previously attempted. The new curves show a relative minimum in phase velocity at periods near 50 sec for 4 perturbed Gutenberg continental models. (Contractor's abstract)

231

California Inst. of Tech., Seismological Lab., Pasadena.

CRUSTAL STRUCTURE IN EAST ANTARCTICA FROM SURFACE WAVE DISPERSION, by G. Dewart and M. N. Toksöz. [1965] [13]p. incl. diagrs. tables, refs. (AFOSR-66-0426) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1337 and National Science Foundation) AD 628463 Unclassified

Also published in Geophys. Jour. Roy Astronom. Soc., v. 10: 127-139, 1965.

The structure of the Earth's crust and the upper mantle in East Antarctica are investigated using the dispersion properties of both the Love and the Rayleigh waves. The group velocities of surface waves between 15 and 70 sec periods are measured over several paths crossing Antarctica from Sandwich Arc and Drake Passage to stations of Wilkes and Mirny. Theoretical dispersion curves are computed for various crust and upper mantle models. The structure that fits the Rayleigh and Love wave data equally well is characterized by a 42 km thick crust and low (7.85 km sec) sub Moho velocities. The average thickness of the ice layer over East Antarctica, between Princess Martha Coast and Wilkes Station, is determined to be about 3 km. The general problem of non-uniqueness in group velocity inversion is also discussed. (Contractor's abstract)

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California Inst. of Tech. [Seismological Lab.] Pasadena.

THE Sa PHASE FROM THE HINDU KUSH EARTHQUAKE OF JULY 6, 1962, by J. N. Brune. [1965] [15]p. incl. diagrs. table, refs. (AFOSR-66-2401) (Sponsored jointly by Air Force Cambridge Research Laboratories, Air Force Office of Scientific Research under AF 49-(638)1337 and U. S. Coast and Geodetic Survey) AD 638278 Unclassified

Also published in Pure and Appl. Geophys., v. 62. 81-95, 1965.

The Hindu Kush earthquake of July 6, 1962 produced an Sa phase (vertical component or Rayleigh type) which was clearly recorded at stations in North America in the distance range 90° to 110°. The propagation of this phase is studied in detail, both by the usual method of measuring velocity of first arrival and also by determining group velocities from the derivative of the phase of the Fourier transform (in the period range 20 to 80 seconds). The energy in the Sa phase propagates in a manner intermediate between that of a single ray and that of a single isolated mode. The expected interference effects which vary as a function of distance are observed and complicate a straight-forward measurement of group velocities. The results are most reliable if only the group velocities corresponding to parts of the spectra with relatively high amplitudes are used. The results show a regional variation in the velocity of the Rayleigh type Sa for continental areas, being higher under shield areas than under areas of more recent tectonic activity. The results are compared with theoretical calculations for the Gutenberg, Jeffreys-Bullen and Canadian Shield models of the Earth and the results indicate regional variations in shear velocity in the upper mantle extending to depths of several hundred km under continents. (Contractor's abstract)

233

California Inst. of Tech. Seismological Lab., Pasadena.

MECHANISM OF DEEP EARTHQUAKES FROM SPECTRUMS OF ISOLATED BODY-WAVE SIGNALS. 1. THE BANDA SEA EARTHQUAKE OF MARCH 21, 1964, by T.-L. Teng and A. Ben-Menahem. [1965] [14]p. incl. diagrs. table, refs. (AFOSR-66-0465) (AF 49-(638)1337) AD 626242 Unclassified

Also published in Jour. Geophys. Research, v. 70: 5157-5170, Oct. 15, 1965.

Spectrums of teleseismic body waves have been obtained for the period range 20-100 sec from the records of a group of USCGS standardized seismograph stations around the source of a deep-focus earthquake in the Banda Sea. Corrections were applied for all the factors which took part in shaping the waveform of the signal during the course of propagation, and the spectrums were extrapolated to the vicinity of the source

according to the equalization procedure described in a previous paper. Radiation patterns drawn from the corrected P wave spectrums over the above period range show that the spatial factor of the source function is independent of frequency up to 0.1 cps. Through a comparison of the empirical radiation patterns with those calculated from an assumed double-couple point source, it was possible to determine the source parameters. These are in good agreement with the solution furnished by first motions. Similar results from S waves confirm the double-couple assumption. All the corrected spectrums confirm the theory that the gross structure of the source time function is of the form $(1 - e^{-t/\tau})H(t)$, with $0 < \tau \leq 10$ sec. From the equalized amplitudes, a quantity L_0ds (source displacement times the area of a virtual fault plane), is found to be 0.125 km^3. Further, by the concept of equivalent source theory, a virtual moment of a volume source can be deduced which leads in a simple way to the total energy of the source. (Contractor's abstract)

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California Inst. of Tech. Seismological Lab., Pasadena.

OBSERVED ATTENUATION AND Q VALUES OF SEISMIC SURFACE WAVES IN THE UPPER MANTLE, by A. Ben-Menahem. [1965] [11]p. incl. diagrs. tables. refs. (AFOSR-66-0467) (AF 49(638)1337) AD 625959 Unclassified

Also published in Jour. Geophys. Research, v. 70: 4641-4651, Sept. 15, 1965.

Attenuation coefficients and Q values of Love and Rayleigh waves in the period range 50-330 sec have been derived from the amplitude spectrums of these waves. Data were obtained from surface wave signals of 12 earthquakes recorded at Pasadena and some other USCGS standardized stations on a variety of seismographs. The resulting absorption parameters, as determined from all seismic events, show a mean scatter of about 10%. Nevertheless, data from each event indicate a systematic higher attenuation (lower Q) for Love waves than for Rayleigh waves. The attenuation coefficients for both waves tend to increase almost linearly with frequency, and the corresponding Q functions are slowly varying in the period range 50-150 sec, with mean values QL = 105 and QR = 145. In contradistinction to the phase velocities, there is not evidence yet for a persistent difference in attenuation of mantle surface waves under oceans and continents.

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California Inst. of Tech. Seismological Lab., Pasadena.

REGIONAL SEISMICITY AND SEISMIC WAVE PROPAGATION FROM RECORDS AT THE TONTO FOREST SEISMOLOGICAL OBSERVATORY, PAYSON, ARIZONA, by S. J. Duda. [1965] [35]p. incl. diagrs. tables, refs. (AFOSR-66-2407) (Sponsored jointly by Air Force Cambridge Research Labs., and Air Force Office of Scientific Research under AF 49(638)1337) AD 316618 Unclassified

Also published in Ann. Geophys., v. 18: 365-397, 1965.

The records of the Tonto Forest Seismological Observatory near Payson, Ariz., were used to investigate the applicability of an array station for the study of local seismicity and seismic wave propagation at short epicentral distances. Inferences are drawn about the seismicity of Ariz. and the characteristics are given for 2 earthquake sequences, in Imperial County, Calif. and in Baja, Calif. The records of the earthquakes and a selection of quarry blasts are used for the study of the propagation of crustal waves.

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California U. Dept. of Astronomy, Berkeley.

THERMODYNAMICS OF A SOLAR COMPOSITION GASEOUS MIXTURE, by M. S. Vardya. [1965] [9]p. incl. tables, refs. (AFOSR-65-2199) (AF AFOSR-63-171) AD 625535 Unclassified

Also published in Monthly Notices Roy. Astronom. Soc., v. 129: 205-213, Oct., 1965.

Computation of several thermodynamic quantities were carried out for a gaseous mixture of solar photospheric chemical composition containing hydrogen in 5 states (H_2^+, H_2, H, H^- and H^+)-helium and 16 other elements in multiple ionization states and with radiation effects included. The discrepancy on various thermodynamic quantities of the neglect of H_2^+ and H^-, of metals and of radiation pressure were estimated. (Contractor's abstract)

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California U. [Dept. of Astronomy] Berkeley.

STUDIES IN STELLAR EVOLUTION. I. THE INFLUENCE OF INITIAL CNO ABUNDANCES IN A STAR OF MASS 2.3, by P. Bodenheimer, J. E. Forbes and others. [1965] [21]p. incl. diagrs. tables, refs. (AFOSR-65-2818) [AF AFOSR-63-171] AD 627966 Unclassified

Also published in Astrophys. Jour., v. 141: 1019-1042, Apr. 1965.

A series of evolutionary sequences have been calculated for a configuration of mass 2.3 magnitude. They cover late pre-main-sequence and main-sequence evolution and differ in their initial chemical compositions. Sequence I begins with concentrations of C, N, and O similar to observed atmospheric values published for stars predominantly of Population I. The C/N and O/N ratios are considerably in excess of their equilibrium values, and there is found to be a pre-main-sequence adjustment period of carbon burning causing an additional pre-main-sequence dip in luminosity on the Hertzsprung-Russell diagram. Sequence IV shows that the dip becomes less marked if the total heavy-element concentration is reduced. Sequence II begins with nearly equilibrium abundances of C^{12} and N^{14} and the carbon dip is not seen. Sequence III illustrates the effect of increasing the O/N ratio and confirms that O^{16} is

only very gradually converted to CN isotopes. The physical approaches and approximations used in these calculations are described in a series of appendices. They are intended to supplement the basic discussion of the numerical technique. They treat the equation of state, opacity, chemical composition changes due to hydrogen burning, chemical homogenization of convective regions and the obtaining of a starting configuration for an evolutionary sequence. (Contractor's abstract)

238

California U. Dept. of Astronomy, Berkeley.

[ATMOSPHERIC MODELS OF THE CENTRAL STARS OF PLANETARY NEBULAE] Atomosphären von Zentralsternen planetarischer Nebel I*, by K.-H. Böhm and W. Deinzer. [1965] [19]p. incl. diagrs. tables, refs. (AFOSR-66-0371) (AF AFOSR-63-171)
AD 641291 Unclassified

Also published in Zeitschr. Astrophys., v. 61: 1-19, 1965.

The calculation of atmospheric models for the central stars of planetary nebulae is discussed. The determination of the effective temperature T_{eff} and the surface gravity g for these stars is based on O' Dell's (1963) recent data. A Fortran program was developed for the purpose of solving simultaneously the equations of hydrostatic and of nongrey radiative equilibrium. The program includes the calculation of the monochromatic absorption coefficients due to H, HeI, HeII, CIII, CIV, NIII, NIV, NV, OIII, OIV, OV, NeII, NeIII, NeIV, NeV. Radiation pressure was taken into account. The equations of nongrey radiative equilibrium are solved by Lucy's (1964) iteration method; this is especially convenient if electron scattering becomes important.

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California U. Dept. of Astronomy, Berkeley.

STUDIES IN STELLAR EVOLUTION. II. LITHIUM DEPLETION DURING THE PRE-MAIN-SEQUENCE CONTRACTION, by P. Bodenheimer. [1965] [11]p. incl. diagrs. tables, refs. (AFOSR-66-0383) (AF AFOSR-63-171) AD 629682 Unclassified

Also published in Astrophys. Jour., v. 142: 451-461, Aug. 15, 1965.

Pre-main-sequence theoretical evolutionary tracks have been calculated for configurations of 6 different masses between 500 and 1200 solar masses in order to determine the extent to which lithium is destroyed in the convective envelopes as a function of mass. The evolutionary sequences are started with an initial amount of lithium based on observed abundances. At each time step in the calculation, reaction rates are calculated in detail, and the resulting chemical compositions are homogenized over the convective envelope. The evolutionary tracks are carried over to the main sequence in order to provide a basis for comparison with recent observations of lithium abundances in main-sequence stars in the Hyades cluster and in the solar neighborhood. The theoretical depletion as a function of position on the main sequence agrees well with the general trend of the observations, for calculations based both on the solar mass-luminosity relation and on the mass-luminosity relation that has been observed for the Hyades. (Contractor's abstract)

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California U., Dept. of Astronomy, Berkeley.

STUDIES IN STELLAR EVOLUTION. III. THE CALCULATION OF MODEL ENVELOPES, by L. Henyey, M. S. Vardya, and P. Bodenheimer. [1965] 14 p. incl. diagrs. refs. (AFOSR-66-1271) (AF AFOSR-63-171)
AD 641297 Unclassified

Also published in Astrophys. Jour., v. 142: 841-854, Oct. 1, 1965.

The formal theory underlying existing techniques for representing the superadiabatic layers in convective envelopes was re-examined. Particular emphasis was placed on the discussion of points of uncertainty and possible controversy. The analysis was carried out in a form which permits the formulation of certain constants, the arbitrariness of whose values represents the inherent uncertainty in the theory. Parallel calculations based on different values of these constants lead to a quantitative evaluation of their effect upon evolutionary tracks in the Hertzsprung-Russell diagram. Marked effects result from uncertainties in the ratio of mixing length to scale height and possibly from inadequate knowledge concerning opacities at low temperatures. (Contractor's abstract)

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California U. [Dept. of Astronomy] Berkeley.

THE TIME EVOLUTION OF AN H II REGION, by W. G. Mathews. [1965] [21]p. incl. diagrs. tables, refs. (AFOSR-66-1582) (AF AFOSR-63-171) AD 641298 Unclassified

Also published in Astrophys. Jour., v. 142: 1120-1140, Oct. 1, 1965.

The dimensions of Strömgren spheres when stellar black-body radiation is first saturated by recombinations are compared to the dimensions of Strömgren spheres in pressure equilibrium. The time scales for the formation of these spheres are compared with the turn-on time for the stellar ultraviolet luminosities and the lifetimes of various stars on the main sequence. The mean absorption coefficient for ionizing hydrogen and the mean photon energy are evaluated as functions of optical depth at the Lyman limit. The equations of hydrodynamics with radiative transfer and cooling by [OII] radiation are differenced. A detailed numerical solution is made for a 30 $\mathfrak{M}_\odot$ star that moves onto the main sequence with the effective temperature and ultraviolet photon luminosity determined from accurate pre-main-sequence evolution tracks of Bodenheimer. On the main sequence $T_* = 41958^\circ K$ and $\mathfrak{Q} = 8.75 \times 10^{48}$

ultraviolet photons/sec. The star is assumed to form in an infinite medium of neutral hydrogen at rest at 100°K. The complete run of gas velocity, density, temperature, pressure, degree of ionization, photon flux, and optical depths are given at time t = 0.919 x 10^4, 3.07 x 10^4 and 6.16 x 10^4 years. It is found that a sharp maximum in the gas temperature follows the ionization front. The cooling by [OII] radiation immediately behind the front and the gradual rise in the equilibrium temperature observed outward from the star keep the velocity of most of the ionized gas in the HII region < 0.1 km/sec. At t = 6.16 x 10^4 years a strong shock is moving ahead of the ionization front into the neutral gas. Allowances for cooling in the neutral gas and magnetic fields are not made. (Contractor's abstract)

242

California U. Dept. of Astronomy, Berkeley.

PRESSURE BROADENING AND OPACITY IN THE M_2V STAR HD_{95735}, by M. S. Vardya and K.-H. Böhm. [1965] 6p. incl. diagrs. table, refs. (AFOSR-66-1592) (AF AFOSR-63-171) AD 641295 Unclassified

Also published in Monthly Notices Roy. Astronom. Soc., v. 131: 89-94, Oct.-Dec. 1965.

The possibility that unknown sources of opacity may exist in the M2V spectral class star, HD95735, has been investigated. The factor by which the known sources of opacity should be multiplied to obtain the opacity obtaining in the star is estimated by comparing the total pressure obtained from model atmosphere and that from pressure broadened wings of λ4227 line of CaI. This factor is close to unity if the effective temperature of the star is about 3400°K, and it increases for lower effective temperatures. The effect of metal abundance has also been considered.

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California U. Dept. of Astronomy, Berkeley.

PRESSURE DISSOCIATION AND MOLECULAR HYDROGEN, by M. S. Vardya. [1965] [6]p. incl. tables, refs. (AFOSR-66-1593) (AF AFOSR-63-171) AD 641296 Unclassified

Also published in Monthly Notices Roy. Astronom. Soc., v. 129: 345-350, Feb. 1965.

The partition functions for molecular hydrogen, with an estimate of pressure dependence included, were calculated, using extension of Heitler-London theory to 3 electron system. These partition functions were used to evaluate the equilibrium constants and internal energies for H_2 as a function of temperature and pressure. Tables of partition functions, equilibrium constants and internal energies have been given for T = 1000° to 15000°K and for pressures as high as 7.7 x 10^9 dyn/cm^2.

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California U. Dept. of Chemistry, Berkeley.

INFRARED SPECTRUM AND VIBRATIONAL ASSIGNMENT FOR CHLORINE MONOXIDE, Cl_2O, by M. M. Rochkind and G. C. Pimentel. [1965] [8]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)944 and National Science Foundation) Unclassified

Published in Jour. Chem. Phys., v. 42: 1361-1368, Feb. 15, 1965.

Infrared studies of chlorine monoxide (O^{16} and O^{18}) in the region 200-4000 cm^{-1} for both gas and condensed phases are presented. The spectra require reassignment of the stretching fundamentals and reveal the previously unknown bending fundamental. The new assignment (solid phase. ν_1 = 630.7, ν_2 = 296.4, ν_3 = 670.8 cm^{-1}) results in a new value for the Cl-O bond stretching force constant, K_r = 2.75 mdyn/A, which is strikingly lower than values previously cited. The bond in chlorine monoxide is proposed as the prototype Cl-O single bond. The low stretching-force constant indicates little ionic character in the Cl-O bond, in disagreement with conclusions based on nuclear quadrupole coupling data. (Contractor's abstract)

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California U. Dept. of Chemistry, Berkeley.

MATRIX PHOTOLYSIS PRODUCTS OF DIAZOMETHANE: METHYLENEIMINE AND HYDROGEN CYANIDE, by C. B. Moore, G. C. Pimentel, and T. D. Goldfarb. [1965] [8]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)944, and Petroleum Research Fund) Unclassified

Published in Jour. Chem. Phys., v. 43: 63-70, July 1, 1965.

Photolysis of diazomethane dimers in solid nitrogen produces methyleneimine, H_2CNH, and HCN, as shown by infrared spectral study. The HCN frequencies show that it forms a strong hydrogen bond to the imine. Deuterium and ^{15}N isotopic substitutions aid in the vibrational assignment of H_2CNH. Normal coordinate analysis indicates that this prototype C=N stretching force constant is (9.3 ± 0.5) x 10^5 dyn/cm despite difficulties in obtaining a satisfactory fit to all of the observed frequencies.

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California U. Dept. of Chemistry, Berkeley.

SPECTROSCOPIC AND THEORETICAL STUDIES OF MOLECULES WITH BONDING WHICH DEVIATES FROM NORMAL VALENCE RULES, by G. C. Pimentel. Final rept. Mar. 1, 1961-Feb. 28, 1965, 11p. incl. refs. (AFOSR-65-0068) [AF AFOSR-63-332] AD 610160 Unclassified

Spectroscopic studies were made of the reactivity and molecular structure of free radicals and reactive molecules using the matrix isolation method. Spectroscopic studies were made of stable molecules selected to develop and expand the applicability of the matrix isolation method. New and novel spectroscopic techniques were developed to facilitate future infrared studies of chemical species with extreme reactivity.

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California U., Dept. of Chemistry, Berkeley.

GAS-LASER FREQUENCY SELECTION BY MOLECULAR ABSORPTION, by C. B. Moore. [1965] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-332] and National Science Foundation) Unclassified

Published in Appl. Opt., v. 4: 252-253, Feb. 1965.

The frequency of a Ne-He laser operating at the 2947.90 cm^{-1} (3.3923-μ) $3s_2 \rightarrow 3p_4$ transition was changed to the nearby frequency of the 2948.79 cm^{-1} (3.3912-μ) $3s_2 \rightarrow 3p_2$ transition by placing CH_4 in the optical resonator and achieving a power level 40% above normal. The use of gas-phase molecular absorption within the laser cavity can discriminate efficiently between 2 frequencies separated by little more than the Doppler line width of the molecular transition. This discrimination is done without introducing into the optical resonator any extra optics or losses at the frequency of the desired transition, as presented in an example.

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California U. Dept. of Chemistry, Berkeley.

HCl CHEMICAL LASER, by J. V. V. Kasper and G. C. Pimentel. [1965] [3]p. incl. diagrs. tables. (AF AFOSR-63-332) Unclassified

Published in Phys. Rev. Ltrs., v. 14: 352-354, Mar. 8, 1965.

Stimulated emission from HCl due to selective vibrational excitation from chemical reactions from a Raman-type multiple reflection cell and from a quartz laser tube were recorded and studied. Results indicated that the emission provides a new avenue to the determination of energy distribution among degrees of freedom in chemical reactions.

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California U. Dept. of Chemistry, Berkeley.

INFRARED DETECTION OF DIIMIDE, N_2H_2, AND IMIDOGEN, NH, BY THE MATRIX ISOLATION METHOD, by K. Rosengren and G. C. Pimentel. [1965] [10]p. incl. diagrs. tables, refs. (AF AFOSR-63-332) Unclassified

Published in Jour. Chem. Phys., v. 43: 507-516, July 15, 1965.

Hydrazoic acid labeled with deuterium and ^{15}N was photolyzed in solid nitrogen at 20°K. The ^{15}N multiplet splitting positively identifies absorptions of photolysis products as those of trans-N_2H_2 (at 1286 cm^{-1}), trans-HNND (at 1181 and 1058 cm^{-1}), trans-N_2D_2 (at 946 cm^{-1}), and cis-N_2H_2 (at 3074 and 1279 cm^{-1}). The spectrum of trans-N_2H_2 is in agreement with a planar symmetric structure and the vibrational frequencies are quite close to corresponding vibrations of ethylene. Imidogen, NH, was also observed in both solid argon and in solid nitrogen as another photolysis product. The ^{15}N splitting in the ammonia absorption shows that the ammonia dimer in solid nitrogen has a cyclic structure.

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California U. Dept. of Chemistry, Berkeley.

INFRARED DETECTION OF REACTIVE SPECIES PRODUCED THROUGH FLASH PHOTOLYSIS, by G. C. Pimentel. [1965] [7]p. incl. diagr., table, refs. [AF AFOSR-63-332] Unclassified

Presented at Eighth European Cong. on Molecular Spectroscopy, Copenhagen (Denmark), Aug. 14-20, 1965.

Published in Pure and Appl. Chem., v. 11: 563-569, 1965.

A review is given of rapid-scan ir spectroscopy, instrumentation, an assessment of results, and prospects for the future.

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California U. Dept. of Chemistry, Berkeley.

INFRARED SPECTRA OF SOLID α AND β-OXYGEN, by B. R. Cairns and G. C. Pimentel. [1965] [7]p. incl. diagrs. tables, refs. (AF AFOSR-63-332) Unclassified

Published in Jour. Chem. Phys., v. 43: 3432-3438, Nov. 15, 1965.

The spectrum of solid α-oxygen deposited at 15° or 20°K consists of a sharp absorption centered at 1549 cm^{-1} (half-width ~ 4 cm^{-1}) and a more intense, broad absorption (half-width ~ 45 cm^{-1}) with well-defined peaks at 1591 and 1617 cm^{-1}. Warming through the $\alpha \rightarrow \beta$ phase transition (at 24° K) causes the broad band to become more diffuse. Recooling restores the low-temperature spectrum and shows that the $\alpha \rightarrow \beta$ transition is rapid and reversible. Slow deposition at 4° K gives an imperfect solid in which the sharp feature is very much intensified. The broad band is due to combinations involving translational lattice modes; the sharp feature is apparently the O_2 fundamental appearing because of lattice imperfections. The β-oxygen spectrum

indicates intermolecular force constants of 0.024 and 0.013 mdyn/A and the α-oxygen spectrum is consistent with a site symmetry of C_{2h} in a space group of C_{2h}^1. None of the spectra, including those of isotopic mixtures, suggests the presence of O_4 molecules.

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California U. Dept. of Chemistry, Berkeley.

INFRARED SPECTRUM AND VIBRATIONAL POTENTIAL FUNCTION OF AMIDE ION, by J. W. Nibler and G. C. Pimentel. [1965] [6]p. incl. diagrs. tables. [AF AFOSR-63-332] Unclassified

Published in Spectrochim. Acta, v. 21: 877-882, May 1965.

The infrared spectra of solid $NaNH_2$, NaNHD, $NaND_2$ in Nujol mulls are given. The NH_2^- fundamental frequencies are: ν_1, 3212.5; ν_2, 1539.5; ν_3, 3263.0 cm^{-1}. These and the isotopic data, coupled with an estimated N—H bond length of 1.03 ± 0.02A (giving a bond angle of 104.6°), yield the valence bond force constants: K_r = 5.72 x 10^5 dyn/cm, K_α = 0.76 x 10 ergs/rad^2, K_{rr} = -0.11 x 10^5 dyn/cm, $K_{r\alpha}$ = -0.31 x 10^3 dyn/rad. The K_α value is quite close to that of water, K_r is about 20 - 25% lower than that of water, and the interaction force constants have the same signs as those of water and similar magnitudes. Comparison to the spectra of H_2O, HOD and D_2O in copper chloride dihydrate suggests the effect of the crystalline environment. (Contractor's abstract)

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California U. [Dept. of Chemistry] Berkeley.

A RAPID-SCAN INFRARED SPECTROMETER; FLASH PHOTOLYTIC DETECTION OF CHLOROFORMIC ACID AND OF CF_2, by K. C. Herr and G. C. Pimentel. [1965] [6]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-332 and Petroleum Research Fund) Unclassified

Published in Appl. Opt., v. 4: 25-30, Jan. 1965.

A rapid-scan infrared spectrometer was constructed and successfully applied to the study of short-lived intermediates produced by flash photolysis. A zinc-doped germanium semiconductor detector and a high-speed rotating Littrow mirror permitted scan rates of 1000 cm^{-1}/100 μsec through the region 5000-650 cm^{-1}. Two transient species, chloroformic acid and CF_2, have been identified, and rough estimates of their lifetimes have been obtained, 50-70 μsec and about 2.5 msec, respectively. This is the first spectroscopic detection of chloroformic acid.

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California U. Dept. of Chemistry, Berkeley.

ACIDITY OF HYDROCARBONS. XVI. EQUILIBRIUM ACIDITIES OF HYDROCARBON ACIDS IN CYCLOHEXYLAMINE, by A. Streitwieser, Jr., , J. I. Brauman and others. [1965] [3]p. incl. diagr., tables, refs. (AFOSR 65-0683) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-554] and Petroleum Research Fund) AD 615134 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 384-386, Jan. 20, 1965.

Equilibrium constants were determined in cyclohexylamine for reactions $A^- M^+ + BH \rightleftharpoons AH + B^- M^+$ in which AH and BH are hydrocarbons whose corresponding carbanions show usable spectral differences and M is lithium or cesium. The solutions were made up on a vacuum line with careful exclusion of air and moisture using known amounts of hydrocarbons and solvent and amounts of lithium cyclohexylamide or cesium cyclohexylamide such that measurable amounts of all 4 components were present. The organocesium compounds studied obeyed Beer's law over a concentration range of at least 10-fold. The lithium salts of all compounds more acidic than p-biphenyldiphenylmethane also obeyed Beer's law, but Beer's law correlations could not be obtained for solutions of p-biphenylydiphenylmethane, triphenylamide-cyclohexylamine. It is clear from the differences between the cesium and lithium salts of these hydrocarbons that the acidity of cyclohexylamine relative to hydrocarbons depends on the metal used. The procedure establishes relative equilibrium acidities; however, it is convenient to record the results as absolute pK values. One of the important aspects of the present results is their confirmation of McEwen's approximate assignments.

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California U. Dept. of Chemistry, Berkeley.

ON THE BROMOPYRENES, by A. Streitwieser, Jr., R. G. Lawler, and D. Schwaab. [1965] [4]p. incl. table, refs. (AFOSR-65-1672) (AF AFOSR-64-554) AD 624329 Unclassified

Also published in Jour. Org. Chem., v. 30: 1470-1473, 1965.

Treatment of 1-bromopyrene with potassium amide in liquid ammonia gave a 50% yield of a 1:1 mixture of 1-amino- and 2-aminopyrene. Sandmeyer reaction with the latter amine gave 2-bromopyrene in low yield. Bromination of 1,2,3,6,7,8-hexahydropyrene gave the 4-bromo derivative which was dehydrogenated at 70 C with o-chloranil to 4-bromopyrene.

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California U. Dept. of Chemistry, Berkeley.

ACIDITY OF HYDROCARBONS. XVII. KINETICS AND

MECHANISM OF PROTON EXCHANGE OF BENZENE AND NAPHTHALENE WITH LITHIUM CYCLOHEXYLAMIDE IN CYCLOHEXYLAMINE, by A. Streitwieser, Jr., R. G. Lawler, and C. Perrin. [1965] [7]p. incl. diagrs. tables, refs. (AF AFOSR-64-554) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 5383-5388, Dec. 1965.

Benzene-t (benzene that has been quenched by phenylmagnesium bromide with tritium-enriched D_2O) exchanges with lithium cyclohexylamide (LiCHA) 0.01 as fast as toluene-α-t (toluene with tritium enriched D_2O an alpha carbon). The k_D/k_T isotope effect is comparatively small (1.6). Kinetic studies are reported of the α and γ positions of naphthalene and the mechanism of the exchange reaction is discussed.

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California U. Dept. of Chemistry, Berkeley.

ACIDITY OF HYDROCARBONS. XVIII. EXCHANGE REACTIONS OF POLYCYCLIC AROMATIC PROTONS WITH LITHIUM CYCLOHEXYLAMIDE, by A. Streitwieser, Jr. and R. G. Lawler. [1965] [7]p. incl. diagrs. tables, refs. (AF AFOSR-64-554) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 5388-5399, Dec. 1965.

Relative rates of deuterium or tritium exchange with lithium cyclohexylamide were determined for various positions in benzene, naphthalene, phenanthrene, anthracene, and pyrene and have been found to span a relative rate range of almost 50-fold. The effect of structure on these rates is considered in terms of carbene resonance structures and molecular orbital polarizabilities, but the best correlation is with an inductive effect model based on a simple classical picture. (Contractor's abstract)

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California U. Dept. of Chemistry, Berkeley.

ACIDITY OF HYDROCARBONS. XX. COMPARISON OF RELATIVE PROTON EXCHANGE RATES OF HYDROCARBONS WITH LITHIUM CYCLOHEXYLAMIDE AND CESIUM CYCLOHEXYLAMIDE, by A. Streitwieser, Jr., R. A. Caldwell and others. [1965] [4]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-554 and Petroleum Research Fund) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 5399-5402, Dec. 1965.

Absolute rate constants for exchange of aryl hydrogens in toluene vary over a wide range with lithium cyclohexylamide LiCHA or cesium cyclohexylamide CsCHA in cyclohexylamine or with KNH_2 in liquid ammonia but relative rates are much the same in the different systems. There is little steric hindrance to exchange ortho to the methyl group. The relative rates of some benzylic positions are also comparable for these exchange systems. The results justify the use of such relative rates as measures of hydrocarbon acidity. (Contractor's abstract)

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California U. [Dept. of Mathematics] Berkeley.

PERFECT CLOSURES OF RINGS AND SCHEMES, by M. J. Greenberg. [1965] [5]p. (AFOSR-65-2604) (AF AFOSR-63-121) AD 628703 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 313-317, Apr. 1965.

A (commutative) ring A of characteristic $p > 0$ is said to be perfect if the endomorphism F given by $F(a) = a^p$ is bijective. It is shown that every ring A has a perfect closure, that is, there is a perfect ring A^*, and a homomorphism $\Phi: A \to A^*$, such that for any perfect ring B, and any homomorphism $\varphi: A \to B$, there is a unique $\varphi^*: A^* \to B$ with $\varphi = \varphi^*\Phi$. The author lists various elementary properties of the operation of perfect closure, and applies them to preschemes. A prescheme $(X, \mathcal{O}_X)$ is called perfect if the pth power endomorphism F of $\mathcal{O}_X$ is bijective. Every prescheme X has a perfect closure, which is a perfect prescheme X^* with a morphism $\Phi: X^* \to X$ satisfying a universal property similar to the one above. (Math. Rev. abstract)

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California U. Dept. of Mathematics, Berkeley.

AN APPROACH TO THE ENUMERATION PROBLEM FOR NON-STABLE VECTOR BUNDLES, by I. James and E. Thomas. [1965] [21]p. incl. refs. (AFOSR-66-0008) (AF AFOSR-63-336) AD 630898 Unclassified

Also published in Jour. Math. and Mech., v. 14: 485-506, May 1965.

Let [X, Y] denote homotopy classes of maps of X into Y. Let $p: E \to B$ be the fibre space induced from the path space over C by a map $f: B \to C$. Nomura's mapping sequence ends with $\cdots [A, \Omega C] \to [A, E] \xrightarrow{p^*} [A, B] \to [A, C]$, where the last three are only sets but the group $[A, \Omega C]$ acts on $[A, E]$ as a transformation group and exactness at this point means $p_*\eta = p_*\eta'$ if and only if there is $\gamma \in [A, \Omega C]$ such that $\eta' = \gamma \cdot \eta$. It is known that the set $p_*^{-1}\xi$ may depend on the element ξ. The authors give a construction for analyzing this dependence in certain important cases. Specifically, they construct a homomorphism $\Delta([f], \xi)$. $[A, \Omega B] \to [A, \Omega C]$ if B is an H-space and C a topological group, and prove Theorem 1.2. Let A be a pathwise-connected space, let B be an H-space, and let C be a topological group. If $\xi \in [A, B]$ is an element such that $f_*\xi$ is trivial, then $p_*^{-1}\xi$ is equivalent, as a set, to the cokernel of $\Delta([f], \xi)$: $[A, \Omega B] \to [A, \Omega C]$. They work out the reflection of this operation in the cohomology of B and C so as to apply it when $C = K(G, q)$ and hence $[A, \Omega C] = H^{q-1}(A, G)$ while $[f] \in H^q(B, G)$.

The main applications are to $B = B_O$ (although as pointed out by W. Sutherland, they apply equally well to $B = B_H$). Theorem 1.6. Let n be odd and $n \geq 3$. Let ξ be a stable real vector bundle over a complex A, where $\dim A = n + 1$. If $\dim A = n$, suppose that $n \equiv 3 \bmod 4$ and that $\xi^* w_{n+1} = 0$. Then the number of classes of n-plane bundles over A which are stably equivalent to ξ is equal to the order of the cokernel of $\Delta(w_{n+1}, \xi)$: $[A, \Omega B] \to H^n(A; Z_2)$. The computations are carried out in one illustrative example, that of n-plane bundles over real projective n-space, P^n. Corollary 1.10. Either let n and k be even or let n be odd, $n \neq 1, 3, 7$. Then the number of classes of n-plane bundles over P^n which are stably equivalent to k_η is equal to 1 or 2 according as $\binom{k-1}{n-1}$ is odd or even. (Math. Rev., abstract)

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California U. Dept. of Mathematics, Berkeley.

ON CROSS SECTIONS TO FIBER SPACES, by E. Thomas. [1965] [2]p. (AFOSR-66-0032) [AF AFOSR-63-336] AD 631126 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 54: 40-41, July 1965.

Let M be a compact, connected, differentiable manifold. The author defines span (M) to be the maximal number of linearly independent tangent vector fields on M. He announces a number of results, of which some examples are given here. Theorem: Let M be orientable and $\dim M \equiv 3 \bmod 4$; then span (M) $\geq$ 2. For $\dim M = 3$ this is a classical result of Stiefel. Theorem: If M is a spin-manifold and $\dim M \equiv 7 \bmod 8$, then span (M) $\geq$ 3. For complex manifolds M the author defines, in an analogous way, the span of M in terms of complex linearly independent continuous vector fields. He obtains, for example, the following sufficient condition for span (M) $\geq$ 2: The complex dimension n of M is divisible by 4, the Chern classes $c_1(M)$, $c_2(M)$, $c_{n-1}(M)$, $c_n(M)$ vanish, and the Chern class $c_{n-2}(M)$ vanishes mod 2. A further theorem applies to the existence of stable almost-complex structures on 8-dimensional manifolds, giving new information in a case studied earlier by Massey (Bull. Amer. Math. Soc., v. 67: 559-564, 1961). The new method of proof for the author's interesting theorems on cross-sections relies on Postnikov invariants and higher-order cohomology operations. It will be described in a forthcoming paper. (Math. Rev. abstract)

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California U. [Dept. of Mathematics] Berkeley.

STEENROD SQUARES AND H-SPACES. II, by E. Thomas. [1965] [23]p. incl. refs. (AFOSR-66-0035) [AF AFOSR-63-336] AD 631127 Unclassified

Also published in Ann. Math., v. 81: 473-495, May 1965.

The author studies how the Steenrod squares act in an H-space by reducing it in certain important cases to a purely algebraic problem. The main algebraic result is: Let A be a finitely generated truncated polynomial algebra over the mod 2 Steenrod algebra. Let D be the ideal of decomposable elements. Let n and t be positive integers such that $\binom{n-1-t}{t} \equiv 1 \bmod 2$. Then $A_n = S^t_\zeta A_{n-t} \bmod D$ and $S^t_q A_n \equiv 0 \bmod D$. Here truncated polynomial algebra means a polynomial algebra A' modulo any ideal contained in $(A')^3$. Using the projective plane of an H-space as in Part I the following sort of result is obtained. Let X be an H-space whose algebra $H^*(X)$ is generated by a finite number of odd-dimensional primitive classes, all of which have distinct degrees. Let $u_{2j-1} \in H^{2j-1}(X)$ $(j > 0)$ denote the primitive class of degree $2j - 1$, if such exists, otherwise, set $u_{2j-1} = 0$. Then $S^{2i}_q u_{2j+1} = \binom{2j+1}{2i} u_{2(i+j)+1}$ for all $i, j \geq 0$. Moreover, if $H^*(X)$ is an exterior algebra on odd-dimensional generators, then the above formula describes completely the action of the Steenrod squares in $H^*(X)$. Stronger results, obtained by assuming associativity of the H-space X, use the classifying space B_X. (Math. Rev. abstract)

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California U. [Dept. of Mathematics] Berkeley.

NONLINEAR EVOLUTION EQUATIONS IN BANACH SPACES, by T. Kato [1965] [18]p. incl. refs. (AFOSR-66-0255) (AF AFOSR-64-553) AD 631158 Unclassified

Also published in Proc. Symposia Appl. Math., v. 17: 50-67, 1965.

The author discusses some results for the problem $u' + A(t)u = f(t, u)$, $u(0) = 0$, where u(t) takes values in a Banach space X (assumed separable, although this is not always necessary) and A(t) is a family of (usually unbounded) operators in X. First, some standard theorems (Picard, Cauchy-Peano) for the case $A(t) \equiv 0$, f(t, u) continuous in (t, u), are cited, and then a recent result of Browder for this case (Ann. Math., v. 80: 485-523, 1964) is indicated, where existence and uniqueness in a Hilbert space X follow from the continuity of $f(\cdot, \cdot)$ and the hypothesis $\mathrm{Re}(f(t, u) - f(t, v), u - v) \leq M\|u - v\|^2$, with f supposed also to map bounded sets into bounded sets. Next, some of the main results are given (due to the author, Yosida, Tanabe, Krasnosel'skiĭ, Krein, Sobolevskiĭ) concerning the explicit construction of an evolution operator U(t, s). The application of these results to the equation $u(t) = U(t, 0)u_0 + \int_0^t U(t, s)f(s, u(s))ds$ is then indicated under various hypotheses on A and f. The following theorem is proved which generalizes a result of Browder. Let X be Hilbert and f demi-continuous from $I \times X$ to X (I is an interval $[0, T]$), mapping bounded sets into bounded sets, and satisfying the monotonicity type hypothesis above. Let $-A(t)$ be the infinitesimal generator of a contraction semigroup with $(A(t) + I)^{-1}$ strongly continuously differentiable, and suppose that

an evolution operator U(t, s) exists having standard properties (without specifying further explicit hypotheses on the A(t) which would insure this). Then the integral equation above has a unique continuous solution for any $v \in X$, and $v \to u$ is continuous from $X \to C(I, X)$. Some theorems for cases when F is "regular" relative to A (A(t) = A here for convenience) are then given, and the question of global solutions is briefly discussed. Examples are given throughout the paper. (Math. Rev. abstract)

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California U. [Dept. of Mathematics] Berkeley.

ON THE CAPACITY OF COMPOSITE CONDUCTORS, by M. H. Protter and H. F. Weinberger. [1965] [9]p. incl. diagrs. (AFOSR-66-1206) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-553] and National Science Foundation) AD 641739 Unclassified

Also published in Jour. Math. and Phys., v. 64: 375-383, Dec. 1965.

Let S_0 be a closed connected 2-dimensional surface in E^3, and let S_1 and S_2 be 2 other closed surfaces lying entirely in the interior of S_0. S_1 and S_2 need not be connected and may intersect, but neither is to be entirely contained in the other. The authors concern themselves with finding inequalities relating the capacities C, C_1, C_2 of the condensers R, R_1, R_2 bounded by the surfaces S_0 and $S_1 \cup S_2$, S_0 and S_1, S_0 and S_2. Main theorem Let u, u_1 and u_2 be the harmonic measures of R, R_1 and R_2 with respect to $S_1 \cup S_2$, S_1 and S_2 (the authors use the term capacitary potential for harmonic measure). Also, let m_1, m_2 be any constants such that $m_1 \le \min u_1$ on S_2, $m_2 \le u_2$ on S_1. Then

$$C \le C_1 + C_2 - \frac{m_2(1-m_1)C_1 + m_1(1-m_2)C_2}{1-m_1m_2}.$$

The theorem is proved by applying the maximum principle to $v = u - ((1-m_2)u_1 + (1-m_1)u_2)/(1-m_1m_2)$ and using the fact that one can evaluate the capacity of a condenser (bounded by B_1 and B_2) by integrating the normal derivative of the harmonic measure relative to B_1 over any simple closed surface containing B_2. Similar methods are used to obtain a corresponding inequality in the other direction. These inequalities are then applied in a number of examples, and comparisons made in some cases where the exact value of C is known. (Math. Rev. abstract)

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California U. [Dept. of Mathematics] Berkeley.

LOWER BOUNDS FOR SOLUTIONS OF DIFFERENTIAL INEQUALITIES IN HILBERT SPACE, by H. Ogawa. [1965] [3]p. (AFOSR-66-1397) (AF AFOSR-64-553) AD 641736 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 1241-1243, Dec. 1965.

Let A be an operator in a Hilbert space and let u(t) be in the domain of A for each $t \in (0, \infty)$. Assuming u is strongly differentiable, Au strongly continuous and du/dt strongly piecewise continuous, all with respect to t, define $Lu = \frac{du}{dt} - Au$. In the case where A is symmetric, i.e., (Au, v) = (u, Av), Cohen and Lees obtained lower bounds for solutions of differential inequalities of the form $|Lu(t)| \ge \phi(t)|u(t)|$. Assuming that A is selfadjoint, Agmon and Nirenberg found a simpler proof of this result, as well as some extensions, by means of convexity theorems. The purpose of this paper is to present still simpler proofs, assuming only that A is symmetric, of the theorem of Cohen and Lees for p =2 and of the extensions of Agmon and Nirenberg.

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California U. Dept. of Mathematics, Berkeley.

ON ACCRETIVE BOUNDARY PROBLEMS OF THE SECOND ORDER, by F. Wolf. [1965] [4]p. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-553, and Miller Inst. for Basic Research in Science) Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 53: 5-8, Jan. 1965.

Let B_0, C_0 be formally hermitian, second-order partial differential operators defined in a domain G of E^n. Let B be the Friedrichs extension in $L^2(G)$ of the restriction of B_0 to C_0^∞ (the set of infinitely differentiable functions with compact supports). If B_0 is uniformly elliptic on any compact subdomain of G, it is shown, under suitable regularity assumptions on the coefficients of B_0 and C_0, that there exists a unique extension C of C_0 so that the operator B + iC has the left-hand half-plane in its resolvent set. It is not required that C_0 be dominated by B_0. For $|(Cu, u)| \le M|(Bu, u)|$ and D(C) D(B), the result was previously known and easily obtained by means of the Lax-Milgram lemma.

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California U. Dept. of Mathematics, Berkeley.

NETS OF THRESHOLD ELEMENTS, by K. Krohn and J. Rhodes. [1965] [10]p. incl. refs. (AFOSR-66-1222) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-848 and Office of Naval Research) AD 641541 Unclassified

Also published in Inform. and Control, v. 8: 579-588, Dec. 1965.

Several theoretical results are obtained concerning properties of the transition function given by a finite net of threshold elements. In particular, an exact characterization of these transition functions is given solely in terms of the Boolean Ring. Specializing this result necessary and sufficient conditions are found that a Boolean function is realizable by a single threshold element. Also axioms for the transition functions of McCulloch-Pitts Nets, etc. are furnished.

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California U. Dept. of Physics, Berkeley.

NUCLEAR SPIN OF 45d IRON-59 (Abstract), by B. M. Dodsworth and H. A. Shugart. [1965] [1]p. (AFOSR-65-1563) [AF AFOSR-62-346] AD 640223 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Also published in Bull. Amer. Phys. Soc., Series II, v. 10: 445, Apr. 26, 1965.

The nuclear spin of 45d iron-59 was measured as 3/2 by the atomic beam, magnetic resonance method. This result is the same as that deduced previously from β decay theory and is consistent with a shell model neutron assignment $(f_{3/2})^3 (f_{5/2})^2$. The radioactivity was produced by the (n, γ) reaction on natural iron metal. A tantalum oven containing a zirconium oxide liner was heated by electron bombardment to produce the beam of iron atoms. After traversing the beam machine, the activity was collected on either freshly deposited copper or sulfur surfaces and was counted in flow proportional β counters. Because of the integral value of the electronic angular momentum in iron, only multiple quantum transitions are observable in the normal flop-in apparatus. Nineteen resonances were observed in the F = 11/2 and 9/2 levels of the $^5D_4$ electronic state at magnetic fields up to approx 27 gauss. Although structure appears on the resonance lines due to beam instability and possible resolution of multiple quantum transitions, the resonances indicate a nuclear spin of 3/2.

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California U. Dept. of Physics, Berkeley.

HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF PROMETHIUM-148 AND ERBIUM-165, by D. Ali, I. Maleh, and R. Marrus. [1965] [5]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-62-346] and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 138: B1356-B1360, June 21 1965.

The hyperfine structure of the $^6H_{7/2}$ level in 5.3-day Pm^{148} and the $^3H_6$ level in 10-h Er^{165} have been measured by atomic-beam magnetic resonance. The spins of these isotopes have been verified to be $I(Pm^{148}) = 1$ and $I(Er^{165}) = 5/2$. The electronic g factor for the $^6H_{7/2}$ level in Pm^{148} is found to be $g_J = -0.8278(1)$. The hyperfine constants and inferred nuclear moments are given for Pm^{148} and for Er^{165}. The nuclear moments of Pm^{148} were calculated from the hyperfine constants and assumptions made concerning the electronic fields at the nucleus; these assumptions include a 2% correction for the breakdown of Russell-Saunders coupling, but do not include corrections for the Sternheimer effect. The stated errors include a 5% uncertainty for $\langle 1/r^3 \rangle$. The Fermi-Segrè formula and the direct measurement of the magnetic moment of Er^{167} were used to calculate the dipole moment of Er^{165}. The quadrupole moment of Er^{165} has not been corrected for the Sternheimer effect. The measurements indicate that Pm^{148} may be described by the shell model, but that Er^{165} is deformed and must be interpreted by the collective model. (Contractor's abstract, modified)

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California U. Dept. of Physics, Berkeley.

VORTICES IN AN IMPERFECT BOSE GAS. I. THE CONDENSATE, by A. L. Fetter. [1965] [9]p. incl. diagrs. refs. (AFOSR-65-1342) (AF AFOSR-63-130) AD 622626 Unclassified

Also published in Phys. Rev., v. 138: A429-A437, Apr. 1965.

A theoretical study of rectilinear vortices in an imperfect Bose gas shows a close correspondence with classical hydrodynamics. The energy and momentum of a vortex pair in an unbounded fluid were calculated. The similarity between a vortex pair and a vortex ring leads to an estimate of the critical velocity v_c of liquid He II in a tube of radius R that includes the effect of the walls $v_c = C\hbar/2mR$, where C is a constant of order unity. A variational treatment of a system of many identical vortices in a container shows that the energy is lowest for a uniform distribution and that the number of vortices per unit area ν agrees with Feynman's result $\nu = 2m\omega/h$. In the classical limit ($h \to 0$), the angular momentum and energy approach the values for solid-body rotation. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley

VORTICES IN AN IMPERFECT BOSE GAS. II SINGLE-PARTICLE EXCITATIONS, by A. L. Fetter [1965] [8]p. incl diagrs. tables, refs. (AFOSR-65-1343) (AF AFOSR-63-130) AD 622848 Unclassified

Also published in Phys. Rev., v. 138 A709-A716, May 3, 1965.

The single particle excitations of an imperfect Bose gas with a vortex in the condensate are studied using the Bogoliubov approximation. The problem is reduced to an eigenvalue equation, whose solution yields both

the single-particle energies and the eigenfunction expansion of the single-particle Green's function. The spectrum of the eigenvalues contains a discrete portion (bound states) and a continuous portion (scattering states). The lowest eigenvalue corresponding to angular momentum $l = 0$ and $l = \pm 1$ is determined variationally. In the long-wavelength limit, the eigenvalue for $l = \pm 1$ agrees with the frequency of normal modes calculated by Kelvin and Pitaevskii. The density of noncondensed particles is expressed in terms of the single-particle Green's function and is shown to be finite at the center of the vortex. (Contractor's abstract)

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[California U. Dept. of Physics, Berkeley].

LOW-TEMPERATURE BEHAVIOR OF THE HEISENBERG FERROMAGNET, by M. Wortis. [1965] [20]p. incl refs. (AFOSR-65-2189) (AF AFOSR-63-130) AD 625930 Unclassified

Also published in Phys. Rev., v. 138: A1126-A1145, May 17, 1965.

The mechanics of spin deviations is formulated in a simple manner, which maintains the true spin kinematics and does not involve the introduction of any artificial interactions. A virial expansion for the thermodynamics based on this mechanics, clearly distinguishes kinematical and dynamical effects. At low temperatures, low-density kinematical effects are easily proved exponentially small. The second virial coefficient is computed unambiguously. Dyson's low-temperature free energy is straightforwardly rederived, and an upper bound is estimated on the validity of the associated low-density boson picture. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

A STUDY OF SOME APPROXIMATION SCHEMES IN QUANTUM MECHANICS, by C. Schwartz. [1965] [15]p. incl. diagrs. table. (AFOSR-65-2190) (AF AFOSR-63-130) AD 625594 Unclassified

Also published in Ann. Phys., v. 32: 277-291, Apr. 1965.

By means of numerical examples in one dimensional Hamiltonian problems, the behavior of the approximation scheme known as the New Tamm-Dancoff method is studied. It is concluded that for good convergence of this, and other related methods, one should arrange to start with a symmetric set of equations. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

NUMERICAL SOLUTION OF FIXED-SOURCE FIELD THEORIES, by C. Schwartz. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2191) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-130 and Atomic Energy Commission) AD 625597 Unclassified

Also published in Phys. Rev., v. 137: B212-B218, Jan 11, 1965.

A modification of the Tamm-Dancoff method for fixed-source meson theories is set up for automatic computation. The Chew (1954) model of pion-nucleon interactions is calculated with up to 6 virtual mesons. Bound-state parameters and scattering phase shifts are obtained, accurate to about 1°, at a cost of about 3 min of computer time each. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

SOLUTION OF A BETHE-SALPETER EQUATION, by C. Schwartz. [1965] [3]p. incl. tables. (AFOSR-65-2192) (AF AFOSR-63-130) AD 625596 Unclassified

Also published in Phys. Rev., v. 137: B717-B719, Feb. 8, 1965.

The Bethe-Salpeter equation arising from a Φ^3 theory is solved numerically for several energies (bound states only) and symmetry states. The method used is a variational calculation in the 4-dimensional Euclidean space arrived at by the transformation due to Wick. A high degree of accuracy is achieved by using only a very small amount of common computing machine capabilities. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

RELATIVISTIC CORRECTIONS TO THE FINE STRUCTURE OF HELIUM, by K. Y. Kim. [1965] [7]p. incl. refs. diagrs (AFOSR-66-0380) (AF AFOSR-63-130) AD 630297 Unclassified

Also published in Phys. Rev., v. 140: A1498-A1504, Nov 29, 1965

Relativistic corrections to the fine structure of the hydrogen atom have been calculated by many authors, but the experimental confirmation of the theory, or alternatively the determination of the numerical value of the fine-structure constant α, is limited to an accuracy of 1 10^5 because of the short lifetime of $2\,^2P$ states of hydrogen. However, in view of the fact that $2\,^3P$ states of helium have a longer lifetime, it is expected that the (fine-structure) intervals of the $2\,^3P$ states of helium can be measured to an accuracy of $1/10^6$ or better. With this expectation, an attempt was made to evaluate semirelativistically the theoretical formula for the helium fine structure to the order $\alpha^4 Ry$. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

EVIDENCE THAT THE DEUTERON IS NOT AN ELEMENTARY PARTICLE, by S. Weinberg. [1965] [7]p. incl. refs. (AFOSR-65-0816) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-232 and Atomic Energy Commission) AD 616214 Unclassified

Also published in Phys. Rev., v. 137: B672-B678, Feb. 8, 1965.

If the deuteron were an elementary particle then the triplet n-p effective range would be approximately -ZR/(I-Z), where R = 4.31F is the usual deuteron radius and Z is the probability of finding the deuteron in a bare elementary-particle state. This formula is model-independent, but has an error of the order of the range m_π^{-1}=1.41F of the n-p force, so it becomes exact only in the limit of small deuteron binding energy, i.e., $R >> m_\pi^{-1}$. The experimental value of the effective range is not of order R and negative, but rather of order m_π^{-1} and positive, so Z is small or zero and the deuteron is mostly or wholly composite. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

PHOTONS AND GRAVITONS IN PERTURBATION THEORY: DERIVATION OF MAXWELL'S AND EINSTEIN'S EQUATIONS, by S. Weinberg. [1965] [15]p. incl. refs. (AFOSR-65-1823) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-232 and Atomic Energy Commission) AD 625562 Unclassified

Also published in Phys. Rev., v. 138: B988-B1002, May 24, 1965.

The S matrix for photon and graviton processes is studied in perturbation theory, under the restriction that the only creation and annihilation operators for massless particles of spin j allowed in the interaction are those for the physical states with helicity ± j. In order to obtain long-range forces, it is necessary to introduce noncovariant potentials in the interaction, and the Lorentz invariance of the S matrix requires that these potentials be coupled to conserved tensor currents, and also that there appear in the interaction direct current-current couplings, like the Coulomb interaction. The potentials for j = 1 and j = 2 must inevitably satisfy Maxwell's and Einstein's equations in the Heisenberg representation. It is shown to be impossible to construct a Lorentz-invariant S matrix for magnetic monopoles and charges in perturbation theory.

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California U. Dept. of Physics, Berkeley.

PHASE OF THE CP-INVARIANCE VIOLATION IN τ^0 DECAY, by S. L. Glashow and S. Weinberg. [1965] [2]p. (AFOSR-65-1868) (AF AFOSR-63-232) AD 626779 Unclassified

Also published in Phys. Rev. Ltrs., v. 14 835-836, May 17, 1965

A previous experiment (Phys. Rev. Ltrs., v. 14: 475, 1965) indicates possible strong CP-invariance violation in the decay mode $K_1^0 \to \pi^+ + \pi^- + \pi^0$. The measured ratio of the K_1^0 and K_2^0 decay amplitudes, $Re(a_1 a_2) = +0.25 \pm 0.65$, $Im(a_1/a_2) = +1.00 \pm 0.65$, suggests that this ratio may have absolute magnitude of order unity and phase near 90°, though the statistics are hardly conclusive. It is pointed out that if $a_1 a_2$ is actually not much less than one in magnitude, then CPT symmetry and the $\Delta T \leq 3/2$ rule require its phase to be very close to ± 90°. This constraint was not imposed in the analysis made in the previous experiment, so the fact that this analysis did give a mostly imaginary ratio lends additional credence to the existence of a strong $K_1^0 \to 3\pi$ mode. If this mode does exist, then a refined measurement of the phase of $a_1 a_2$ can provide a sensitive test of CPT and/or $\Delta T \leq 3/2$.

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California U. Dept. of Physics, Berkeley.

IS CHARGE-CONJUGATION INVARIANCE BADLY BROKEN?, by S. L. Glashow and C. M. Sommerfield. [1965] [3]p. incl. table, refs. (AFOSR-65-1951) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-232 and Office of Naval Research) AD 626894 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 78-80, July 12, 1965.

Several simple C-nonconserving interactions are considered, any one of which could provide a mechanism for the decay $K_2^0 \to 2\pi$. Present experimental data relating to C-nonconserving mesonic decay rates with phase-space estimates are compared. There is considerable suppression for C-nonconserving $\omega\pi\eta$ and $\phi\pi\eta$ coupling constants but no meaningful limit on the strength of the C-nonconserving $\rho\eta\pi$ coupling constant is obtained. It is shown that even if this coupling is strong, it would not produce a significant charge asymmetry in η decay.

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California U. Dept. of Physics, Berkeley.

MODEL OF WEAK INTERACTIONS WITH CP VIOLATION, by S. L. Glashow. [1965] [4]p. (AFOSR-66-0831) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-232 and [Office of Naval Research]) AD 641451 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 35-38, Jan. 4, 1965.

A simple model of weak interactions is proposed which allows for CP violation. A single current-current coupling is introduced where vector and axial-vector currents transform differently under SU(3), yet each transforms like a member of a unitary octet.

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California U. Dept. of Physics, Berkeley.

ON THE CURVES IN THE GRENINGER AND LEONHARDT NETS, by A. Bernalte. [1965] [3]p. incl. refs. (AFOSR-66-1599) (AF AFOSR-63-290) AD 641483 Unclassified

Also published in Acta Cryst., v. 19: 916-918, Dec. 1965.

The algebraic equations for the lines in both the Greninger and Leonhardt charts are derived, in order to complete or correct the statements found in the current literature. The meridians are conics and the parallels are quartics. Also, parametric equations are given for computational purposes. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

CYCLOTRON RESONANCE IN ALUMINUM, by F. W. Spong and A. F. Kip. [1965] [17]p. incl. illus. diagrs. table, refs. (AF AFOSR-63-290) Unclassified

Published in Phys. Rev., v. 137: A431-A447, Jan. 18, 1965.

A systematic study of Azbel'-Kaner cyclotron resonance in aluminum at 35 Gc/sec has clarified and extended previous work. Results on the orientation dependence and relative values of the cyclotron mass for different electron orbits correspond closely with expectations based on Harrison's free-electron model. However, the observed mass values are consistently 55-60% higher than those predicted by the free-electron model. Since the nearly-free-electron model agrees with ab initio band-structure calculations which exist for aluminum and which are thought to be reliable within the independent-particle model, the bulk of this discrepancy is presumed to be attributable to the many-body effects of correlation and electron-phonon interactions. The anomalous cyclotron resonance spectrum attributed in previous work to a cyclotron mass of 3.10m (m is the free electron mass) is elucidated in terms of current sheets which reproduce the skin currents deep within the metal. These sheets are produced by the spatially periodic magnetic focusing of limiting-point electrons on the Fermi surface. This mechanism leads to a cyclotron mass for these electrons of 1.55m, just one half the value given on the Azbel'-Kaner model. Quantum oscillations in the surface impedance analogous to the de Haas-van Alphen oscillations in the susceptibility are observed at ~1.5° K. Observed periods agree with the de Haas-van Alphen periods measured by Gunnersen. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

CYCLOTRON RESONANCE IN SILVER, by D. G. Howard. [1965] [11]p. incl. diagrs. refs. (AF AFOSR-63-290) Unclassified

Published in Phys. Rev., v. 140: A1705-A1715, Nov. 29, 1965.

Azbel'-Kaner-type cyclotron resonance has been used to examine the Fermi surface of silver. The types of resonances observed from a (110)-surface sample are very like those reported for copper. Resonances originating from orbits about the zone contact regions have been observed over a limited range of angles. Relatively strong signals have been obtained from orbits near the limiting points when the field lies nearly parallel to the [001] direction of the (110) surface. The 2 orbits reported in copper whose centers lie neither at the center nor the edge of the zone have been observed, and in addition a third orbit of this type has been identified and measured over a large range of angles. Data taken on a (100)-surface specimen (not available in the copper studies) have shown resonances due to both hole and electron orbits; these resonances are consistent with the previous knowledge of the geometry of the Fermi surface. The effect on cyclotron resonance signals of a magnetic field inclined with respect to the specimen surface has been investigated. Apparent shifts in the measured cyclotron mass as large as 50% per degree of field misalignment have been obtained. The similarity of a number of the signals to the peak-reversal phenomena observed in potassium and aluminum is discussed. Certain of the signals in fields inclined at large angles to the surface have yielded a measure of the neck size in excellent agreement with de Haas-van Alphen measurements. (Contractor's abstract)

285

California U. [Dept. of Physics] Berkeley.

THE SURFACE IMPEDANCE OF METALS IN A WEAK MAGNETIC FIELD, by J. F. Koch and A. F. Kip. [1965] [5]p. incl. diagrs. (Sponsored jointly by Advanced Research Projects Agency and Air Force Office of Scientific Research under [AF AFOSR-63-290]) Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed.by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. B): 818-822, 1965.

The absorption derivative signals in single crystals of tin, indium, and aluminum are studied. The crystals were cut with several different symmetry planes from single-crystal boules, and subsequently electropolished The experiments were done at frequencies between 30 and 70 Gcps and at liquid-helium temperatures. The results and observations are summarized: (1) A typical signal consists of a number of distinct derivative maxima and minima at magnetic fields below 100 Oe, (2) The effect shows a striking dependence on the sample surface

in which it is observed; (3) Polarization of the RF current affects the amplitude, but not the position of the derivative maxima; (4) If the experimental frequency is increased, the peak positions shift to higher fields as $\omega^{3/2}_{RF}$; (5) The low-field effect can readily be observed with the magnetic field tipped at arbitrarily large angles with respect to the sample surface; (6) The preparation of a highly polished surface is essential to the observation of the effect; and (7) The effect is independent of temperatures between 4.2°K and the superconducting transition temperature. It is suggested that the observed signals are due to the interaction of conduction electrons, traversing the skin region on a segment of cyclotron orbit, with the RF electric field; electron trajectory through the region of the skin depth is discussed.

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California U. Dept. of Physics, Berkeley.

OBSERVATIONS OF LONG-PERIOD PULSATIONS OF ELECTRON PRECIPITATION IN CONJUGATE REGIONS OF THE AURORAL ZONES, by R. R. Brown, J. R. Barcus and others. [1965] [4]p. incl. diagrs. (AFOSR-65-1877) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-331, National Science Foundation, and Office of Naval Research) AD 626096 Unclassified

Also published in Jour. Geophys. Research, v. 70: 1246-1249, Mar. 1, 1965.

Observations are summarized for a long-period pulsation event in ionospheric absorption of cosmic radio noise at Kotzebue, Alaska and at the Australian National Antarctic Research Expeditions' Station at Macquarie Island. Although there is a great degree of simultaneity and similarity, additional features of pulsating electron precipitation are shown from x-ray and riometer observations. These observations outside the immediate vicinity of the conjugate regions indicate spatial structure on a scale of a few hundred km.

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California U. Dept. of Physics, Berkeley.

EVIDENCE SUGGESTING DUMPING OF SEMITRAPPED ELECTRONS ON THE NIGHT SIDE OF THE EARTH, by J. R. Barcus. [1965] [3]p. incl. diagrs. (AFOSR-65-1878) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-331, and Office of Naval Research) AD 626097 Unclassified

Also published in Jour. Geophys. Research, v. 70 1237-1239, Mar. 1, 1965.

A precipitation event intense enough to make a near maximum demand on the outer zone was observed by means of bremsstrahlung x-rays, with a balloon-borne scintillation detector. The balloon was launched from Barrow, Alaska, in March 1963 during the recovery phase of a magnetic storm. X-ray activity above 100 kev was barely detectable, except for an extremely intense burst (~ 350 times normal) occurring at approximately 1030 UT. The origin of this striking spectral variation is considered. It is pointed out that local acceleration, other than untrapping mechanisms, need not necessarily coincide with the region of precipitation. It is possible that daytime events, extensive in space and time, are the result of energization processes occurring in the sunlit magnetosphere; the transient and localized bursts occurring near midnight are the result of partial dumping of the semitrapped enhancement in the outer zone.

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California U. Dept. of Physics, Berkeley.

BALLOON OBSERVATIONS ON THE RELATIONSHIP OF ENERGETIC ELECTRONS TO VISUAL AURORA AND AURORAL ABSORPTION, by J. R. Barcus. [1965] [13]p incl. illus. diagrs. refs. (AFOSR-65-1879) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-331 and 62-422, National Science Foundation, and Office of Naval Research) AD 626502 Unclassified

Also published in Jour. Geophys. Research, v. 70 2135-2147, May 1, 1965.

Simultaneous bremsstrahlung x-ray and photometric measurements show a rather loose correlation, in the sense of a detailed space-time association, between the appearance of x-rays at balloon altitudes and visual aurora at large L values. The observations suggest that essentially different, though not infrequently coupled, mechanisms are responsible for the low and high energy portions of the precipitated electron spectrum. Detailed examination of an ionospheric absorption event associated with auroral breakup indicates that the event is largely accounted for by the same flux of low energy electrons responsible for the simultaneous luminosity enhancement. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

OBSERVATIONS ON THE SPATIAL STRUCTURE OF PULSATING ELECTRON PRECIPITATION ACCOMPANYING LOW FREQUENCY HYDROMAGNETIC DISTURBANCES IN THE AURORAL ZONE, by J. R. Barcus and T. J. Rosenberg. [1965] [10]p. incl. diagrs (AFOSR-65-1880) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-331, National Science Foundation, and Office of Naval Research) AD 626503 Unclassified

Also published in Jour. Geophys. Research, v 70 1707-1716, Apr. 1, 1965.

Low-frequency hydromagnetic disturbances which are generated in a sunlit part of the distant magnetosphere and propagate as transverse waves to auroral latitudes are accompanied by pulsating electron precipitation and ionospheric absorption of cosmic radio noise with a similar temporal behavior The region over which this pulsating activity occurs is belt-like, ~ 1000 km long and ~ 100-400 km across. Sometimes the instantaneous pattern of precipitation exhibits spatial structure over

these dimensions, but at least on one occasion the pulsations were in phase over a large region near the noon meridian. A unique acceleration process does not appear to be required, as the bremsstrahlung x-ray spectrums obtained for the pulsations are not essentially different from those observed during activity preceding or following these events. The statically trapped radiation is eliminated as a possible source, and some mechanisms involving local energization are briefly discussed. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

BALLOON OBSERVATIONS OF AURORAL ZONE X RAYS IN CONJUGATE REGIONS. 1. SLOW TIME VARIATIONS, by R. R. Brown, J. R. Barcus, and N. R. Parsons. [1965] [20]p. incl. diagrs. tables, refs. (AFOSR-65-1881) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-331, National Science Foundation, and Office of Naval Research) AD 626098 Unclassified

Also published in Jour. Geophys. Research, v. 70: 2579-2598, June 1, 1965.

Conjugate aspects of auroral zone electron precipitation are examined using data from ten simultaneous balloon flights of x-ray detectors from Fairbanks, Alaska, and Macquarie Island, Australia, as well as riometer data from Kotzebue and College, Alaska. These results indicate a close correspondence, in similarity and simultaneity, in regions of near conjugacy over a wide range (K_p = 0+ to 6_0) of geophysical disturbance. Whereas gross features of activity remain intact, dissimilarities become quite evident at locations well removed from near conjugacy (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

BALLOON OBSERVATIONS OF AURORAL ZONE X RAYS IN CONJUGATE REGIONS. 2. MICROBURSTS AND PULSATIONS, by R. R. Brown, J. R. Barcus, and N. R. Parsons. [1965] [14]p. incl. diagrs. table. (AFOSR-65-1882) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-331, National Science Foundation, and Office of Naval Research) AD 626099 Unclassified

Also published in Jour. Geophys. Research, v. 70: 2599-2612, June 1, 1965.

Simultaneous balloon observations of x-ray pulsations in the 5-10 sec range made from Fairbanks, Alaska, and Macquarie Island, Australia, showed no detailed correlation in time or amplitude. Observations in the northern hemisphere, with 2 balloon instruments separated by about 150 km in the east-west direction, showed no obvious correlation, but when the separation was reduced to about 100 km in the north-south direction, x-ray pulsations showed in-phase variations. Observations with 2 balloon instruments separated by 150 km in the east-west direction showed time coincidences for about 1/3 of the microbursts; the other 2/3 were observed on one balloon or the other. From the small scale size of microburst electron precipitation it is suggested that magnetospheric plasma instabilities are responsible for the electron bombardment of the auroral zone atmosphere. Similar considerations are suggested for pulsating electron precipitation. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

STORAGE OF RADIOACTIVE DEBRIS IN THE POLAR VORTEX, by J. R. Barcus. [1965] [3]p. incl. diagr. (AFOSR-65-2787) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-331, and Office of Naval Research) AD 627759 Unclassified

Also published in Jour. Atmos. Sci., v. 22: 460-462, July 1965.

Several observations of the storage of radioactive debris in the polar stratosphere are presented. The measurements were made incidentally to a series of high altitude balloon flights primarily intended for auroral zone research and released from Point Barrow, Alaska, during Mar. 1963. This period followed by some months an intensive high latitude series of atmospheric nuclear tests which had been conducted by the USSR from Aug. 5 to Dec. 25, 1962.

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California U. Dept. of Physics, Berkeley.

OBSERVATIONS ON THE ASSOCIATION OF AURORAL LUMINOSITY WITH AURORAL X-RAYS AND COSMIC NOISE ABSORPTION, by T. J. Rosenberg. [1965] [9]p. incl. diagrs. table. (AFOSR-65-2798) (AF AFOSR-63-331) AD 627541 Unclassified

Also published in Jour. Atmos. and Terrest. Phys., v. 27: 751-759, June 1965.

Simultaneous observations of auroral luminosity and bremsstrahlung x-rays from the same balloon payload are reported here. Comparison of the balloon measurements with riometer records has shown the same variety of associations that appear in other studies of auroral phenomena. Because the photometer and scintillation counter geometries are fixed relative to each other and view equivalent regions of the sky at the production layer, it has been possible to investigate behavioral differences in the low and high energy portions of the precipitated electron spectrum with more certainty than when comparing balloon and ground-based observations. Certain aspects of the present observations suggest that temporal variations in these two energy ranges are rather independent, on occasion. These observations support the suggestion that two mechanisms having characteristically different energy spectra control the acceleration and/or precipitation of energetic electrons.

Correlations of auroral luminosity with x-rays then depend upon the degree of coupling between the mechanisms. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

COMMENTS ON RELATIVISTIC SUPERMULTIPLET THEORIES, by S. Weinberg. [1965] [5]p. incl. refs. (AFOSR-65-1815) (AF AFOSR-64-232) AD 625573 Unclassified

Also published in Phys. Rev., v. 139: B597-B601, Aug. 9, 1965.

It is proved that it is impossible to extend the SU(6) symmetry to a well-behaved group of unitary operators on the physical Hilbert space since no such group can have irreducible representations containing all spin states of the particles involved. It is shown that the recently proposed U(12) symmetry evades the theorem by acting on the generalized M function rather than on the physical Hilbert space. A brief explanation is provided for the use of the M function. Some evasions of the theorem other than the U(12) symmetry are also discussed.

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California U. Dept. of Physics, Berkeley.

DETERMINATION OF THE SPINS AND PARITIES OF RESONANCES, by C. Zemach. [1965] [16]p. incl. tables. (AFOSR-66-0016) (AF AFOSR-64-232) AD 630324 Unclassified

Also published in Phys. Rev., v. 140: B109-B124, Oct. 11, 1965.

The properties of angular-momentum tensors described in item no. 296, are used to develop tests for the spins and parities of resonances. Fermion resonances decaying into particles of spin zero and spin one-half or spin zero and spin three-halves and boson resonances decaying into particles of spin zero and spin one are considered in some detail. Attention is given to angular correlations between production and decay configurations, both generally and in special cases such as forward production, low-energy production, and peripheral collisions. A moment analysis of the decay distributions is developed. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

USE OF ANGULAR-MOMENTUM TENSORS, by C. Zemach. [1965] [12]p. incl. tables. (AFOSR-66-0017) (AF AFOSR-64-232) AD 630308 Unclassified

Also published in Phys. Rev., v. 140: B97-B108, Oct. 11, 1965.

The properties of tensor representations are developed for application to angular-momentum problems in elementary-particle reactions. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

THREE-BODY N/D EQUATIONS. I. INTEGRAL ANGULAR MOMENTA, by S. Mandelstam. [1965] [22]p. incl. diagrs. (AFOSR-66-0016) (AF AFOSR-64-232) AD 630309 Unclassified

Also published in Phys. Rev., v. 140: B375-B396, Oct. 25, 1965.

Equations are derived for calculating 3-body partial wave amplitudes once all singularities other than the unitarity discontinuity are known. The equations can easily be reduced to Fredholm equations. They have a similar structure to the 2-body equations, but are more complicated owing to the presence of disconnected diagrams. The D function is related to the form factor in the usual way, and it has the expected zeros and cuts on the unphysical sheet. A subsidiary problem which is treated is the determination of a function with kinematical branch points when the discontinuities across the dynamical cuts on all sheets are known. Also, a brief discussion is given of the many-channel analog of the Omnes equation. This discussion may be useful to those who do not wish to study the mathematical theory in detail. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

INFRARED PHOTONS AND GRAVITONS, by S. Weinberg. [1965] [9]p. (AFOSR-66-0021) (AF AFOSR-64-232) AD 640277 Unclassified

Also published in Phys. Rev., v. 140: B516-B524, Oct. 25, 1965.

It is shown that the infrared divergences arising in the quantum theory of gravitation can be removed by the familiar methods used in quantum electrodynamics. An additional divergence appears when infrared photons or gravitons are emitted from noninfrared external lines of zero mass, but it is proved that for infrared gravitons this divergence cancels in the sum of all such diagrams. (The cancellation does not occur in massless electrodynamics.) The formula derived for graviton bremsstrahlung is then used to estimate the gravitational radiation emitted during thermal collisions in the sun, and this found to be a stronger source of gravitational radiation (though still very weak) than classical sources such as planetary motion. The conjecture of Dalitz that divergences in the Coulomb-scattering Born series may be summed to an innocuous phase factor is verified, and it is shown how this result may be extended to processes involving arbitrary numbers of relativistic or nonrelativistic particles with arbitrary spin. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

UNSTABLE-PARTICLE SCATTERING AND THE STRIP APPROXIMATION, by I. T. Drummond. [1965] [18]p. incl. diagrs. refs. (AFOSR-66-0025) [AF AFOSR-64-232] AD 630237 Unclassified

Also published in Phys. Rev., v. 140: B482-B499, Oct. 25, 1965.

The problem of formulating a bootstrap calculation when one of the scattering particles is unstable, is examined. The unstable-particle scattering amplitude is defined as an S-matrix pole residue, the analytic structure of which may be determined from the usual Landau rules. Although the instability of the external particle complicates the structure it does not do so too severely. Therefore, it can be postulated that, in analogy with the stable case, the unstable-particle amplitude exhibits Regge asymptotic behavior. A strip approximation to the amplitude which is a crossing-symmetric superposition of Regge pole terms can then be constructed. This approximation exhibits, in some respects, satisfactory analytic structure. In particular it takes quite well into account certain anomalous threshold effects. It satisfies a quasi-Mandelstam representation which is used to explore the analytic structure of the corresponding partial-wave amplitudes and their continuation to arbitrary angular momentum. Certain simple discontinuity formulas are used to obtain dynamical equations for the partial-wave amplitudes and a complete bootstrap scheme is formally constructed. (Contractor's abstract, modified)

300

California U. Dept. of Physics, Berkeley.

INTENSITY CORRELATIONS IN RAMAN SCATTERING, by A. L. Fetter. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-2046) (AF AFOSR-65-130) AD 627729 Unclassified

Also published in Phys. Rev., v. 139: A1616-A1623, Aug. 30, 1965.

Correlated counting rates in Raman scattering are proposed as a means of studying optical phonons in crystals. This technique may be used to measure both the lifetime and spatial coherence of the vibrational states. Experimental counting times are estimated to be the order of 50 μsec for the case of a gas laser as a light source. (Contractor's abstract)

301

California U. Dept. of Physics, Berkeley.

VORTICES IN AN IMPERFECT BOSE GAS. III. SCATTERING OF SINGLE-PARTICLE EXCITATIONS, by A. L. Fetter. [1965] [9]p. incl. refs. (AFOSR-66-0373) (AF AFOSR-65-130) AD 630279 Unclassified

Also published in Phys. Rev., v. 140: A452-A460, Oct. 18, 1965.

The scattering of single-particle excitations by a vortex in the condensate of an imperfect Bose gas is studied using the Bogoliubov approximation. The S matrix is calculated as in conventional scattering theory, and the phase shifts are determined with the Schwinger variational principle. The differential cross section in the long-wavelength limit is found to be $d\sigma/d\varkappa = 1/2\pi (\hbar/mc^2)k \cot^2(1/2\varkappa)$, where m is the mass of one atom and c is the speed of sound. This cross section agrees precisely with that found previously for scattering of sound by a classical vortex with circulation h/m. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

SPHERICAL IMPURITY IN AN INFINITE SUPERCONDUCTOR, by A. L. Fetter. [1965] [16]p. incl. diagrs. refs. (AFOSR-66-1546) (AF AFOSR-65-130) AD 641036 Unclassified

Also published in Phys. Rev., v. 140: A1921-A1936, Dec. 13, 1965.

The modifications in a superconducting medium due to a single, spherically symmetric, nonmagnetic impurity are examined using the BCS theory of superconductivity. The energy spectrum of quasiparticles has both a discrete portion (bound states) and a continuous portion (scattering states). In the scattering region ($E > \Delta$), a given energy corresponds to two distinct momentum states, one above and one below the Fermi level. The calculation of the S matrix for the impurity scattering is thus a problem of two coupled channels. The electron density $n(\gamma)$ and the order parameter $\Delta(\gamma)$ far from the impurity are evaluated asymptotically in terms of the eigenphase shifts and mixing parameter of the two channels. Two soluble models for the impurity are considered. With a hard-sphere, long-range spatial oscillations are found in $\Delta(\gamma)$ as well as in $n(\gamma)$. With a delta-shell potential, a resonant enhancement occurs in the scattering of quasiparticles with momentum near the Fermi momentum. Both the spatial oscillations and the resonant enhancement are expected to appear for more general impurity potentials. (Contractor's abstract)

303

California U. Dept. of Physics, Berkeley.

ACCURACY OF MEASUREMENT FOR COUNTING AND INTENSITY-CORRELATION EXPERIMENTS, by M. L. Goldberger and K. M. Watson. [1965] [10]p. incl. diagrs. refs. (AFOSR-66-1588) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-130 and Atomic Energy Commission) AD 641034 Unclassified

Also published in Phys. Rev., v. 140: B500-B509, Oct. 25, 1965.

A quantum-mechanical analysis is made of the experimental accuracy to be expected for particle-counting and intensity-correlation experiments. The mean-square

fluctuation for an ensemble, consisting of a large number of experiments each conducted over a time interval T, is calculated. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

DECAY MODES OF SPIN-TWO MESONS, by S. L. Glashow and R. H. Socolow. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-65-2797) (AF AFOSR-65-232) AD 627728 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 329-333, Aug. 16, 1965.

The observed partial decay widths of spin-two mesons are compared with theoretical predictions based on SU(3). The results strongly support the assignment of these states to the reducible $1 \oplus 8$ representation of SU(3) with considerable f, f' mixing.

305

California U. Electronics Research Lab., Berkeley.

THE INSTABILITY OF CENTRIFUGAL-ELECTROSTATIC-FOCUSED FLOW, by R. Lundgren. Sept. 23, 1965, 102p. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-117 and Electronics Technology Division) AD 474598 Unclassified

The stability of thin centrifugal- electrostatic-focused (CEF) streams is investigated. It is found that these streams can be unstable for axially asymmetric perturbations, but that perturbation growth stops or is severely damped after the beam attains some specific thickness. Linear analysis of the thin stream model shows that it is usually unstable for two-dimensional perturbations, with exponential time growth dependent on the azimuthal wave number. Moving the coaxial focusing walls closer to the stream first causes the growth rate at small n to decrease, then vanish, and finally to reappear accompanying a stream-image charge instability. The physical mechanism of growth is examined in detail and compared to its dual, the magnetically focused model of Kyhl-Webster-Pierce. The large-amplitude growth region is examined by numerical integration using a two-dimensional charged-rod model. The accuracy of the numerical method is checked against the results of a single-rod small-amplitude analysis. Starting points for the non-linear calculations are small density perturbations for n = 5, and 15 = 30. Growth of the stream thickness is exponential for approximately one or two stream revolutions, then quickly limits, going to a much slower or zero growth rate.

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California U. [Electronics Research Lab.] Berkeley.

A CENSUS OF FINITE AUTOMATA, by M. A. Harrison. [1965] [14]p. incl. diagrs. tables. (AFOSR-65-0902) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-63-139) AD 617877 Unclassified

Also published in Canad. Jour. Math., v. 17: 100-113, 1965.

A finite automaton may be thought of as a possible abstraction of a digital computer. This note solves the problem of counting the number of equivalence classes of finite automata. The solution consists of a number of theorems on the enumeration of functions, which includes a representation of a finite automaton by a directed graph whose modes represent internal states and whose branches denote transitions. Connected automata are also considered, and some numerical results are given.

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California U. [Electronics Research Lab.] Berkeley.

AN OPTIMAL REGULATOR PROBLEM, by A. Chang. [1965] [14]p. incl. refs. (AFOSR-65-0908) (AF AFOSR-63-139 and AF AFOSR-63-292) AD 618347 Unclassified

Also published in Siam Jour. Control, Ser. A, v. 2: 220-233, 1965.

An optimal regulator problem is considered for systems whose behavior may be described by the linear differential equation $\dot{x}(t) = Ax(t) + Bu(t)$, where A and B are matrices of real constants. Given this system, an initial state x_0, and the conditions (a) the pair (A, B) is controllable, i.e., rank $[B, AB, \ldots, A^{n-1}B] = n$; (b) the pair (A, Q) is observable, i.e., rank $[Q, AQ, \ldots, A^{n-1}Q] = n$; (c) the autonomous system $\dot{x} = Ax$ is Ljapunov stable, let $T \subset U$ be the set of all admissable controls which transfer x_0 to the origin. The problem is to find a $u \in T$ such that $J(u, x_0) = \inf_{\nu \in T} J(\nu, x_0)$. It is shown that there exists a unique optimal control for any choice of the initial state and that Pontryagin's maximum principle gives necessary and sufficient conditions for a control to be optimal. The problem of optimal feedback control is considered, and it is shown that an optimal feedback control is a linear function of the state in a neighborhood of the origin. The final result is that the optimal feedback control is a continuous function of the state which, in principle, makes this computation feasible.

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California U. [Electronics Research Lab.] Berkeley.

QUASISTATIC ANALYSIS OF WAVES IN A PLASMA-FILLED WAVEGUIDE, by J. E. Scharer and A. W. Trivelpiece. [1965] [2]p. incl. diagrs. (AFOSR-65-0909) (Sponsored jointly by Air Force Cambridge Research Lab; [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-63-139]) AD 617238 Unclassified

Also published in Jour. Appl. Phys., v. 36: 318-319, Jan. 1965.

Using the quasistatic approximation in bounded magnetized plasmas, the dispersion equation obtained predicts phase velocities greater than the velocity of light for a certain region of the ω-β plane. This is considered to invalidate the quasistatic analysis. In this note the region is investigated for an idealized plasma-filled guide with propagation and magnetic field oriented axially along the guide, and the conditions for validity of the dispersion relation for this region are determined. The magnetic and electric fields and power flow are obtained, and the validity for the quasistatic analysis for the backward-wave mode and forward-wave mode is studied.

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California U. Electronics Research Lab., Berkeley.

THE DETECTION OF WEAK MAGNETIC FIELDS USING DIPOLE RESONANCE IN THIN-PERMALLOY FILMS, by C. E. Frank. Jan. 18, 1965, 91p. incl. illus. diagrs. tables, refs. (Rept. no. 65-4) (AFOSR-65-1141) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-63-139) AD 468085 Unclassified

Anisotropic magnetic thin films can be formed by vacuum evaporation and deposition of ferromagnetic materials in a dc magnetic field parallel to the substrate. Such films, especially those of nickel-iron of "permalloy" composition, have been extensively studied in the past, primarily with respect to properties which are useful in digital computer applications. Recently, interest in these devices has developed for detecting very weak magnetic fields, using low-frequency-switching methods as described by West, Odom, Rice, and Penn. The work reported here makes use of a new ultra-high-frequency magnetic-spin-resonance method devised by the author. Among the new results obtained are analytical and experimental verifications of the high sensitivity attainable. Although the actual sensitivities measured in ordinary laboratory surroundings were limited to approximately 10 gauss by the ambient magnetic noise level, it is demonstrated that the system is capable of much greater sensitivity if used in quieter locations.

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California U. Electronics Research Lab., Berkeley.

THE ANALYSIS AND SYNTHESIS OF PROBABILITY TRANSFORMERS, by D. L. Moorehead. Jan. 28, 1965, 64p. incl. diagrs. refs. (Rept. no. 65-6) (AFOSR-65-1223) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-63-139, and National Science Foundation) AD 463597 Unclassified

The purpose of this report is to investigate the effect of finite state machines on an input random process, and to propose a method whereby a machine can be designed that transforms the probability measure of a process into a specified measure. Of particular interest is what a finite automaton does to certain important properties that random processes can have. It is shown that all finite state machines can preserve the stationarity of input processes via specifying an appropriate initial probability distribution over the states of the machine. Necessary and sufficient conditions are obtained on the structure of a finite state machine such that the process consisting of the sequence of states will be ergodic. This is achieved by extension of a theorem in information theory on similar conditions for finite state channels. A topic given considerable attention is the synthesis of a finite state machine whose output will be a random process with a specified finite order probability distribution, given a particular input process and its associated measure. It can be shown that this problem cannot be solved exactly, but that an arbitrarily close approximation can be achieved subject to an error criterion defined in the report. A class of processes, the measure of which can be realized exactly, is also given. Necessary and sufficient conditions are given on a machine such that the output process be a finite Markov chain.

311

California U. Electronics Research Lab., Berkeley.

ANODE STRUCTURES FOR COLD-CATHODE HIGH-POWER MAGNETRONS, by Y. Ikeda and C. Susskind. [1965] [7]p. incl. diagrs. table. (AFOSR-65-2194) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-63-139) AD 625583 Unclassified

Also published in Radio and Electron. Engineer, v. 29: 93-99, Feb. 1965.

The characteristics of anode structure suitable for cold-cathode high-power magnetrons have been investigated analytically and experimentally, with special emphasis on increasing the interaction and maximizing the area of coherent interaction with the electron beam at a given frequency. The structures analyzed were designed for large mode separation, high interaction impedance, and easy coupling to the output circuit. They may be applicable to travelling-wave amplifiers; some circuit characteristics of the structures are therefore also included. (Contractor's abstract)

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California U. [Electronics Research Lab.] Berkeley.

OPTIMAL CONTROL OF APERIODIC DISCRETE-TIME SYSTEMS, by B. W. Jordan and E. Polak. [1965] 15p. incl. diagrs. (AFOSR-66-0044) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-63-139, and National Aeronautics and Space Administration) AD 641493 Unclassified

Also published in Siam Jour. Control, Ser. A, v. 2: 332-346, 1965.

Much of previous work on the optimal control of discrete-time processes was concerned with sampled-data systems in which the sampling instants are fixed and equi-spaced and in which the optimization is carried out over the amplitudes of the piecewise constant controls. Necessary conditions for optimal control of a class of fixed duration, discrete-time processes with aperiodically modulated inputs, which are suggested by engineering considerations were established. The plants of the systems under consideration were described by nonlinear differential equations and the inputs are piecewise constant, suitably restricted in amplitude, and required to have K or fewer discontinuities whose position is not restricted. (K is a fixed, positive integer.) Using techniques analogous to the ones used in establishing the Pontryagin maximum principle, it is shown that for an admissible control to be optimal, it is necessary that a Hamiltonian-like functional be either locally maximum or stationary with respect to the admissible controls, and that a set of transversality conditions be satisfied. Computational and engineering aspects of this problem are dealt with in a separate paper to be published soon.

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California U. Electronics Research Lab., Berkeley.

STATISTICAL THEORY OF ELECTRON TRANSPORT IN CROSSED FIELDS: CHARACTERISTICS OF THE SMOOTH-BORE MAGNETRON, by K. Mouthaan. Aug. 6, 1965, 102p. incl. diagrs. refs. (Rept. no. 65-29) (AFOSR-66-0368) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-63-139 and Army Electronics Laboratories) AD 626296 Unclassified

Electron transport across the magnetic field in crossed electric and magnetic fields is described on the basis of random fluctuations in the fields. The theory is formulated in terms of the slipping-stream instability, so that a definite mechanism behind the fluctuations in the fields is established. The transport equation appropriate to the analysis is shown to be the diffusion equation; a definite expression for the diffusion tensor is obtained. The components of the diffusion tensor transverse to the magnetic field are found to be proportional to the square of the electric field, and inversely proportional to the cube of the magnetic field, the exponential-growth rate of the slipping-stream instability determines the magnitude of the diffusion coefficients. Application of the theory is made to find the cut-off characteristics of the smooth-bore magnetron. Explicit expressions for the space-charge distribution, the electric-field distribution, the anode current, and the circulating current are obtained. The results are compared with available experimental results. The agreement between theoretical and experimental values is good, particularly for the anode current. The new theory thus appears to provide, for the first time, a correct theoretical explanation of the cut-off characteristics of the smooth-bore magnetron. (Contractor's abstract)

314

[California U. Electronics Research Lab., Berkeley]

AN ALGEBRAIC CHARACTERIZATION OF CONTROLLABILITY, by A. Chang. [1965] [2]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-63-139) Unclassified

Published in IEEE Trans. Automatic Control, v. AC-10: 112-113, Jan. 1965.

A theorem is proved for complete controllability for linear differential systems. Systems are considered whose state at time t is described by an n-dimensional vector x(t) that satisfies the differential equation $\dot{x}(t) = A(t)x(t) + B(t)u(t)$, where the control, u(t), is assumed to be an r-dimensional vector, and A(t) and B(t) are n x n and n x r matrices, respectively.

315

California U., [Electronics Research Lab.] Berkeley.

A NEW MODEL FOR SIMPLE NEURAL NETS AND ITS APPLICATION IN THE DESIGN OF A NEURAL OSCILLATOR, by T. Pavlidis. [1965] [15]p. incl. diagrs. refs. (AF AFOSR-63-292) Unclassified

Published in Bull. Math. Biophys., v. 27: 215-229, June 1965.

The results of a previous theoretical study of a class of systems are applied for the design of neural nets which try to simulate biological behavior. Besides the models for single aperiodic and periodic neurons, a neural oscillator is developed which consists of 2 cross-excited neurons. Its response is similar to the firing pattern of certain biological neural oscillators, like the flying system of the locust. Also, by proper change of its parameters, it can be made highly irregular, providing a deterministic model for the spontaneous neural activity. (Contractor's abstract)

316

California U. Electronics Research Lab., Berkeley.

FUZZY SETS, by L. A. Zadeh. Nov. 16, 1964 [16]p. incl. diagrs. (Rept. no. 64-44) (AFOSR-64-2507) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139, and National Science Foundation) AD 608981 Unclassified

Also published in Inform. and Control, v. 8. 338-353, June 1965

A fuzzy set is a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function which assigns to each object a grade of membership ranging between zero and one. The notions of inclusion, union, intersection, complement, convexity, etc., are extended to such sets, and various properties of these notions

in the context of fuzzy sets are established. In particular, a separation theorem for convex fuzzy sets is proved without requiring that the fuzzy sets be disjoint. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

ON THE RELATION BETWEEN ORDINARY AND STOCHASTIC DIFFERENTIAL EQUATIONS, by E. Wong and M. Zakai. Aug. 11, 1964, 29p. (Rept. no. 64-26) (AFOSR-65-0265) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139 and National Science Foundation) AD 609826 Unclassified

Also published in Internat'l. Jour. Eng. Sci., v. 3: 213-229, June 1965.

The following problem is considered in this paper: Let x_t be a solution to the stochastic differential equation: $dx_t = m[x_t, t]\,dt + \sigma[x_t, t]\,dy_t$ where y_t is the Brownian motion process. Let $x_t^{(n)}$ be the solution to the ordinary differential equation which is obtained from the stochastic differential equation by replacing y_t with $y_t^{(n)}$ where $y_t^{(n)}$ is a continuous piecewise linear approximation to the Brownian motion and $y_t^{(n)}$ converges to y_t as $n \to \infty$. If x_t is the solution to the stochastic differential equation (in the sense of Ito) does the sequence of the solutions $x_t^{(n)}$ converge to x_t? It is shown that the answer is in general negative. It is however, shown that $x_t^{(n)}$ converges in the mean to the solution of another stochastic differential equation which is: $dx_t = m[x_t, t]\,dt + 1/2\sigma[x_t, t]\,(\partial\sigma[x_t, t]/\partial x_t)\,dt + \sigma[x_t, t]\,dy_t$. (Contractor's abstract)

318

California U. Electronics Research Lab., Berkeley.

SOLUTION OF CIRCULAR LOOP ANTENNAS AND SCATTERING FROM CONDUCTING LOOPS BY NUMERICAL METHODS, by A. Baghdasarian and D. J. Angelakos. Jan. 8, 1965, 23p. incl. diagrs. (Rept. no. 65-1) (AFOSR-65-0549) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 457192 Unclassified

The integral equation of the current distribution along a circular loop antenna is solved by numerical methods. It is shown that the integral equation can be converted into a set of linear simultaneous equations, solutions of which give the current distribution. First, the loop antenna driven by a voltage source is considered and solutions to loops of various sizes are obtained. Secondly, current distributions are obtained for the loop as a scatterer illuminated by a plane wave. Finally, from the knowledge of the current on the illuminated loops, backscattering patterns are obtained for rotating loops. Measurements are also performed for the latter case and the results compared with calculations. (Contractor's abstract)

319

California U. Electronics Research Lab., Berkeley.

PROPAGATION AND INSTABILITIES OF WAVES IN BOUNDED FINITE TEMPERATURE PLASMAS, by A. J. Lichtenberg and J. S. Jayson. [1965] [7]p. incl. diagrs. refs. (AFOSR-65-0912) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-139 and National Science Foundation) AD 617232 Unclassified

Also published in Jour. Appl. Phys., v. 36: 449-455, Feb. 1965.

The quasistatic analysis is used to examine propagation and instabilities of waves in a plasma in which the transverse bounds and the temperature are important. A dispersion equation is derived by use of a dielectric tensor, which is correct within the quasistatic assumption and the assumption of longitudinal velocity, only. The dispersion curves have a smooth transition from the zero temperature case at long wavelengths to the unbounded finite temperature case at short wavelengths. The stop-bands which appear in the zero temperature analysis become propagating regions in the more general case. Landau-type damping is calculated; the cyclotron wave is strongly damped. The effect of the boundaries and the magnetic field on a double-humped velocity distribution is examined. The transverse boundaries are stabilizing with respect to space-charge waves, but the cyclotron interactions are strengthened. The temperature always exerts a stabilizing influence which is particularly marked for the interaction between the cyclotron waves. Curves of the limiting regions of stability, with respect to various parameters, are given, illustrating these effects. By the use of an example it is demonstrated that a moderate temperature can suppress the cyclotron instability. The result is in agreement with the experimental observation that a plasma, predicted to be unstable with respect to the cyclotron-wave interaction, was actually stable. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

ON CONVERGENCE OF THE SOLUTIONS OF DIFFERENTIAL EQUATIONS INVOLVING BROWNIAN MOTION, by E. Wong and M. Zakai. Jan. 19, 1965, 17p. (Rept. no. 65-5) (AFOSR-65-0913) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 463598 Unclassified

Let $y(t, \omega)$ be a Brownian motion process ($E\{[y(t) - y(s)]^2\} = |t - s|$), and let $\{y_n(t, \omega)\}$ be a sequence of "well-behaved" approximations to $y(t, \omega)$. Consider the sequence of solutions $\{x_n(t)\}$ of the differential equation

$dx_n(t) = m[x_n(t), t]\,dt + \sigma[x_n(t), t]\,dy_n(t)$, $a \le t \le b$. In this paper it is shown that for polygonal approximations $\{y_n(t)\}$ and under quite general conditions on m and σ l.i.m. $x_n(t) = x(t)$, where x(t) is the solution of a stochastic differential equation $\sigma'(x,t) = \sigma(x,t)\,\sigma_x$

$dx(t) = m[x(t), t]\,dt + 1/2\,\sigma'[x(t), t]\,\sigma[x(t), t]\,dt + \sigma[x(t), t]\,dy(t)$, $a \le t \le b$.

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California U. Electronics Research Lab., Berkeley.

MULTIPARAMETER SENSITIVITY ANALYSIS FOR LINEAR SYSTEMS, by R. N. Biswas and E. S. Kuh. Mar. 9, 1965, 25p. incl. diagrs. (Rept. no. 65-8) (AFOSR-65-1326) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139, and National Science Foundation) Unclassified

A new method of sensitivity analysis for linear multiparameter systems is presented. The method depends on the existence of a simple matrix flow graph model. The matrix sensitivity $S = (\delta x)^{-1} X W^{-1} \delta W$ as introduced by Cruz and Perkins is reviewed first. The relations between the conventional multiparameter scalar sensitivity and the elements of the sensitivity matrix are then obtained. These formulas are simple to compute and give insight to the design of multiloop systems. Higher order multiparameter sensitivities are also derived. Examples are given in terms of general RLC networks and multiloop feedback systems. Preliminary results indicate that the method is also useful in the synthesis of general transfer functions, and may prove to be important in the design of integrated electronic circuits. (Contractor's abstract)

322

California U. Electronics Research Lab., Berkeley.

STUDY OF WIDE-BAND PARAMETRIC AMPLIFIERS AND CONVERTERS, by M. Fukada. Apr. 30, 1965, 101p. incl. diagrs. tables, refs. (Rept. no. 65-10) (AFOSR-65-1459) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 465194 Unclassified

A rather complete broadbanding theory is presented for varactor parametric amplifiers and inverting-type converters, including single-varactor, multiple-varactor and traveling-wave parametric amplifiers. In all these cases, theoretical limitations on gain-bandwidth and the method of synthesizing optimum amplifiers are obtained. In the theory of single-varactor amplifiers, an extension of Kuh and Fukada's work on lossless shunt-varactor amplifiers has been made. It is shown that any dissipative-varactor amplifier can be treated in a manner similar to the lossless-varactor case if the reflection-coefficient of its associated matching network is defined properly. Examination of series-varactor amplifiers shows that their gain-bandwidth limitation is the same as in shunt-varactor amplifiers. A practical transmission-line network design is also developed and demonstrated by an experimental microwave degenerate amplifier. The theory of multiple varactor amplifiers and converters includes nonreciprocal equalization, reciprocal equalization and traveling-wave parametric amplifiers.

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California U. Electronics Research Lab., Berkeley.

MICROWAVE LOSS IN A REFLEX PLASMA DISCHARGE, by P. Govindan, A. J. Lichtenberg, and J. R. Woodyard. May 3, 1965, 50p. incl. illus. diagrs. tables, refs. (Rept. no. 65-11) (AFOSR-65-1460) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 464949 Unclassified

Also published in Jour. Appl. Phys., v. 38: 382-389 Jan. 1967. (AFOSR-68-0091)

The Q of a partially ionized plasma with fluctuating density, created by a reflex discharge, is determined by measuring the decay of microwave energy in a cavity coaxial to the plasma column. The measurements indicate that for $\omega_p/\omega < 1$ the losses are predominately due to electron-neutral collisions, but that virtual collisions with the ends of the interaction region may also be significant. For $\omega_p/\omega > 1$ electron-ion collisions appear to be a significant source of loss for hot cathode discharges but not for cold cathode discharges. Anomalous diffusion does not play a significant role in the microwave losses. The absolute magnitude of the experimentally determined collision time is considerably lower than that calculated from the theory. This discrepancy can be at least partly explained, with some additional assumptions, for hot-cathode operation. For cold-cathode operation there remain some unexplained inconsistencies within the experimental results. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

[BASIC RESEARCH IN ELECTRONICS], by D. J. Angelakos and J. R. Whinnery. Final rept. Feb. 15, 1964-Mar. 15, 1965. June 1, 1965, 59p. incl. illus. diagrs. tables, refs. (Rept. no. 65-13) (AFOSR-65-1531) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-139) AD 465548 Unclassified

A survey is presented of research in the following areas. (1) Bioelectronics including studies with bound water, macromolecules, the nervous system, and aides for the blind; (2) Computer sciences including experimental data acquisition and digital data processing systems, (3) Electron streams and interactions comprising cold-cathode magnetron and thermionic cathode studies and electron trajectory calculations, (4) Plasma including magnetic-mirror compression, homopolar rotating plasmas, and low-temperature plasmas, (5) Quantum and optical electronics including

laser mode and ion laser studies and electro-optic light beam deflection; (6) Radiation and propagation concerning antenna studies and the lunar surface; (7) Solid-state electronics dealing with the areas of materials and mechanisms, active solid-state circuits, and scanning electron microscopy; (8) Systems and circuit theory including tunnel diode networks, network synthesis and circuit and network analysis.

325

California U. Electronics Research Lab., Berkeley.

OPTICAL LEVEL POPULATION INVERSIONS IN A SODIUM-MERCURY MIXTURE DISCHARGE, by L. H. Lin. June 4, 1965, 48p. incl. diagrs. tables, refs. (Rept. no. 65-15) (AFOSR-65-2219) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-139) AD 469266 Unclassified

Population densities of excited sodium levels in a glow discharge of a mixture of sodium and mercury vapors were obtained by spectral line intensity measurements. Comparison with the case of pure sodium vapor discharge was made. It was found, in the mixture discharge, that the population densities of sodium levels, which have energies close to the energies of mercury 6^3P_1 and 6^3P_0 levels, are highly populated by the process of resonance excitation transfer to the extent that many population inversions result between these levels and some lower off-resonance levels. The excitation transfer between the mercury metastable level 6^3P_0 and the sodium level $7^2S_{1/2}$ is most significant: the corresponding cross section is estimated to be 4.7×10^{-15} cm^2. Optically allowed transitions between the population inverted levels are all in the infrared region, the shortest wavelength being approximately 3.37 μ ($7^2S_{1/2} - 5^2P_{1,2,3/2}$). The negative absorption coefficients for some important transitions are also calculated.

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California U. Electronics Research Lab., Berkeley.

COCHLEAR SENSORY-FIELD EFFECTS BASED ON INTER-UNIT COUPLING, by G. G. Furman. July 6, 1965, 118p. incl. diagrs. tables, refs. (Rept. no. 65-19) (AFOSR-65-2220) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 470556 Unclassified

The characteristics of a variety of possible inhibitory-connection schemes among elements lying within the cochlea were investigated. The characteristics were obtained analytically and were supplemented by and checked against data obtained from digital simulation. It was found that, under certain conditions, all of these connective schemes can lead to a sharpening of the frequency sensitivity of any single neuron. An anatomy-oriented inhibition scheme, called shunting inhibition, was developed. Apart from its possible application in the cochlea, shunting inhibition leads to theoretically intersecting operations in sensory information processing, operations not possible with the classical subtractive type of inhibition.

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California U. Electronics Research Lab., Berkeley.

THE STATE VARIABLE APPROACH TO NETWORK ANALYSIS, by E. S. Kuh and R. A. Rohrer. May 20, 1965, 21p. incl. diagrs. tables, refs. (Rept. no. 65-12) (AFOSR-65-2285) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139, and National Science Foundation) AD 624075 Unclassified

Also published in Proc. IEEE, v. 53: 672-686, July 19, 1965. (AFOSR-66-0051)

The universality of the state-variable approach to network analysis is demonstrated in general discussions and specific examples. The method of formulation of the state equations for an arbitrary lumped, linear, finite, reciprocal, passive, time-invariant network is presented fully, while the relaxation of these restrictions is indicated in detail; i.e., the state-variable characterization of active, nonreciprocal, time-variable, and nonlinear networks is discussed. Finally, there is a brief guide of the current research where the state-variable analysis is brought to bear upon certain qualitative aspects of classical and nonclassical network behavior. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

A UNIFIED THEORY OF SYNTHESIS WITH UNSYMMETRIC FOUR-ELEMENT LOSSLESS LATTICES, by C. W. Ho and I. T. Frisch. [1965] [11]p. incl. diagrs. (AFOSR-65-2444) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 625576 Unclassified

Also published in IEEE Internat'l. Conv. Rec., Pt. 7: 147-157, 1965.

A complete theory is given for the use of unsymmetric lossless lattices with 4 elements in the cascade synthesis of transfer functions and driving-point functions. The major results are a new lattice equivalent for a Darlington-C section under specified constraints on the driving-point impedance and a new, simple condition of applicability for the Miyata lattice. For both lattices explicit formulas for the element values are developed in terms of the given impedance.

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California U. [Electronics Research Lab.,] Berkeley.

WAVE-MECHANICAL APPROACH TO THE NON-LINEAR THEORY OF O-TYPE TRAVELLING-WAVE

TUBES, by K. Mouthaan, [1965] [11]p. incl. diagrs. (AFOSR-65-2447) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139, and Army Electronics Laboratories) AD 625708 Unclassified

Also published in Internat'l. Jour. Electron., v. 18: 301-311, Apr. 1965.

The one-dimensional motion of electrons in O-type travelling-wave devices is described in terms of wave mechanics. For the case of large-signal interaction it is found that in the final state of the interaction the electrons travel along at discrete energy levels involving Planck's constant. By making use of the Pauli exclusion principle, the saturation power and electronic efficiency of the large-signal travelling-wave tube are obtained. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

SEMIANNUAL PROGRESS REPORT NO. 1, by D. J. Angelakos. Nov. 16, 1964-June 30, 1965, 304p. incl. illus. tables, refs. (AFOSR-65-2860) [AF AFOSR-64-139] AD 474661 Unclassified

Research projects are grouped into the following areas: bioelectronics, electron streams and interactions, plasmas, quantum and optical electronics, radiation and propagation, solid-state electronics, and systems.

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California U. Electronics Research Lab., Berkeley.

LIMITING STABLE CURRENTS IN BOUNDED ELECTRON AND ION STREAMS, by W. B. Bridges, J. I. Frey, and C. K. Birdsall. [1965] 9p. incl. tables, refs. (AFOSR-66-0042) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 641709 Unclassified

Also published in IEEE Trans. Electron Devices, v. ED-12 264-272, May 1965.

The classical static analysis of the infinite planar diode has been extended to include the effects of finite transverse beam size. Simple expressions have been found for the increase in maximum stable current density over that of an infinite stream for finite cylindrical and strip streams flowing between plates of infinite diodes. The results are also given in terms of stream perveance. The effect of a nonuniform distribution of current across the stream is shown to be relatively small. Experimental values of maximum stable current agree with those obtained from the analysis. A further extension of the static analysis has been made to include the effects of additional conducting plane boundaries parallel to the stream motion. For length-to-width ratios $L/D < 0.25$ the tube is adequately described by the results for the infinite planar diode and for $L/D > 4$, the infinitely-long drift tube theory suffices. At intermediate values of L/D, the maximum amount of current that can be stably passed through the tube is greater than that predicted by either asymptotic theory. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

MONOCHROMATIC ILLUMINATION OF CADMIUM-SULFIDE OSCILLATOR, by R. M. White. [1965] [2]p. incl. diagr. table. (AFOSR-66-0043) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 641711 Unclassified

Also published in Proc IEEE, v. 53: 745-746, July 1965.

The period, waveform, and amplitude of current oscillations in a uniformly illuminated cadmium-sulfide oscillator have been found to depend strongly upon the wavelength and intensity of the light used. The observations described here show that a given feature of the oscillation (e.g., a particular waveshape) is not associated solely with a single wavelength, but rather that the wave-length at which the feature occurs depends upon the light intensity. The observations strongly suggest that the wavelength and intensity of illumination are not primary parameters, but rather, by their effects upon resistivity of the CdS they affect the oscillations.

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California U. Electronics Research Lab., Berkeley.

STABILITY OF LINEAR TIME-VARYING NETWORKS-THE STATE SPACE APPROACH, by E. S. Kuh. [1965] 8p. incl. diagrs. refs (AFOSR-66-0113) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139 and National Science Foundation) AD 641713 Unclassified

Also published in IEEE Trans. Circuit Theory v. CT-12: 150-157, June 1965.

This paper is concerned with linear networks which contain time-varying resistors, inductors, and capacitors. The state-variables formulation is used to describe the general circuit. General sufficient conditions for Liapunov stability are derived in terms of the network parameters and the incidence submatrices of the graph. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley

SYNTHESIS AND REALIZATION OF COUNTING BISTABLE CIRCUITS, by D. A. Hodges Aug 31, 1965, 87p. incl. illus diagrs. tables, refs. (Rept no. 65-33) (AFOSR-66-0366) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research

Office (Durham), and Office of Naval Research] under AF AFOSR-64-139, and Electronics Technology Division) AD 627797 Unclassified

Synthesis procedures are extended for counting bistable circuits from given dc bistable configurations and 2 silicon-integrated bistable circuits are described. Active devices are presented by a controlled-conductance model which is first derived from a consideration of the principles underlying charge-control device operation. The model is also applicable to non-change-control active devices. These results make evident the straight-forward application of the synthesis procedures utilizing enhancement or depletion mode active devices. A linearized active region analysis is carried out for a basic bistable configuration. Either symmetrical or nonsymmetrical triggering techniques are allowed. Conditions are determined for regenerative switching and practical triggering techniques are predicted for the basic junction-type field-effect transistor (FET) circuit and a bipolar junction transistor (BJT)-FET circuit. With minor changes, the conclusions are valid for the cross-coupled and emitter-coupled circuits. A dc bistable circuit and a counting bistable circuit were designed and fabricated in silicon integrated form. Each experimental monolithic circuit incorporates as the active devices one BJT and one FET. Predicted and measured results for dc circuit characteristics and switching times are in reasonable agreement. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

LASER ARRAYS, by J. C. Gibson. July 23, 1965 [44]p. incl. diagrs. tables, refs. (Rept. no. 65-21) (AFOSR-66-0402) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 476149 Unclassified

This paper deals with the application of various types of array techniques. The laser is assumed to have a Gaussian field distribution at its aperture, and its far field pattern is developed from this aperture pattern. The linear broadside array factor is applied to both the Gaussian element pattern and to an element consisting of a circular aperture uniformly illuminated with a plane wave. The Dolph-Tchebyscheff and binomial amplitude distribution array factors are applied to the Gaussian element pattern to reduce sidelobe levels with equal element spacing. Ishimaru's technique of unequal element spacing is applied to the Gaussian element pattern to reduce sidelobes, and then to suppress the secondary beam. The half-power beamwidths are calculated and compared, and the circular array is investigated for application to the Gaussian element pattern. Results concerning relative sidelobe levels and grating lobe levels are tabulated and compared. Conclusions are made concerning the feasibility of applying array theory to lasers with element spacings of hundreds of wavelengths. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

SYNTHESIS OF INTEGRATED SELECTIVE AMPLIFIERS FOR SPECIFIED RESPONSE AND DESENSITIVITY, by A. A. Gaash. June 17, 1965, 105p. incl. diagrs. tables, refs. (Rept. no. ERL-65-31) (AFOSR-66-1065) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-139) AD 628677 Unclassified

The fundamental objective of the report is the realization of highly selective, bandpass network functions in the medium of semiconductor integrated circuitry. Realization of such circuit performance has to take into consideration the special properties of integrated, monolithic microcircuitry. In view of the unavoidable dependence of integrated passive and active components on environmental conditions and on manufacturing tolerances, syntheiss procedures via sensitivity functions are explored. Attention is focused on closed sensitivity formulations in order to reveal extra degrees of freedom available for desensitization. To that end, various sensitivity functions in single-loop and multi-loop feedback structures are investigated. The effect of the variation of integrated passive components is then assessed. The corresponding sensitivity contributions are shown to be independent of the circuit configuration and are expressed in form of sensitivity invariants. Based on the sensitivity formulation, sensitivity criteria are incorporated into the synthesis procedures, permitting simultaneous realization of specified response and sensitivity. The procedures make use of multi-loop feedback structures, wherein redundant transmission loops are introduced together with the correlated nature of the time-dependent and time-independent changes of integrated components.

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California U. Electronics Research Lab., Berkeley.

SEMICONDUCTOR INTEGRATED OSCILLATORS, by G. D. Hachtel. Aug. 31, 1965 [191]p. incl. illus. diagrs. tables, refs. (Rept. no. 65-32) (AFOSR-66-1066) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-139) AD 629578 Unclassified

The realization of oscillation in monolithic semiconductor integrated circuits was considered. A procedure was developed for the synthesis of integrable, near-harmonic, oscillators from known, integrable, bistable circuits. By the insertion of resistors, capacitors, and batteries, the procedure converts the integrable bistable circuits into 'inductor-less' oscillators. Experimental integrated realizations of oscillators synthesized were fabricated.

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California U. [Electronic Research Lab.] Berkeley.

DIRECT MEASUREMENT OF THE DEPLETION LAYER WIDTH VARIATION VS APPLIED BIAS FOR A P-N JUNCTION, by N. C. MacDonald and T. E. Everhart. [1965] [3]p. incl. diagrs. illus. (AFOSR-66-0344) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139 and Electronic Technology Division) Unclassified

Also published in Appl. Phys. Ltrs., v. 7: 267-269, Nov., 1965.

Using the scanning electron microscope, the width of the depletion region of a reverse-biased silicon N^+-P junction was measured as a function of the applied voltage. It was observed that as the reverse bias across the junction is increased, dynamical broadening of the depletion layer occurs in both the voltage-contrast and the electron-beam-induced current modes of operation. The specimens were angle lapped to expose the junction profile. Measurement of the depletion layer width w as a function of the reverse bias V_R followed the familiar $w \propto (V_R)^{1/2}$ relationship for an abrupt junction.

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California U. Electronics Research Lab., Berkeley.

THE NUMBER OF TERMS IN THE GENERAL GAIN FORMULAS FOR COATES AND MASON SIGNAL FLOW GRAPHS, by J. P. Jacob. [1965] [4]p. incl. diagrs. (AFOSR-67-0346) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) AD 646838 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 601-604, Dec. 1965.

The question: 'Given a Coates flow graph or a Mason signal flow graph, how many 'connection paths' or 'loop products' will one have to find in order to compute the numerator and denominator of their general gain formula?' was answered with the help of the concept of the permanent of a matrix.

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California U. Electronics Research Lab., Berkeley.

NECESSARY CONDITIONS FOR THE REALIZABILITY OF n-PORT RESISTIVE NETWORKS WITH MORE THAN (n+1) NODES, by I. T. Frisch and K. R. Swaminathan. [1965] [8]p. incl. diagrs. (AFOSR-67-0487) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-139) AD 647457 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 520-527, Dec. 1965.

A new set of necessary conditions are presented for an nth-order square symmetric matrix Y with real entries to be the n-port admittance matrix of a network containing positive resistors and (n ≥ 2) nodes. The so-called "supremacy" conditions represent a symmetric set of inequalities among products of pairs of elements in a matrix S obtained in a simple manner as linear combination of entries in Y. The conditions are derived by augmenting the given matrix Y with an additional port to form a connected port structure, transforming the port structure until it is linear, applying the "uniform tapering conditions" and then eliminating the augmenting port. Extensions are given to the case of n+p nodes with 2 < p n. (Contractor's abstract)

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[California U. Electronics Research Lab., Berkeley]

A CONSTRUCTIVE DERIVATION OF THE CAPACITY OF A BANDLIMITED CHANNEL, by D. J. Sakrison and L. P. Seidman. [1965] 5p (Bound with its Rept. no 65-14; AD 468178 (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) Unclassified

By expanding the expression C W log 2 $(1 + \frac{P}{2N_0W})$ which is for the capacity of a channel limited to bandwidth $2W$, to C W log 2 $(1 + \frac{(1-\epsilon)P}{2N_0W} + \frac{\epsilon P}{2N_0}$ log 2^e which is a channel with additive white Gaussian noise of 2 sided spectral density, it is shown that the channel can be reduced to a collection of amplitude continuous time discrete channels whose joint capacity is easily computed

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California U. Electronics Research Lab., Berkeley

ELECTRON-STREAM DIODE INSTABILITIES WITH ELASTIC COLLISIONS, by J. Frey and C. K. Birdsall [1965] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-139) Unclassified

Published in Jour. Appl. Phys., v. 36: 2962-2964, Sept. 1965.

Instabilities can be induced in parallel-plane (diode) configurations when a very high current is passed through the diode, even if this current is neutralized by ions This work extends Pierce's original calculation of the critical current for instability to find the growth rate for a wide input-current range, and then goes on to include collisions of the injected stream with background neutrals and allow for mobile neutralizing particles. Collisions damp the instability, increasing the value of input current at which onset of instability will occur, if the collision frequency ν is such that $\omega_p^2 L, \nu u_0 \quad 4\pi$,

approximately, then there is no time growth. Allowing the background ions to be mobile also eliminates this type of instability. The results without collisions compare favorably with some experiments involving essentially collisionless diodes; those with collisions included do not agree with some experiments involving collision-dominated triode lasers. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

A NOTE ON THE PERMANENT OF A MATRIX, by J. P. Jacob. [1965] 9p. incl. diagr. (Bound with its Rept. no. 65-14, AD 468178) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) Unclassified

The method of counting non-zero additive terms in the expansion of the determinant of a matrix was investigated. Several applications on the concept of the permanent were found, but these proved harder than alternative methods known previously. The graph theory (the counting of the total number of trees in a graph) resulted from this study.

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California U. Electronics Research Lab., Berkeley.

NOTES ON SYSTEM THEORY, VOLUME VII. May 1965, 170p. incl. diagrs. refs. (Rept. no 65-14) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139, Air Force Office of Scientific Research under AF AFOSR-64-292, and AF AFOSR-64-639, National Science Foundation, and National Aeronautics and Space Administration) AD 468178 Unclassified

The purpose of this note is twofold (1) to provide an auxiliary publication medium for short contributions by students and faculty engaged in research in systems and related areas, (2) to contribute to the development of system theory as a basic scientific discipline.

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[California U. Electronics Research Lab., Berkeley]

ON THE EQUIVALENCE OF FINITE-STATE SEQUENTIAL MACHINE MODELS, by O. H. Ibarra. [1965] 19p. incl. diagrs. (Bound with its Rept. no. 65-15; AD 468178) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) Unclassified

By means of differential equations a proof is presented of the equivalence of sequential machine models. Some effective procedures are presented for transforming one model to the other which preserves machine minimality.

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[California U. Electronics Research Lab., Berkeley]

ON THE STABILITY OF FEEDBACK CONTROL SYSTEMS WITH PERTURBATION GAIN, by C. T. Chen. [1965] 10p. incl. diagrs. (Bound with its Rept. no. 65-14, AD 468178) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-139) Unclassified

This paper considers a special class of single-loop feedback systems both in the continuous and in the sampled-data cases. It is shown that if the gain deviation from the linearity of the memoryless nonlinear element, $\tilde{\sigma}(\sigma,t)$, is smaller than $\lambda(t)\sigma$, then $\lambda(\cdot) \in L^1(0,\infty)$ implies that the system output is bounded for any bounded input. As $t \to \infty$, the system output tends to that of the linearized ($\tilde{\sigma}(\sigma,t) = 0$) system as $t \to \infty$. Similar results hold for the sampled-data case. (Contractor's abstract)

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California U. [Electronics Research Lab.] Berkeley.

SYNCHROTRON RADIATION FROM A SELF-CONSISTENT PLASMA (Abstract), by A. J. Lichtenberg and D. Tuma. [1965] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [AF AFOSR-64-139] and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10, 238, Feb. 25, 1965.

The Fokker-Planck equation with radiation added as a friction term is solved numerically to obtain the time-dependent distribution of the high-energy tail of a plasma with an initial Maxwellian distribution. The synchrotron radiation spectrum is then obtained for a transparent plasma with an analytic density distribution that approximates that found by the numerical integration. It is found for a plasma with density $n_e = 10^{11}/cm^3$, temperature $T_e = 75$ kev, in a magnetic field of 50 k Gauss, parameters appropriate to an experimental magnetic-mirror configuration, that the radiation term dominates. Within a few msec, although the temperature has not changed appreciably, the number of high-energy electrons has altered significantly. This decrease is sufficient to lower the radiation in the higher cyclotron harmonics by an amount that should be observable. For example, after 5 msec, the radiation in the 8th harmonic has been decreased by 40%.

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California U. Electronics Research Lab., Berkeley

A NOTE ON THE EVALUATION OF THE TOTAL

SQUARE INTEGRAL, by E. I. Jury. [1965] [2]p. (AFOSR-65-2431) (AF AFOSR-64-292) AD 629795 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10: 110-111, Jan. 1965.

The purpose of this correspondence is to show the general formulation of the total square integrals in discrete systems. For such a formulation it is only necessary to expand an (n-1) order determinant.

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California U. Electronics Research Lab., Berkeley

A GENERAL FORMULATION OF THE TOTAL SQUARE INTEGRALS FOR CONTINUOUS SYSTEMS, by E. I. Jury and A. G. Dewey. [1965] [2]p. (AFOSR-65-2432) (AF AFOSR-64-292) AD 627761 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10: 119-120, Jan. 1965.

The problem of evaluating the total square integral arises in the analysis and design of feedback control systems, both for deterministic and for stochastic inputs. The first approach to this problem was made by James, et. al. using the solution of a recurrence formula. Integrals up to the seventh order were tabulated. A few years later, Newton et al presented a method based on the solution of a matrix equation dependent on whether n, the order of the system, was even or odd. The earlier table was extended up to the tenth order. Kalman and Bertram recently mentioned an approach from the point of view of Liapunov functions However, this leads to the solution of a system of algebraic equations and the method has no computational advantage over that of Newton. The points discussed in this correspondence are (1) The formulation of a general expression for any order n as the ratio of two determinants. This could easily be programmed on a digital computer. (2) It is shown that the denominator determinant is precisely equal to Δ_n, the nth Hurwitz determinant. This equivalence guarantees the existence of the total square integral for a stable system. (3) Finally a scheme is shown whereby the amount of computation is minimized. For design problems where there are algebraic coefficients, an expression is given involving the expansion of only (n-2) determinants of order (n-3). In this expression no cancellation of terms occurs.

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California U. Electronics Research Lab., Berkeley.

ANALYSIS OF A NEW CLASS OF PULSE-FREQUENCY MODULATED FEEDBACK SYSTEMS, by T. Pavlidis and E. I. Jury. [1965] [9]p. incl. illus. diagrs. refs. (AFOSR-65-2433) (AF AFOSR-64-292) AD 627762 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10: 35-43, Jan. 1965.

A new class of pulse-frequency modulated systems is presented. These systems, referred to here as Σ-PFM, have many advantages over previously used schemes such as integral PFM. Most significant advantages are improved stability and simpler physical implementation of the modulator. The major part of the paper is concerned with the study of sustained oscillations using a specially developed quasi-describing function. One important feature of these kinds of PFM systems is that they often present a limit annulus and not a limit cycle, a feature which is common in most nonlinear discrete feedback systems. A few examples with experimental verification are presented and the limitations of the method are discussed. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

A NOTE ON AIZERMAN'S CONJECTURE, by A. G. Dewey and E. I. Jury. [1965] 2p. incl. diagrs. (AFOSR-66-0657) (AF AFOSR-64-292) AD 641685 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10: 482-483, Oct. 1965.

The contribution of this note has been to present a numerical counter-example to Aizerman's conjecture Such an example for continuous systems has not previously appeared in the literature even though the work of Pliss has been known for many years. Since Aizerman's conjecture is not true in general, the approach to the problem of absolute stability must be that of Bergen and Williams, that is, to single out those classes of systems for which the conjecture can be verified.

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[California U. Electronics Research Lab., Berkeley]

ON THE NUMBER OF ROOTS OF A REAL POLYNOMIAL INSIDE (OR OUTSIDE) THE UNIT CIRCLE USING THE DETERMINANT METHOD, by E. I. Jury [1965] 4p (Bound with its Rept. no. 65-14; AD 468178) (AF AFOSR-64-292) Unclassified

A procedure is presented for finding the number of roots outside and inside the unit circle of a real polynomial. The proof presented requires the evaluation of either odd or even determinants.

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[California U. Electronics Research Lab., Berkeley]

THE PROBLEM OF NEURON MODELING, by J. G. Blanchard and E. I. Jury. [1965] 16p. incl. diagrs. (Bound with its Rept. no 65-14, AD 468178) (AF AFOSR-64-292) Unclassified

A study was conducted on the problem of neuron modeling correlating the ideas of bioengineers and physiologists Results indicated the need for the development of accurate models based on quantitative and qualitative experimental data about the chemical and electrical

behavior of the precise neural element to be studied. Another finding was the desire for the development of simplified models, which enable the bioengineer to investigate very complex problems similar to those arising in the behavior of groups of neurons or synapses.

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California U. [Electronics Research Lab.] Berkeley.

ANALYSIS AND SYNTHESIS OF STABLE LINEAR SEQUENTIAL CIRCUITS, by A. Gill. [1965] [9]p. incl. diagr. (AFOSR-65-0630) (AF AFOSR-64-639) AD 614164 Unclassified

Also published in Jour. Assoc. Comput. Mach., v. 12: 141-149, Jan. 1965.

Linear sequential circuits (LSC's) are finding an increasing number of uses in error-correction, computer control, random number generation and other digital applications. The purpose of this paper is to develop analysis and synthesis techniques for the class of autonomous "stable" LSC's which is of special interest in error-correction schemes. Properties of such LSC's are described in terms of their state graphs, and a method is presented for constructing the state graph from the characteristic matrix of a given LSC. Necessary and sufficient conditions are formulated for a given graph to correspond to a realizable stable circuit, and a procedure is given for finding this circuit's characteristic matrix and synthesizing it by means of shift registers. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

A CENSUS OF FINITE AUTOMATA, by M. A. Harrison. [1965] [3]p. incl diagrs. tables. (AFOSR-65-0631) (AF AFOSR-64-639) AD 614746 Unclassified

Also published in Proc. Fifth Annual Symposium on Switching Circuit Theory and Logical Design, Princeton U., N. J., (Nov. 11-13, 1964) [1965] p 44-46.

Closed form expressions are obtained for enumerating the non-equivalent finite automata under several definitions of equivalence. Algorithms are presented for determining the number of connected automata and automata with a distinguished initial state. Useful lower bounds and asymptotic results are obtained. (Contractor's abstract)

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California U. [Electronics Research Lab.] Berkeley.

THE MINIMIZATION OF LINEAR SEQUENTIAL CIRCUITS, by A. Gill. [1965] 3p. (AFOSR-66-0023) (AF AFOSR-64-639) AD 632732 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 292-294, June 1965.

It is shown how the characterizing matrices of the linear form of a given linear sequential circuit can be computed directly from the characterizing matrices of the given circuit. An immediate corollary of the shown procedure and of Moore's result concerning the uniqueness of the minimal form is the following. If a sequential machine can be realized by means of a linear circuit, then its minimal form can also be thus realized. It can be noted that no use was made of the fact that GF (p) is a finite field. In fact, the minimization algorithm remains valid for linear time-discrete systems associated with (finite or infinite) fields, and in particular for linear time-discrete systems ('sampled data' systems) where the underlying field is that of real numbers.

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California U. Electronics Research Lab., Berkeley.

ON THE BOUND TO THE MEMORY OF A SEQUENTIAL MACHINE, by A. Gill. [1965] 3p. incl. diagrs. (AFOSR-66-0028) (AF AFOSR-64-639) AD 641808 Unclassified

Also published in IEEE Trans. Electron. Comput., v. EC-14: 464-466, June 1965.

A sequential machine consists of a finite input alphabet X, a finite output alphabet Y, a finite state set S, a next-state function δ, and an output function λ, defined (for all integers t) by

$$\left.\begin{aligned} s_{t+1} &= \delta(s_t, x_t) \\ y_t &= \lambda(s_t, x_t) \end{aligned}\right\} x_t \in X,\ y_t \in Y,$$

$s_t \in S$. A machine has memory μ if μ is the least integer such that $y_t = f(x_t, x_{t-1}, \ldots, x_{t-\mu}, y_{t-1}, \ldots, y_{t-\mu})$. If a a minimal n-state machine has a finite memory μ, then $\mu < n(n-1) = N$. In this note it was proven that $N = n(n-1)\ 2$ is the best possible upper bound for μ.

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California U. Electronics Research Lab., Berkeley.

ON THE ERROR CORRECTING CAPACITY OF FINITE AUTOMATA, by M. A. Harrison. [1965] 21p. incl. diagrs. refs. (AFOSR-66-0029) (AF AFOSR-64-639) AD 641809 Unclassified

Presented at Internat'l. Colloq. on Automata Theory and Algebraic Linguistics, Jerusalem (Israel), Aug. 24-25, 1964.

Also published in Inform. and Control, v. 8: 430-450, Aug. 1965.

One interesting application of sequential machines is to consider them as encoders and decoders for an information channel. Results concerning the structure of error correcting automata were obtained. Another reason for the study of these automata was that the regular sets which they recognized are particularly simple.

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California U. [Electronics Research Lab.] Berkeley.

THE DISTRIBUTION OF MATRICES RESULTING FROM NEWTON'S IDENTITIES IN A FIELD OF CHARACTERISTIC TWO, by E. R. Berlekamp. [1965] 7p. incl. table. (Bound with its Rept. no. 65-14, AD 468178) (AF AFOSR-64-639) Unclassified

Methods have been previously studied for the decoding of polynomials of the lowest degree, with a limited set e of error patterns. Because of the expansion of the correctable error patterns with more than e errors this work was undertaken. An inevitible transformation of equations was introduced in order to obtain expansion over the entire ensemble of possible matrices.

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[California U. Electronics Research Lab., Berkeley]

STABILITY ANALYSIS OF MONOTONE FEEDBACK SHIFT REGISTERS, by C. J. Tan and A. Gill. [1965] 10p. incl. diagrs. (Bound with its Rept. no. 65-14; AD 468178) (AF AFOSR-64-639) Unclassified

This research investigated a special class of feedback shifts registers, or FSR's called monotone. A general test for the stability of monotone FSR's is derived by use of the Boolean matrices. A proof of this theorem representing stability is presented.

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California U. Electronics Research Lab., Berkeley.

A GENERAL MATCHING THEORY AND APPLICATION TO TUNNEL DIODE AMPLIFIERS, by Y. T. Chan and E. S. Kuh. Aug. 17, 1965, 51p. incl. diagrs. refs. (Rept. no. 65-23) (AFOSR-65-2284) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-139, and National Science Foundation) AD 474217 Unclassified

Youla's theory of broadband matching to include both passive and active 1-port load impedances is generalized. The design philosophy of lossless coupling networks for an active load is different from that of a passive load; however, the design theory is quite similar. The theory is illustrated in a detailed example with a tunnel diode as the active load. Both series resistance and inductance are used in the equivalent circuit representation. New results in terms of theoretical limitation on gain-bandwidth and a sufficient condition for potential stability are obtained. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

REPRESENTATION OF NONLINEAR NETWORKS, by E. S. Kuh. Sept. 30, 1965, 6p. incl. diagrs. refs. (Rept. no. 65-25) (AFOSR-66-0082) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-139, and National Science Foundation) AD 625987 Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill., Oct. 25-27, 1965.

Also published in Proc. Nat'l. Electronics Conf., v. 21: 702-707, Oct., 1965.

The signal flow graph representation puts in evidence the 2 sets of equations which characterize a general nonlinear time varying network, the set specifying the network topology and the set describing the branch relations. Conditions for reduction of simple nonlinear signal flow graph are illustrated. To obtain the governing differential equation, one needs to reduce the signal flow graph. Obvious sufficient conditions in terms of the nonlinear branch relations and linear topology are immediately obtained.

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California U. Electronics Research Lab., Berkeley.

H-GUIDE LOG-PERIODIC SLOT ANTENNA, by G. N. Vornoff. Dec. 6, 1965, 126p. incl. illus. diagrs. tables, refs. (Rept. no. 65-34) (AFOSR-66-0367) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-139) AD 627417 Unclassified

A theoretical and experimental investigation of an end-fire (as contrasted to a conventional back-fire design) flush-mounted log-periodic slot antenna is described. The antenna consists of 2 periodic slot arrays cut in one of the metal walls of a tapered H-guide. The antenna receives excitation at the large end of the structure and radiates toward the small end, yet retaining pattern integrity over large bandwidth This is made possible by judiciously employing the surface wave properties of a broadband TE_{01} mode propagated in a tapered H-guide.

It has been shown theoretically that the energy can be transported from the large end of the structure to a desired active region located near the small end, without appreciably exciting the preceding portions of the antenna. The results of the near field measurements, antenna VSWR, and radiation patterns are presented. The antenna radiates essentially constant patterns over a 3:1 bandwidth with half-power beamwidths of approximately 20° in the E- and H-planes. The results of this study indicate that the antenna can generate a narrow beam and is potentially capable of transmitting high power. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley

PLASMA RESEARCH. Quarterly progress rept. no. 2, Apr. 1-June 30, 1965, 63p. incl. diagrs. tables, refs. (AFOSR-66-0403) (Sponsored jointly by Air Force Avionics Laboratory, [Air Force Office of Scientific

Research, Army Research (Durham), and Office of Naval Research] under AF AFOSR-65-139, Atomic Energy Commission, and National Science Foundation) AD 625424 Unclassified

This research in plasmas is part of an integrated program of research and teaching in the problems of creation, containment, heating, stability, radiation, and measurement of the physical and electromagnetic properties of high- and low-temperature plasmas. The basic high-temperature plasma research facility consists of a 250,000-joule capacitor energy-storage system and related electronic control and safety equipment. This bank operates two basic experiments each of which requires pulse magnetic magnetic fields in excess of 50,000 gauss.

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California U. Electronics Research Lab., Berkeley.

PROPAGATION AND INSTABILITIES IN BOUNDED AND FINITE TEMPERATURE PLASMAS, by J. S. Jayson. Sept. 22, 1965, 115p. incl. diagrs. tables, refs. (Rept. no. 65-24) (AFOSR-66-0617) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-139; Air Force Office of Scientific Research under AF 33(615)1078; and National Science Foundation) AD 630128 Unclassified

The quasi-static analysis is used to examine propagation and instabilities in plasmas in which both the transverse bounds and the temperature are important. Initially only longitudinal thermal velocity is assumed and two stream instabilities are studied. With the introduction of transverse temperature, instabilities resulting from temperature anisotropy are also studied. The full set of Maxwell's equations is utilized for an investigation of the effects of dispersion on the synchrotron radiation spectrum. The investigation of hot plasmas with finite boundaries was undertaken initially to explain the differences between phenomena found in experimental observations and those predicted by the cold plasma theory. Longitudinal temperature is added to the model and it is found that strong cyclotron wave damping and the absence of the cyclotron-cyclotron interaction in a two stream configuration are predicted by the theory. Introducing transverse temperature into the model, using the Boltzmann equation, instabilities arising from temperature anisotropy are investigated and it is found that, for a bi-Maxwellian distribution, for low values of k_z the plasma is stable. The investigation of finite plasmas with transverse temperature is pursued by consideration of a configuration in which a boundary layer region is included and the particle density decreases to zero through this region.

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California U. Electronics Research Lab., Berkeley.

NOTES ON SYSTEM THEORY, VOLUME VIII. Nov. 1, 1965, 98p. incl. diagrs. tables, refs. (ERL Rept no. 65-639) (AFOSR-66-0768) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-139; Air Force Office of Scientific Research under AF AFOSR-65-639, and National Science Foundation) AD 632067 Unclassified

This is the eighth issue of Notes on System Theory The purpose of these notes is twofold: first, to provide an auxiliary publication medium for short contributions by students and faculty engaged in research in systems and related areas: second, to contribute to the development of system theory as a basic scientific discipline.

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California U. Electronics Research Lab., Berkeley.

SEMIANNUAL PROGRESS REPORT NO. 2, by D. J. Angelakos. Dec. 31, 1965 [353]p. incl. illus. diagrs. tables, refs. (AFOSR-66-1379) [AF AFOSR-65-139] AD 487278 Unclassified

Research projects conducted are grouped into the following areas: bioelectronics, electron streams and interactions, plasmas, quantum and optical electronics, radiation and propagation, scanning electron microscopy, semiconductor electronics, and systems and computer sciences.

368

California U. Electronics Research Lab., Berkeley.

PLASMA RESEARCH. Quarterly progress rept. no. 3, by C. K. Birdsall, A. J. Lichtenberg, and A. W. Trivelpiece. July 1-Sept. 30, 1965, 37p. incl. illus. diagrs. (AFOSR-66-2365) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-139, Atomic Energy Commision, Electronics Technology Division, and National Science Foundation) AD 641083 Unclassified

Progress is reported on experimental and theoretical research in problems of creation, containment, heating, stability, radiation, and measurement of the physical and electromagnetic properties of high and low temperature plasmas. The hot-electron experiment operated without difficulty during most of the report period. Most of the effort was concerned with obtaining adequate data to determine the absolute intensity of the synchrotron radiation emitted by the hot-electron plasma. The electron and loss energy analyzer was completed, and the electron end-loss plasma camera used in conjunction with an image converter was used to improve the estimates of the size and location of the plasma. The inconclusive results of the laser-scattering experiments have led to a study of the scattering of laser photons by a hot-electron plasma. A turbulent heating experiment was performed in order to study ion heating by an electron current modulated at the ion-cyclotron frequency. Calibration of the ion energy analyzer is proceeding. A description of the turbulent heating experiment is presented. The experimental apparatus for plasma instability experiments is being prepared. An analysis of flute modes in a mirror machine plasma with diffused boundary was completed. Related research includes the testing of a computer model for nonlinear investigation

of plasma interchange instability, investigation of the damping and instabilities of cyclotron waves in a plasma, and the study of nonlinear interaction of an electron with an electromagnetic wave. (Contractor's abstract)

369

California U. Electronics Research Lab., Berkeley.

A "GAIN" FORMULA FOR LINEAR-VECTOR FLOW GRAPHS, by R. N. Biswas. [1965] [15]p. incl. diagrs. (Bound with its AFOSR-66-0768, AD 632067) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-139) Unclassified

An alternative method is presented which bypasses the elimination procedure and simplifies the bookkeeping by expressing the transfer matrix in terms of transfer matrices of a subgraph.

370

California U. Electronics Research Lab., Berkeley

LA GRANGE MULTIPLIERS AND SIGNAL DESIGN, by L. P. Seidman. [1965] [12]p. (Bound with its AFOSR-66-0768; AD 632067) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-139) Unclassified

It is demonstrated that it is often easy to show that a given signal configuration is a critical point of probability of error. The method used is a simplification of La Grange multipliers.

371

California U. Electronics Research Lab., Berkeley.

ENCODING A GEOMETRIC SOURCE, by E. R. Berlekamp. [1965] [7]p. (Bound with its AFOSR-66-0768; AD 632067) (AF AFOSR-65-639) Unclassified

A mathematical calculation for finding an infinite number of source outputs is presented.

372

California U. Electronics Research Lab., Berkeley.

PATTERN CLASSIFICATION IN "QUBIC", by I. L. Traiger. [1965] [17]p. incl. diagrs. tables. (Bound with its AFOSR-66-0768, AD 632067) (AF AFOSR-65-639) Unclassified

Polya's theorem was used to calculate the number of equivalence classes for any state of game of "Qubic" (three-dimensional tic-tac-toe).

373

California U. Electronics Research Lab., Berkeley.

SOME COMMENTS ON B1 CODES, by E. R. Berlekamp. [1965] [7]p. incl. tables (Bound with its AFOSR-66-0768; AD 632067) (AF AFOSR-65-639) Unclassified

A B1 code may be able to correct b 2^{h-1} bursts. Any B1 code is also a B2 code and for short constraint lengths, the former is more advantageous than the latter. This advantage dies out when either code is interlaced with itself sufficiently often to correct very long bursts. Mathematical calculation for the optimum B1 code of rate is described.

374

California U. Inst. of Engineering Research, Berkeley.

EXPERIMENTAL STUDY OF WAVE PHENOMENA ASSOCIATED WITH THE ONSET OF GASEOUS DETONATION, by P. A. Urtiew. Feb. 1965 [114]p. incl. illus. diagrs. tables, refs. (Rept. no. AS-65-1) (AFOSR-65-1277) (AF AFOSR-64-129) AD 621214 Unclassified

A study is made of wave processes that occur at the instant of transition from the deflagrative to the detonative mode of propagation of the combustion wave in an explosive gas mixture. Experimental observations are made by means of Schlieren photography with pressure transducer measurements using stoichiometric hydrogen-oxygen mixtures. Theoretical interpretation of experimental results reveals that the transition is promoted by the action of a spherical detonation wave generated by a point explosion ahead of the main combustion zone. The theory of self-similar motion is applied to analyze the flow field induced by the initial transverse wave. On the basis of experimental observations a specific model is proposed for the geometric pattern of the oscillating wave system in the burned medium. The frequency of vibrations obtained from the analysis of this model is shown to be in satisfactory agreement with the eigenvalue of the linear wave equation.

375

California U. [Inst. of Engineering Research,] Berkeley.

PRESSURE WAVE GENERATION IN A FISSIONING GAS. II. EFFECTS OF DISSOCIATION AND MULTIPHASE COMPOSITION, by H. P. Smith, Jr., R. D. Evans and others. [1965] [4]p. incl. diagrs. table. (AFOSR-66-0064) (AF AFOSR-64-129) AD 632323 Unclassified

Also published in Phys. Fluids, v. 8· 1421-1425, Aug. 1965.

The analysis of pressure pulses which are generated in a fissioning gas by neutron irradiation is extended to the case of a dissociating medium including a condensed phase. After a satisfactory check of the process induced in boron trifluoride that was treated previously,

the analysis is applied to borazine for which the former method would be quite inadequate since now the effects of dissociation, involving the formation of free liquid boron, become predominant in controlling the thermodynamic behavior of the substance. (Contractor's abstract)

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California U. Inst. of Engineering Research, Berkeley.

DYNAMICS OF THE GENERATION OF PRESSURE WAVES BY ACCELERATING FLAMES, by P. A. Urtiew, A. J. Laderman, and A. K. Oppenheim. [1965] [6]p. incl. illus. diagrs. (AFOSR-66-0349) (AF AFOSR-64-129) AD 631159 Unclassified

Also published in Tenth Symposium (Internat'l.) on Combustion, Cambridge (Gt. Brit.) (Aug. 17-21, 1964), Pittsburgh, Combustion Inst., 1965, p. 797-804, 1965.

The theory of initial flame acceleration in an explosive gas contained in a constant cross-section tube, developed previously for a hemispherically shaped flame, was extended to include flames of spheroidal shapes. An expression for the flame world-line was developed, which depends only on a single parameter that accounts for the effects of the thermodynamic properties of the mixture and the geometry of the flamefront. Its value is determined graphically on the basis of experimental data. This leads to an unambiguous technique for the evaluation of the relative flame-propagation speed and for the calculation of the pressure wave generated by the flame. (Contractor's abstract)

377

California U. Inst. of Engineering Research, Berkeley.

STUDY OF THE DEVELOPMENT AND STABILIZATION OF DETONATIONS, by A. K. Oppenheim. Final rept. Oct. 1964-Oct. 1965, 7p. incl. refs. (AFOSR-66-0777) (AF AFOSR-65-129) AD 632575 Unclassified

The most significant progress made during last year's research work is associated with the successful development of novel experimental techniques which yielded a more penetrating insight into the detonation phenomena than that possible by any other means. This includes: (1) stroboscopic laser schlieren system permitting the attainment of extremely sharp (less than 10^{-8} sec) light pulses with an ultra-high (up to 10^6/sec) repetition rate for high speed schlieren photography; (2) ultra-high frequency response bar-type pressure transducers, permitting the measurement of a pressure pulse at a point of not more than 1 mm in diameter with a submicrosecond rise time; (3) soot-film technique for recording traces of detonation waves which, in our investigations, are particularly useful in pinpointing the location of their onset, and in the study of their structure. The most interesting progress made in analytical investigations is concerned with the study of the generation of pressure waves in fissioning gases.

378

California U. Inst. of Engineering Research, Berkeley.

AN EXPERIMENTAL STUDY OF THE ROTATIONAL DISTRIBUTION FUNCTION OF NITROGEN IN A SHOCK WAVE, by F. Robben and L. Talbot. May 1965, 1v. (Rept. no. AS-65-6) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-538 and Air Force Office of Scientific Research and Office of Naval Research under Nonr-22245) AD 466306 Unclassified

The electron beam fluorescence technique has been used to measure the rotational energy distribution through shock waves in nitrogen. At Mach 1.7, the deviation from thermodynamic equilibrium was found to be small, and the rotational temperature profile followed the density profile. Comparison with theoretical calculations yielded the rotational relaxation collision number $Z_r = 5$, in reasonable agreement with other determinations. At high Mach numbers, the measured rotational distribution function within the shock wave could not be represented by a single temperature, but was found to be representable approximately by the merging of 2 rotational distribution functions corresponding to temperatures upstream and downstream of the shock wave. The profile of the average local 'temperature' defined by the ratio of the total measured rotational energy to the gas density, was found to precede the density profile through the shock wave by an amount which increased with Mach number.

379

California U. Inst. of Engineering Research, Berkeley.

MEASUREMENT OF SHOCK WAVE THICKNESS BY THE ELECTRON BEAM FLUORESCENCE METHOD, by F. Robben and L. Talbot. May 1965, 33p. (Rept. no. AS-65-4) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-538 and Air Force Office of Scientific Research and Office of Naval Research under Nonr-22245) AD 466304 Unclassified

Shock wave thicknesses and density ratios have been measured in helium, argon and nitrogen by means of the electron beam fluorescence method, over the range $1.5 < M < 17.4$, in a low density wind tunnel. The shock thickness in argon and helium agreed well with Mott-Smith theory at the higher Mach numbers, and were between Navier-Stokes and Mott-Smith theory at the lowest Mach number. In nitrogen, the measured shock thicknesses were considerably greater than the predictions of Navier-Stokes theory. Measured density ratios across the shock wave were in good agreement with theory, in the lower density flows. Poorer agreement was found at higher flow densities, leading to estimates of upper bounds for the range of linear variation of fluorescence intensity with gas density. Measured density ratios for shocks produced in divergent free-jet flows were found to be in better agreement with theory after a viscous curvature correction was applied.

380

California U. Inst. of Engineering Research, Berkeley.

SOME MEASUREMENTS OF ROTATIONAL TEMPERATURES IN A LOW DENSITY WIND TUNNEL USING ELECTRON BEAM FLUORESCENCE, by F. Robben and L. Talbot. May 1965, 1v. (Rept. no. AS-65-5) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-538 and Air Force Office of Scientific Research and Office of Naval Research under Nonr-22245) AD 466305 Unclassified

The fluorescence of a 30 kv electron beam has been used as a probe to measure the rotational distribution function of flowing nitrogen in a low density wind tunnel. The fluorescence consists predominantly of the so-called first negative system of nitrogen. Measurements of the intensities of the rotational structure of the (o-o) vibrational band have been used to calculate, through a theoretical model, the original rotational distribution function of N_2 before excitation. A series of measurements was performed in the undisturbed flows of a subsonic nozzle, a Mach 4 nozzle, and free jet expansions from sonic orifices at Mach numbers ranging up to 19. The rotational temperature measurements are shown to be about 3% high at 280°K, with a progressively increasing error at lower temperatures. These measurements also indicated no measurable lag in rotational temperature in the free jet expansion.

381

California U. [Inst. of Engineering Research] Berkeley.

EFFECT OF BASE BLEEDING ON THE NEAR WAKE FOR VERY LOW REYNOLDS NUMBERS, by S. A. Berger and H. Viviand. [1965] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under Nonr-22245) Unclassified

Published in AIAA Jour., v. 3: 2154-2156, Nov. 1965.

Results are presented of the effect of base bleeding on the near-wake structure calculated according to a formulation involving the solution of incompressible Stokes approximate equations. The study is concerned with the problem of determining the structure of the incompressible base and near-wake flow for values of 0 large enough for this flow to be entirely viscous, the case being of interest for slender bodies at sufficiently low Reynolds numbers. A numerical example, is presented and discussed.

382

California U. [Inst. of Engineering Research] Berkeley.

HEAT TRANSFER AND SHEAR BETWEEN COAXIAL CYLINDERS FOR LARGE KNUDSEN NUMBERS, by D. R. Willis. [1965] [3]p. (Sponsored jointly by [Air Force Office of Scientific Research] and Office of Naval Research under Nonr-22245) Unclassified

Published in Phys. Fluids, v. 8: 1908-1910, Oct. 1965.

The heat transfer between coaxial cylinders for large Knudsen number is obtained using the method of Knudsen iteration. The BGK model equation, together with an extension which allows the Prandtl number to be set arbitrarily is used. Results are compared with those obtained by moment methods. It is found that the criterion proposed by Hurlbut for validity of the free molecular results is reasonable. Results are also presented for the rotating cylinder problem in a high Knudsen number flow.

383

California U. [Inst. of Engineering Research] Berkeley.

HYDRODYNAMICAL THEORY OF DIFFUSIVE SEPARATION OF MIXTURES IN A FREE JET, by F. S. Sherman. [1965] [7]p. incl. diagr. tables, refs. (Sponsored jointly by [Air Force Office of Scientific Research] and Office of Naval Research under Nonr-22245) Unclassified

Published in Phys. Fluids, v. 8: 773-779, May 1965.

The static molar concentration and fractional molar flow rates of the components of a binary mixture are computed to order $(Re)^{-1}$ on the centerline of an axially symmetric free jet, under conditions of nearly inviscid flow. These computed results confirm the conclusions of Reiss and Fenn regarding the mechanism underlying measured separation effects in jets at relatively high Reynolds number. Some qualitative comments about probe-induced separation are given.

384

California U. [Inst. of Engineering Research] Berkeley.

INCOMPRESSIBLE LAMINAR AXISYMMETRIC NEAR WAKE BEHIND A VERY SLENDER CYLINDER IN AXIAL FLOW, by H. Viviand and S. A. Berger. [1965] [7]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under Nonr-22245) Unclassified

Published in AIAA Jour., v. 3: 1806-1812, Oct. 1965.

A solution to the near wake problem behind a very slender cylinder in axisymmetric incompressible laminar flow is obtained in the form of an asymptotic expansion, by the technique of inner and outer expansions. The influence of the recirculating flow is neglected. Although the solution thus found applies only up to a very limited distance downstream of the base, it exhibits important differences with the corresponding 2-dimensional problem of the wake behind a flat plate; these differences are characteristic of the axisymmetry of the flow.

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California U. Inst. of Engineering Research, Berkeley.

RECENT EXPERIMENTAL AND THEORETICAL EXTENSIONS OF NEARLY FREE MOLECULAR FLOW, by

G. J. Maslach, D. R. Willis and others. June 22, 1964 [11]p. incl. illus. diagrs. tables, refs. (Rept. no. AS-64-11) (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under Nonr-22245, and National Science Foundation)
Unclassified

Also published in Rarefied Gas Dynamics: Proc. of the Fourth Internat'l. Symposium, Toronto U. (Canada), (July 14-17, 1964), ed. by J. H. de Leeuw. New York, Academic Press, v. 1: 433-443, 1965.

A new comparison is made between experimental results for cylinder and flat strip models in near free molecule flow and corresponding theoretical results. It is found that a new relation between the Knudsen number and the natural rarefaction parameter occurring in the theoretical calculation leads to much better agreement between experiment and theory than was observed in similar comparisons presented at the previous symposium. (Contractor's abstract)

386

California U. Inst. of International Studies, Berkeley.

TRENDS IN SOCIAL SCIENCE RESEARCH IN LATIN AMERICAN STUDIES: A CONFERENCE REPORT, Palo Alto, California, Oct. 9-11, 1964. March 1965. 104p. incl. tables, refs. (AFOSR-65-0713) (AF AFOSR-65-758) AD 614999 Unclassified

The conference was held in an attempt to answer some of the questions on the state of the social science disciplines in Latin America and how research, theory, and strategy should be constructed to meet the accrued problems in this field and area. Appropriateness of theory, research training, and criteria for analysis formed the agenda of the conference.

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California U. [Minerals Research Lab.] Berkeley.

THE DILATION CONTRIBUTION TO THE HEAT CAPACITY OF COPPER AND α-BRASS AT ELEVATED TEMPERATURES, by Y. A. Chang and R. Hultgren. [1965] [4]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)83] and Atomic Energy Commission)
Unclassified

Published in Jour. Phys. Chem., v. 69 4162-4165, Dec 1965.

For pure copper and an α-brass containing 9.7 atom % Zn, the compressibilities were measured from 77 to 800 K, and the heat contents of the brass, from 298 to 800 K. From these and other data found in the literature, the dilation term $C_p - C_v$ of the heat capacity was calculated. The Nernst-Lindemann approximate formula was found to express accurately the dependence of the dilation term on temperature for these two substances. However, data found in the literature for 8 other substances indicate the Nernst-Lindemann approximation more usually gives too rapid an increase of the dilation term with temperature.

388

California U. Seismographic Station, Berkeley.

A STUDY OF THE AFTERSHOCKS AND FOCAL MECHANISM OF THE SALINAS-WATSONVILLE EARTHQUAKES OF AUGUST 31 AND SEPTEMBER 14, 1963, by A. Udias. [1965] [22]p. incl. diagrs. tables, refs. (AFOSR-65-2253) (AF 49(638)904) AD 614335
Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 85-106, Feb. 1965.

The earthquake sequences connected with the earthquakes of Aug. 31 and Sept. 14, 1963 in the Salinas-Watsonville region of California are studied with reference to the background seismic activity. A very favorable distribution of permanent and mobile stations in this area permits the analysis to include earthquakes of small magnitudes. The mechanism of the larger aftershocks of both sequences is found to be similar to the mechanism of the main shock of Sept. 14, 1963. The orientation of the principal axes of stress derived from the focal mechanism of the Sept. 14 earthquake, is related to the strike of the San Andreas fault. (Contractor's abstract)

389

California U. Seismographic Station, Berkeley.

CRUSTAL STRUCTURE IN CENTRAL CALIFORNIA IN RELATION TO THE SIERRA NEVADA, by T. Mikumo. [1965] [19]p. incl. diagrs. tables, refs. (AFOSR-65-2906) (AF 49(638)904) AD 614352 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 65-83, Feb. 1965.

Crustal structure in central California (between the latitudes of 36° and 41°N) including the Sierra Nevada was studied by travel times of P_n waves from Nevada explosions and earthquakes, dispersion of surface waves, and correlation between computed and observed gravity anomalies. Simple 2-dimensional models are presented for the structure, parameters of which are determined by least-squares from P_n observations. Theoretical gravity distributions expected from the crustal models are computed by a 2-dimensional technique and compared with Bouguer anomalies. In the preferred model, the overall crustal depths to the Moho-discontinuity beneath the Pacific coast region, the Central Valley and the Sierra Nevada are found to be about 22, 26 and 43 km, respectively, indicating a steep crustal thickening under the high mountain region. The dispersion of group velocities of Rayleigh and Love waves passing across the region was investigated from Nevada and Utah earthquakes, Love waves from the Utah earthquake give evidence in support of the derived structure (Contractor's abstract)

390

California U., Seismographic Station, Berkeley.

ESTIMATION OF CRUSTAL STRUCTURE WITHIN THE UNIVERSITY OF CALIFORNIA SEISMIC ARRAY, by B. A. Bolt and T. V. McEvilly. [1965] [7]p. incl. diagr. tables. (Bound with its Final rept.; AD 458052) [AF 49(638)904] Unclassified

Within the boundaries of the California U. array are several quarries which occasionally fire charges large enough to be well recorded at all stations. The accumulation of travel-time data from such sources provides a novel means of closely estimating the crustal structure within the area, through systematic refinements of a least squares procedure. Nine independent parameters describing surface and crustal velocities (with gradient), P_n velocity, and a curved, dipping Moho are variable in any combination in determining the best (in the least-squares sense) structure for the area.

391

California U., Seismographic Station, Berkeley.

GRADIENTS OF TRAVEL-TIME CURVES FROM DEEP-FOCUS EARTHQUAKES, by B. A. Bolt. [1965] [16]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)904 and National Science Foundation) AD 618781 Unclassified

Presented at Symposium on Theory and Computers, Leningrad and Moscow (USSR), May 15-21, 1964.

Also published in Rev. Geophys., v. 3: 83-98, Feb. 1965.

Inferences that can be drawn about the structure of the upper mantle from observations of surface-reflected longitudinal body phases are discussed. In particular, some aspects of previous observational, statistical, and theoretical work on the phase pP are reviewed. Recently, mathematical work has thrown more light on the properties of the cusps of the surface-reflected longitudinal phases. Seismological experiments are discussed that are designed to determine the actual behavior of the wave pulses near the cusps. Some preliminary attention has been given to this problem using a seismic array with linear dimension about 10 times greater than the observed wavelength. Computer analysis of the pulses observed at the array elements leads to estimates of the gradients of the travel-time curves Weighting must be arranged to take into account the measured lateral refraction and crustal delays at each element. Analysis of the deep-focus earthquake of Apr. 2, 1963, is presented as an example.

392

California U. Seismographic Station, Berkeley.

MAGNETIC-TAPE DATA-ACQUISITION SYSTEM, by P. W. Rodgers, W. C. Marion and others. [1965] [26]p incl. diagrs. (Bound with its Final rept., AD 458052) [AF 49(638)904] Unclassified

The Berkeley magnetic-tape data-acquisition system was put into operation on June 17, 1964 and has been recording the output of a 2-component seismometer system satisfactorily since that time. The system consists of the seismometers, amplifiers, and 2 tape transports, one for recording and one for playback. Seismic signals are generated by 3 Lehner and Griffith Press-Ewing long-period seismometers with 30 sec free period. Their outputs are filtered, amplified with transistorized amplifiers and applied to the tape system input. The magnetic tape system is designed to provide for simultaneous recording of 14 channels of data with a bandwidth of 0 to 10 cps. In its present preliminary form the primary use of the tape-recorded data is the detailed examination of recorded earthquakes from seismograms.

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California U. Seismographic Station, Berkeley

THE NOVEMBER 1964 EARTHQUAKE SEQUENCE NEAR CORRALITOS, CALIFORNIA, by T. V. McEvilly. [1965] [14]p. incl. diagrs. (Bound with its Final rept., AD 458052) [AF 49(638)904] Unclassified

Data accumulated from the 1964 earthquake sequence at Corralitos indicated 3 major phenomena: (1) an extremely localized region of energy release—in this case a volume on the order of a 1 or 2 km radius sphere at a depth of 5 to 10 km; (2) a mechanism continually supplying energy to the local region in such a uniform way that the first motion radiation pattern is constant. (3) a process of interaction or adjustment whereby a large shock in the sequence but outside the small source volume (in this case probably on the major fault in the area) can occur with apparently different force orientation and perturb the mechanism of the concurrent small shocks in the localized source toward this different orientation.

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California U., Seismographic Station, Berkeley

STATION USAGE, by C. Lomnitz. [1965] [5]p. incl. table. (Bound with its Final rept., AD 458052) [AF 49(638)904] Unclassified

With the introduction of the telemeter network, new trends have been initiated in seismographic station usage. The more important of these include (1) prompt epicenter determination within and outside of the array. (2) simplified procedures for locating teleseisms, and (3) simplified station data processing and storage, for optimum scientific use.

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California U. Seismographic Station, Berkeley.

A STUDY OF FOCAL MECHANISM AND AFTERSHOCK

CHARACTERISTICS OF SMALL EARTHQUAKES, by P. Byerly and B. A. Bolt. Final rept. July 1, 1960-Dec. 31, 1964. Feb. 15, 1965, 68p. incl. diagrs. tables, refs. (AF 49(638)904) AD 458052
Unclassified

The research accomplishments of this project are summarized. Intensive study has been made of small earthquakes in Central California to investigate (1) the relationship of the magnitude and focal depth of the main shock to the number of aftershocks, (2) the pattern of first motions of P and S waves of low magnitude earthquakes, (3) amplitude ratios of P and S and surface waves in small earthquakes, and (4) the relationships of aftershocks to focal depth, magnitude and geographic location of the main shock.

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California U. Dept. of Mathematics, Davis.

SOME INEQUALITIES FOR THE FUNDAMENTAL FREQUENCY OF A NONHOMOGENEOUS MEMBRANE, by D. O. Banks. [1965] [4]p. (AFOSR-66-0022) (AF AFOSR-64-82) AD 641707 Unclassified

Also published in Jour. Soc. Indus. and Appl. Math., v. 13: 635-638, Sept. 1965.

This paper gives a method of finding explicit lower bounds for the lowest eigenvalue of a nonhomogeneous membrane with a fixed boundary. The method for obtaining these bounds is an adaptation of the method due to Payne and Weinberger for finding explicit lower bounds for the lowest eigenvalue of a homogeneous membrane in terms of the fundamental eigenvalues of homogeneous strings.

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California U. Dept of Aerospace and Engineering Sciences, La Jolla.

RESPONSE OF A BURNING FUEL PLATE TO SOUND VIBRATIONS, by F. A. Williams. [1965] [13]p. incl. diagrs. table, refs. (AF AFOSR-65-927)
Unclassified

Presented at AIAA Second Aerospace Sciences Meeting, New York, Jan. 25-27, 1965.

Published in AIAA Jour., v 3: 2112-2124, Nov 1965.

Combustion instability is considered from the viewpoint of the time dependent response of a flat-plate boundary layer with mass transfer to standing or traveling acoustic vibrations in the gas. The acoustic admittance is defined in terms of the response of the boundary layer at [illegible] and is employed to obtain necessary conditions for wave amplification. Results for the gasification rate at the wall, the wall shear stress, and the acoustic admittance are obtained as expansions in the parameter ωx/U (ω oscillation frequency, x distance from the upstream edge of the plate, and U velocity of gas relative to the plate. It is shown that the zero-order (quasi-steady) response rarely leads to amplification of a standing wave. Effects of pressure oscillations alone seldom produce wave amplification. The velocity oscillations lead to the greatest acoustical energy emission and absorption, and the presence of a flame in the boundary layer greatly enhances the influence of velocity oscillations. Results to first and second orders in the parameter ωx/U are presented. The opposite limiting case, in which ωx/U is large compared with unity, is also considered. (Contractor's abstract)

398

California U. Dept. of Chemistry, La Jolla.

RESONANCE STABILIZATION OF A-FERROCENYL CARBONIUM IONS, by J. C. Ware and T. G. Traylor, [1965] [8]p. incl. diagrs. table, refs. (AFOSR-65-1669) (AF AFOSR-64-514) AD 624364 Unclassified

Also published in Tetrahedron Ltrs., no. 18, 1295-1302, 1965.

Results of resonance stabilization experiments on the ferrocenyl group indicated that the ferrocenyl group is best considered as a somewhat complexed cyclopentadienide anion and its ability to supply electrons by resonance is severely decreased by this complexing. Nevertheless, the remaining resonance effect on solvolysis rates is approx. 6 kcal/mol larger than that of a phenyl group.

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California U. Dept. of Mathematics, La Jolla.

WEIGHT FACTORS FOR THE TWO-DIMENSIONAL ISING MODEL, by G. Baxter. [1965] [7]p. incl. diagrs. (AFOSR-65-2636) (AF AFOSR-65-722) AD 629844
Unclassified

Also published in Jour Math. Phys., v. 6: 1015-1021, July 1965.

A group of local weights is constructed for the square, honeycomb, and triangular lattices which counts for any closed path in the lattice 1/2 π times the change in the argument of the tangent vector (mod 2) and the number of enclosed units of area (mod 2). These weights are used to evaluate the partition function of the 2-dimensional Ising model with nearest-neighbor interaction and with a particular, imaginary external magnetic field For the square lattice, the method gives a result announced by Lee and Yang (Contractor's abstract)

400

California U Dept of Physics, La Jolla

SELF-CONSISTENT TREATMENT OF KONDO'S EFFECT IN DILUTE ALLOYS, by Y. Nagaoka. [1965] [9]p incl diagrs (AFOSR-65-2534) (AF AFOSR-64-610) AD 628434 Unclassified

Also published in Phys. Rev., v. 138 A1112-A1120, May 17, 1965

Investigation is made of how conduction electrons in dilute alloys are affected by the exchange interaction with localized spins of impurities. It is shown that, if the interaction is antiferromagnetic, the perturbational treatment breaks down below a critical temperature, and that near the Fermi surface there appears a quasibound state between the conduction-electron spin and the localized spin. Because of the appearance of this quasibound state, the resistivity increases with decreasing temperature, but has a finite value at T = 0. There is no logarithmic term in the resistivity at low temperatures, in contrast to Kondo's theory of the resistance minimum. There also appears an anomaly in the specific heat at low temperatures.

401

California U. Dept. of Physics, La Jolla.

DISPERSION THEORY OF THE KONDO EFFECT, by H. Suhl. [1965] [9]p. incl. diagr. refs. (AFOSR-65-2540) (AF AFOSR-64-610) AD 627627 Unclassified

Also published in Phys. Rev., v. 138: A515-A523, Apr. 1965.

According to recent work by Kondo, the scattering-cross section of an electron in exchange interaction with a paramagnetic impurity immersed in a Fermi sea of electrons has a logarithmic infinity as the electron energy approaches the Fermi energy. This problem was examined by means of the Chew-Low method first devised for meson-nucleon scattering. It is found that the singularity is replaced by a resonant scattering close to the Fermi level. (Contractor's abstract)

402

California U. Dept. of Physics, La Jolla.

INERTIAL MASS OF A MOVING FLUXOID, by H. Suhl. [1965] [4]p. (AFOSR-65-2541) (AF AFOSR-64-610) AD 627765 Unclassified

Also published in Phys. Rev. Ltrs., v. 14 226-229, Feb. 15, 1965.

Expressions were derived on the basis of Landau-Ginburg theory, for the inertial and electromagnetic masses of a moving fluxoid; the relaxation time of a fluxoid is estimated to be less than 10^{-12} sec, making the observation of collective modes of a fluxoid system very difficult.

403

California U. Dept. of Physics, La Jolla.

ENERGY GAP IN A CUBICAL MODEL FOR NUCLEI, by C. J. Thompson. [1965] [4]p. incl. diagrs. (AFOSR-65-2542) (AF AFOSR-64-610) AD 628436 Unclassified

Also published in Phys. Ltrs., v. 14: 146-149, Jan. 15, 1965.

The energy gap is calculated for a simple finite model for nuclei. The result contains oscillations with nuclear size which agree with the gross behavior of the proton pairing energy. The calculated energy gap does not however vary much from isotope to isotope in contrast to experiment.

404

California U. Dept. of Physics, La Jolla.

ALGEBRAIC DERIVATION OF THE PARTITION FUNCTION OF A TWO-DIMENSIONAL ISING MODEL, by C. J. Thompson. [1965] [4]p. incl. refs. (AFOSR-66-0274) (AF AFOSR-64-610) AD 629176 Unclassified

Also published in Jour. Math. Phys., v. 6: 1392-1395, Sept. 1965.

In the algebraic formulation of the Ising model, the partition function is expressed as the trace of a power V^M of the transfer operator V, or equivalently, as the sum of Mth powers of the eigenvalues of V. In the derivation of Kaufman, Onsager, and more recently of Schultz, Mattis, and Lieb (SML), the transfer operator is first reduced to a more amenable form for computation and then, in principle at least, diagonalized. For the infinite lattice, only the largest eigenvalue of V is needed, and this is all Onsager and SML compute. Kaufman finds all the eigenvalues and is thus able to write down the partition function for the finite lattice. In the present work we give an alternative derivation of the SML form for V, and show how the Kaufman result can be obtained from this form withoht actual diagonalization. Instead of diagonalizing V, the evaluation of the trace is done directly after assigning a simple representation to V (Contractor's abstract)

405

California U Dept. of Physics, La Jolla.

PARAMAGNETIC IMPURITIES IN METALS AT FINITE TEMPERATURES, by H. Suhl. [1965] [21]p. (AFOSR-66-0275) (AF AFOSR-64-610) AD 629174 Unclassified

Also published in Physics, v. 2: 39-59, 1965.

Dispersion theory is combined with the Green's function technique to discuss the scattering of electrons by paramagnetic impurities in normal metals at finite temperatures The thermodynamic Green's function is derived from an approximate solution of an equation for a modified (non-unitary) scattering matrix. As a check on the consistency of theory, it is generalized to arbitrary impurity spin S, and shown that in the limit $S \to \infty$, it reduces to ordinary potential scattering of electrons with spin parallel or antiparallel to a localized fixed Zeemann field. Some observations are made on the problem of the residual resistance. The effect of additional non-magnetic scattering is briefly considered. A justification is given for the neglect of multiparticle intermediate states in the dispersion equations. (Contractor's abstract)

406

California U. Dept. of Physics, La Jolla.

ON THE DETECTION OF SECOND SOUND IN CRYSTALS BY LIGHT SCATTERING, by A. Griffin. [1965] [3]p. (AFOSR-66-0276) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-610 and Atomic Energy Commission) AD 629175 Unclassified

Also published in Phys. Ltrs., v. 17: 208-210, July 15, 1965.

This research suggests that Rayleigh scattering of light may hold great promise as a probe for collective temperature waves in pure anharmonic crystals, although it is useless in He II. A formal dispersion relation for second sound (in normal systems) involving a frequency dependent thermal conductivity coefficient is also reported.

407

California U. Dept. of Physics, La Jolla.

INEQUALITY WITH APPLICATIONS IN STATISTICAL MECHANICS, by C. J. Thompson. [1965] [2]p. (AFOSR-66-1487) (AF AFOSR-64-610) AD 641779 Unclassified

Also published in Jour. Math. Phys., v. 6: 1812-1813, Nov. 1965.

It is proven for Hermitian matrices (or more generally for completely continuous self-adjoint linear operators in Hilbert space) A and B that $Tr(e^{A+B}) \quad Tr(e^{A}e^{B})$. The inequality is shown to be sharper than the convexity property (0 α 1)$Tr(e^{\alpha A+(1-\alpha)B})$ $[Tr(e^{A})]^{\alpha}$ $[Tr(e^{B})]^{1-\alpha}$, and its possible use for obtaining upper bounds for the partition function is discussed briefly.

408

California U. Dept. of Physics, La Jolla.

HEISENBERG MODEL WITH LONG RANGE INTERACTION, by C. J. Thompson. [1965] [5]p. incl. refs. (AFOSR-66-1520) (AF AFOSR-64-610) AD 641773 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1977-1981, Dec. 1965.

The functional integral method as used by Siegert in his study of the Ising model with long range interaction, is generalized and applied to the Heisenberg model. Above the Bragg-Williams Curie point, the functional integral expression for the partition function is evaluated by a saddle point approximation. This gives an expansion in powers of the reciprocal range of the interaction which is essentially identical with the Ising model result, in agreement with Brout who used a ring summation approximation. The expansion is not valid through the Curie point, and in its present form, this method seems to be incapable of giving spin waves.

409

California U. Dept. of Physics, La Jolla.

ENTROPY TRANSPORT BETWEEN TWO SUPERCONDUCTORS BY ELECTRON TUNNELING, by K. Maki and A. Griffin. [1965] [3]p. incl. refs. (AFOSR-66-1550) (AF AFOSR-64-610) AD 641781 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 921-923, Dec. 1965.

Some preliminary calculations of this tunneling heat current are reported. The surface thermal resistance depends very much on whether the metals are in the superconducting or normal phases. In addition there is an oscillatory heat flux due to fluctuations in the quasiparticle tunneling between 2 superconductors. The change in chemical potential due to the temperature difference δT can give rise to the ac and dc Josephson supercurrents. However, calculations show that no entropy is carried by these currents, which is in agreement with one's physical expectations.

410

California U. Dept. of Physics, La Jolla.

GROUND STATE OF CORRELATED ELECTRONS IN A NARROW ALMOST HALF-FILLED s BAND, by Y. Nagaoka. [1965] [4]p. (AFOSR-66-1551) (AF AFOSR-64-610) AD 641777 Unclassified

Also published in Solid State Commun., v. 3: 409-412, Oct. 1965.

Consideration was given to a system of conduction electrons in an almost half-filled s band with an infinitely strong δ-function type repulsive potential, and with nonvanishing transfer matrix elements only between nearest neighbors. It was found that the totally polarized ferromagnetic state is the ground state for sc and bcc and for fcc and hcp with $N_e > N$, N_e and N being respectively the number of electrons and atoms, and that is not the ground state for fcc and hcp with $N_e < N$. (Contractor's abstract)

411

California U. Dept. of Physics, La Jolla.

EFFECT OF THE SUHL-ABRIKOSOV RESONANCE ON THE TRANSITION TEMPERATURE OF SUPERCONDUCTORS, by A. Griffin. [1965] 4p. incl. diagrs. refs. (AFOSR-66-1552) (AF AFOSR-64-610) AD 641775 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 703-706, Oct. 25, 1965.

A study of how the transition temperature T_c of a superconducting paramagnetic alloy is affected by the previously mentioned anomalous scattering (which is sometimes referred to as the "Kondo effect") was discussed.

412

California U. [Dept. of Physics] La Jolla.

SUPERCONDUCTIVITY IN ONE AND TWO-DIMENSIONS, by T. M. Rice. [1965] [3]p. incl. refs. (AFOSR-66-1554) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-610 and Office of Naval Research) AD 639480 Unclassified

Also published in Phys. Rev., v. 140: A1889-A1891, Dec. 13, 1965.

The effect of thermodynamic fluctuations on off-diagonal long-range order (ODLRO) is discussed. The 2-particle Yang correlation function is calculated using the Ginzburg-Landau theory allowing such fluctuations. The behavior of the correlation function at large separation is examined and it is found to be consistent with Yang's criterion for ODLRO only in 3 dimensions. In 1 and 2 dimensions Yang's criterion is not satisfied. (Contractor's abstract)

413

California U. [Dept. of Physics] La Jolla.

TOWARDS A QUANTUM MANY-BODY THEORY OF LATTICE DYNAMICS. I. TIME-DEPENDENT HARTREE APPROXIMATION, by D. R. Fredkin and N. R. Werthamer. [1965] [11]p. incl. refs. (AFOSR-66-2233) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-610 and National Research Council) AD 644907 Unclassified

Also published in Phys. Rev., v. 138: A1527-A1536, May 31, 1965.

The phonon is discussed as an example of a collective mode which restores a symmetry property (in this case, translational invariance) to a system whose Hamiltonian is invariant under the symmetry operation, but in whose ground state the symmetry is broken. The crystal lattice is first studied within the time-independent Hartree approximation. It is then shown that allowing small time-dependent changes in the Hartree field generates an equation for the normal modes of vibration. The three $k = 0$ modes with $\omega = 0$ are shown to represent uniform translations of the solid, as expected. The $k \neq 0$ modes are analyzed to extract those three which may be identified as one-phonon modes, and the contribution of these modes to the free energy is computed. The recent theory of Brout is found to be equivalent to the Hartree approximation with the further assumption that the atoms are infinitely heavy. No restrictions are made here on the interatomic potential other than that a hard core is absent. The reduction of the present theory to well-known results in the case of harmonic forces is demonstrated. An extension to include hard cores, analogous to the Brueckner theory, is discussed. (Contractor's abstract)

414

[California U. Dept. of Physics, La Jolla]

CALCULATIONS OF SOUND VELOCITIES IN CRYSTALLINE HELIUM AT ZERO TEMPERATURE, by L. H. Nosanow and N. R. Werthamer. [1965] 4p. incl. diagrs. tables, refs. [AF AFOSR-64-610] Unclassified

Published in Phys. Rev. Ltrs., v 15: 618-621, Oct. 11, 1965.

By making use of the time-dependent Hartree approximation, along with the results of variational calculations of the ground-state, energy calculations were obtained of the sound velocities for various densities of crystalline helium at zero temperature. An estimation of the Debye θ as a function of density is also reported.

415

California U. Dept. of Physics, La Jolla.

SOME FURTHER REMARKS ON ENTROPY TRANSPORT BETWEEN TWO SUPERCONDUCTORS BY ELECTRON TUNNELING, by A. Griffin and K. Maki. [1965] [6]p. (AF AFOSR-64-610) Unclassified

This note is in the nature of an addendum to a recent paper by K. Maki and A. Griffin (item no. 409, v. 9). Its purpose is to clarify certain points in the original paper as well as to give more explicit results for the surface thermal resistance R.

416

California U. [Dept. of Physics] La Jolla.

SUPERCONDUCTIVITY OF α-TITANIUM SOLID SOLUTIONS WITH VANADIUM, NIOBIUM, AND TANTALUM, by Ch. J. Raub and U. Zwicker. [1965] [2]p. incl. table, refs. (AFOSR-65-0790) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-631] and National Science Foundation) AD 616054 Unclassified

Also published in Phys. Rev., v. 137: A142-A143, Jan. 1965.

The superconductivity of α-Ti-V, α-Ti-Nb, and α-Ti-Ta alloys was investigated. Beta-filament contamination was avoided. A nearly linear increase in T_c was found. There was no difference in the effect of V, Nb, or Ta.

117

California U. [Dept. of Physics] La Jolla.

SUPERCONDUCTIVITY OF Nb_3Ge, by B. T. Matthias, T. Geballe and others. [1965] [6]p. incl. refs. (AFOSR-65-2125) (AF AFOSR-64-631) AD 629089 Unclassified

Also published in Phys. Rev., v. 139: A1501-A1503, Aug. 30, 1965.

Evidence is presented to show that the maximum transition temperature of compounds with the β-w type structure (A_{15}) occurs at the stoichiometric composition A_3B, when B is a nontransition element. The niobium-germanium A_{15}-type compound, which normally forms with excess Nb, has a transition temperature of 6.9°K. It has been found that Nb_3Ge compounds prepared by rapid-quench techniques, in the presence of excess germanium, have transition temperatures as high as 17 K. This large increase in transition temperature is attributed to a closer approach to the stoichiometric 3:1 composition. (Contractor's abstract)

118

California U. [Dept. of Physics] La Jolla

SEARCH FOR SUPERCONDUCTIVITY IN α-CERIUM, by T. F. Smith. [1965] [3]p. incl. diagr. table, refs. (AFOSR-65-2151) (AF AFOSR-64-631) AD 629090 Unclassified

Also published in Phys Rev., v. 137: A1435-A1437, Mar. 1, 1965.

The α modification of cerium, formed from the normal, room-temperature modification under a pressure of 10,000 atm, has been cooled to 1.25 K and tested for superconductivity. The nature of the state of the 4f electron in α-cerium is discussed in relation to the absence of superconductivity. (Contractor's abstract)

119

California U. [Dept. of Physics] La Jolla.

SUPERCONDUCTIVITY OF THE ALKALI TUNGSTEN BRONZES, by A. R. Sweedler, Ch. J. Raub, and B. T. Matthias. [1965] [2]p. incl. table. (AFOSR-65-2533) [AF AFOSR-64-631] AD 629828 Unclassified

Also published in Phys. Ltrs., v. 15: 108-109, Mar. 15, 1965.

The investigation shows that the superconductivity of the Na-W bronze is not an isolated phenomenon but rather is a general property of the alkali tungsten bronzes. Superconductivity was found for all samples having either the tetragonal I or hexagonal symmetry. The lattice parameters of the superconducting phases are given. However, the perovskite phase and the tetragonal II phase of the sodium tungsten bronze was found not to become superconducting above 11 millidegrees and 40 millidegrees respectively.

420

California U. Dept. of Physics, La Jolla.

ELECTRONICS STRUCTURE OF INDIUM-CADMIUM ALLOYS, by M. F. Merriam. [1965] [2]p. incl. diagr., refs. (AFOSR-65-2536) [AF AFOSR-64-631] AD 627764 Unclassified

Also published in Phys. Ltrs., v. 17: 16-17, June 15, 1965.

Recent measurements are reported of superconducting transition temperature and lattice parameter, in In-Cd alloys, which strongly support some aspects of Svechkarev's proposal. The measurements show an electronic structure effect which was inferred by Svechkarev.

421

California U. [Dept. of Physics] La Jolla.

EFFECT OF PRESSURE ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF LANTHANUM, by W. E. Gardner and T. F. Smith. [1965] [3]p. incl. diagr. refs. (AFOSR-65-2573) [AF AFOSR-64-631] AD 629826 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 519, Apr. 26, 1965.

Also published in Phys. Rev., v. 138: A484-A486, Apr. 19, 1965.

The variation of the superconducting transition temperature of hcp lanthanum has been measured as a function of pressure up to 10 kbar. An approximately linear increase of T_c with applied pressure was observed ($\partial T_c/\partial P \sim 14 \times 10^{-5}$°K bar^{-1}). The relation of this behavior to 2 recently proposed theories for the superconductivity of lanthanum is discussed. (Contractor's abstract)

422

California U. Dept. of Physics, La Jolla.

SUPERCONDUCTIVITY IN THE TIN-GALLIUM SYSTEM, by G. Knapp and M. F. Merriam. [1965] [3]p. incl. diagr. table, refs. (AFOSR-66-0053) [AF AFOSR-64-631] AD 629824 Unclassified

Also published in Phys. Rev., v. 140: A528-A530, Oct. 18, 1965.

Superconducting transition temperatures were measured for a number of Sn-Ga compositions in both the

'quenched' (quick cast) and annealed states. The increases in T_c in the 'quenched' samples are not large (usually about 0.1-0.2°K), and can be accounted for on the basis of internal stresses in the sample. The equilibrium transition temperatures are consistent with the known phase diagram of Predel. Within the Sn solid solution T_c first drops (mean-free-path effect), then rises to 3.9°K. Compositions in the neighborhood of the eutectic show depressed and broadened transitions; these are attributed to proximity effects. (Contractor's abstract)

423

California U. Dept. of Physics, La Jolla.

THE RESISTANCE MINIMUM IN DILUTE Ti-Mn ALLOYS, by W. E. Gardner and Ch. J. Raub. [1965] [5]p. incl. diagr. table, refs. (AFOSR-66-0054) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-631] and National Science Foundation) AD 629823 Unclassified

Also published in Proc. Phys. Soc. (London), v. 86: 647-651, 1965.

From resistance measurements on dilute alloys of manganese in titanium it has been concluded that the resistance minimum observed in these alloys is associated both with localized moments on manganese atoms in the α phase and also with a proposed transformation of any β filaments which are present. (Contractor's abstract)

424

California U. [Dept. of Physics] La Jolla.

SUPERCONDUCTIVITY OF BARIUM TUNGSTEN BRONZE, by A. R. Sweedler, T. K. Hulm and others. [1965] [1]p. (AFOSR-66-1289) [AF AFOSR-64-631] AD 641789 Unclassified

Also published in Phys. Ltrs., v. 19: 82, Oct. 1, 1965.

Barium tungsten bronze (Ba_xWO_3) was prepared and found superconducting at a temperature of 1.9°K. This is the first bronze with an alkaline earth metal substitute to be found superconducting. The crystal structure is isomorphous to the tetragonal I structure of the sodium tungsten bronze, which is also superconducting. The perovskite phase of the sodium tungsten bronze (Na_xWO_3) with x = .3, .4, .8, was also measured to .3°K, and no superconductivity was found.

425

[California U. Dept. of Physics, La Jolla]

THE OCCURRENCE OF SUPERCONDUCTIVITY IN SULFIDES, SELENIDES, TELLURIDES OF PT-GROUP METALS, by Ch. J. Raub, V. B. Compton and others. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-66-1295) (In cooperation with Bell Telephone Labs., Inc., Murray Hill, N. J.) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-631] and National Science Foundation) AD 641793 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 2051-2057, Dec. 1965.

Superconductivity has been discovered in Pd compounds with Se and Te, in $IrTe_3$ and in PtTe. The superconducting transition temperature of a Pd-Se alloy containing 85 to 87 at-% Pd is 0.66°K which is unusually high for its valence-electron concentration. A homogeneity range exists for the hexagonal $B8_1$-type compound PdTe and for the trigonal C6-type compound $PdTe_2$. The results of the low temperature heat capacity measurements of PdTe and $PdTe_{1.04}$ show that the large change in the transition temperature with composition is accompanied by a large change in the linear heat capacity coefficient γ. (Contractor's abstract)

426

California U. [Dept. of Physics] La Jolla.

ELECTRON DENSITY AND ELECTRONIC PROPERTIES IN NOBLE-METAL TRANSITION ELEMENTS, by M. A. Jensen, B. T. Matthias, and K. Andres. [1965] [2]p. incl. diagrs. (AFOSR-66-1297) [AF AFOSR-64-631] AD 641796 Unclassified

Also published in Science, v. 150: 1448-1450, Dec. 1965.

It is shown empirically that the superconducting transition temperature as well as the magnetic susceptibility and the electronic specific heat of noble-metal transition elements and alloys can be described reasonably well as universal functions of the valence electron density, that is, the number of valence electrons per cubic centimeter. (Contractor's abstract)

427

California U. [Dept. of Physics] La Jolla.

PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF URANIUM, by T. F. Smith and W. E. Gardner. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-66-1317) [AF AFOSR-64-631] AD 641803 Unclassified

Also published in Phys. Rev., v. 140: A1620-A1623, Nov. 1965.

The superconducting transition temperature T_c of uranium has been observed to increase from 1.0 to 2.3°K on the application of a pressure of 10 kbar. From this result the possibility that T_c will increase with isotopic mass has been suggested. (Contractor's abstract)

428

California U. Dept. of Physics, La Jolla.

[SUPERCONDUCTIVITY AND PARTICLES SIZE IN HETEROGENEOUS COPPER LEAD ALLOY] Supraleitung und Teilchengrosse in heterogenen Kupfer-Blei-Legierungen, by Ch. J. Raub and E. Raub. [1965] [9]p. incl. illus. diagrs. tables, refs. (AFOSR-67-0159) [AF AFOSR-64-631] Unclassified

Also published in Zeitschr. Phys., v. 186 310-318, 1965.

It was shown that small lead particles of a size of 1 μm and smaller distributed in a copper matrix can cause this heterogeneous alloy to exhibit complete superconductivity. According to the size of the lead particles and their distribution the transition temperatures vary between 0.3 and 7° K. (Contractor's abstract)

429

California U. [Dept. of Physics, La Jolla].

SUPERCONDUCTING TRANSITION TEMPERATURES IN INDIUM SOLID SOLUTIONS (Abstract), by M. F. Merriam. [1965] [1]p. [AF AFOSR-64-631] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 346, Mar. 24, 1965.

Transition temperatures have been measured in the solid solutions of indium with Hg, Cd, Tl, Sn, Pb, and Bi to higher solute concentrations than previously. The Seraphim empirical rule, $\Delta T_c = k_1 x + k_2 x \ln x$, is not adequate to describe the results. Except for kinks attributed to Brillouin-zone effects, T_c is a linear function of composition in the more concentrated alloys. The slopes of the T_c vs composition lines for the alloy systems not reported previously (in K/at%) are. In-Cd, 0-2% Cd 0.067; In-Cd, 2-5% Cd 0.016; In-Tl 0.0044; In-Bi 0.29. The In-Cd data show a kink at 2% Cd, indicating an apparent Brillouin-zone effect. The results are discussed in terms of Ginsberg's hypothesis. The jump in T_c at the tetragonal-cubic transformation that occurs in most of these alloy systems is also discussed.

430

California U. [Dept. of Physics] La Jolla.

SUPERCONDUCTIVITY AND HIGH PRESSURES, by B. T. Matthias. [1965] [6]p. incl. refs. (In cooperation with Bell Telephone Labs., Murray Hill, N. J.) [AF AFOSR-64-631] Unclassified

Published in Physics of Solids at High Pressures, Proc. First Internat'l. Conf., Tucson, Arizona (Apr 20-23, 1965), ed. by C. T. Tomizuka and R. M. Emrick. New York, Academic Press, 1965, p. 225-230. (AFOSR-66-0131)

The occurrence of superconductivity under pressure in otherwise normal metals, and the effect of pressure on the transition temperature, are both considered. Pressure induces superconductivity in Bi, Sb and Te; it seems likely that Ge, Si, As, Be and possibly Ce may show similar behavior. The effects are due either to changes in lattice symmetry or electron configuration, and their importance to the theory of superconductivity is pointed out.

431

California U. [Dept. of Physics, La Jolla].

SUPERCONDUCTIVITY IN THE TRANSITION METALS (Abstract), by M. A. Jensen. [1965] [1]p. [AF AFOSR-64-631] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 45, Jan. 27, 1965.

The variation of superconductivity in the transition metals is known to be approximately symmetric about $n = 6$ (n is the number of valence electrons) with peaks near $n = 5$, 7. On looking at the beginning and end of the transition-metal series corresponding to $n = 3$, 10 one finds that superconductivity decreases rapidly at both ends. The theory of superconductivity of Morel and Anderson and the recent ideas of Clogston about the enhancement of the density of states due mainly to electron-lattice interactions are combined to calculate the expected variation of $N(0)V$ X $[T_c = 1.15\,\Theta_D \exp(-1/N(0)V)]$ in the transition metals. By including estimates of the band structure in the calculations, reasonable qualitative agreement between the experimental and theoretical curves for $N(0)V$ from $n = 4$ to $n = 10$ was obtained. There remains a large disagreement between the experiment and theory at the beginning of the transition metals (Sc, Y, Lu), which probably can not be explained by the presence of rare-earth impurities.

432

California U. Inst. of Geophysics and Planetary Physics, La Jolla.

COHERENCE MEASUREMENTS WITH TIME SAMPLING OCEAN-BOTTOM SEISMOMETERS, by H. Bradner, J. Dodds and R. Foulks. [1965] [3]p. incl. illus. diagrs. (AF 49(638)1388) AD 629466 Unclassified

Also published in Proc. IEEE, v. 53: 1906-1908, Dec. 1965.

Instruments for obtaining simultaneous records of ocean-bottom seismic motion are described. Preliminary ocean-bottom seismic data with two simultaneous three-component instruments indicates that instrument noise

and water currents may cause small differences in the detailed spectra. The general features of the spectra, however, appear to be the same from proximate instruments. (Contractor's abstract)

433

California U. Inst. of Geophysics and Planetary Physics, La Jolla.

EARTH NOISE, 5 TO 500 MILLICYCLES PER SECOND 1. SPECTRAL STATIONARITY, NORMALITY, AND NONLINEARITY, by R. A. Haubrich. [1965] [13]p. incl. diagrs. tables, refs. (AFOSR-65-2898) (AF AFOSR-62-420) AD 618623 Unclassified

Also published in Jour. Geophys. Research, v. 70: 1415-1427, Mar. 1965.

Earth noise below 0.5 cps does not differ significantly from stationary normally distributed random noise for record lengths of the order of hours. Earthquake waves, as well as locally generated ground motion such as that due to wind, produce records which differ significantly from the above. The cross-frequency coherence is a sensitive test for nonstationary effects such as earthquakes, and the more generalized 2-dimensional spectrum appears to be the appropriate one for looking at transient events. For stationary processes, the bispectrum is a convenient method for testing nonlinear interactions, but microseisms measured so far have produced no cases of significant bispectrums. (Contractor's abstract)

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California U. Inst. of Geophysics and Planetary Physics, La Jolla.

EARTH NOISE, 5 TO 500 MILLICYCLES PER SECOND 2. REACTION OF THE EARTH TO OCEANS AND ATMOSPHERE, by R. A. Haubrich and G. S. MacKenzie. [1965] [13]p. incl. diagrs. tables, refs. (AFOSR-65-2899) (AF AFOSR-62-420) AD 628829 Unclassified

Also published in Jour. Geophys. Research, v. 70: 1429-1440, Mar. 1965.

Sources of earth noise have been identified and located for different parts of the frequency band from 5 to 500 mc/s. In the typical microseism bands around 75 and 150 mc/s, sources are associated with storm waves arriving at both distant and local sea coasts. During the winter months the primary-frequency microseisms measured at La Jolla come mostly from the coast north of Cape Mendocino and are due to major storms in the North Pacific. Double-frequency microseism sources are generally within a few hundred kilometers of La Jolla, but more distant sources have also been observed. In addition, both ocean and atmosphere produce local loading which becomes significant at frequencies below the storm microseism band. (Contractor's abstract)

435

California U. Inst. of Geophysics and Planetary Physics, La Jolla.

INVESTIGATION OF MICROSEISM SOURCES WITH OCEAN-BOTTOM SEISMOMETERS, by H. Bradner, J. G. Dodds, and R. E. Foulks. [1965] [16]p. incl. diagrs. tables, refs. (AFOSR-66-0427) (AF AFOSR-62-420) Unclassified

Presented at Thirty-fourth annual Internat'l. SEG meeting, Los Angeles, Calif., Nov. 18, 1964.

Also published in Geophysics, v. 30: 511-526, Aug. 1965.

Recordings to depths of 5 km have been made on the Pacific Ocean bottom with self-rising internally recording seismometers. Simultaneous recordings have been made at land stations. The ocean-bottom noise spectrum is between 1 and 5-orders of magnitude higher power than the land spectrum in the region from 0.1 to 9.0 cps. Coherence between 2 simultaneous instruments separated one-quarter km is above the 95% confidence level from 0.1 cps to 0.6 cps. Attempts to associate narrow-beam Love and Rayleigh peaks with large storm-generating areas or with heavy swell striking shore have not produced consistent results. Although some records show the bulk of the microseism peak energy in well-defined modes, the energy is carried in different modes at different times and locations. Some of our data fit a model of microseism generation in a 100-mile strip, by a statistical superposition of incident waves and waves reflected from shore; and the subsequent conversion of the energy to Rayleigh and Love modes propagating away from the generation zone. However, the shapes of the mid-ocean spectra strongly imply additional sources far from shorelines of recognized storms, unless microseisms attenuate far less in the ocean than on land. (Contractor's abstract)

436

California U. Inst. of Geophysics and Planetary Physics, La Jolla.

TIDES OF THE PLANET EARTH, by W. H. Munk. [1965] [4]p. [AF AFOSR-62-420] Unclassified

Published in Science in the Sixties; Tenth Anniversary AFOSR Scientific Seminar, Cloudcroft, N. M. (June 14-15, 1965), ed. by D. L. Arm. Albuquerque, Mexico U. Office of Publiscations, 1965, 134-137.

The nonharmonic method initiated by Lubbock for prediction of ocean tides and the classical harmonic method of Kelvin and George Darwin are reviewed. Modern computers have made possible spectroscopy of tides and the prediction of tides by a response method. Past observations are used to obtain the response curves of a port, and predictions are then obtained by playing the theoretical tide input through the appropriate response filter (done numerically, using computers). There is no time-harmonic expansion, as the complexity of the tide-potential is already built into the input functions. The response method takes full account of Newton-Kepler mechanics, while the harmonic method uses

astronomy only to identify the frequencies. It can also be systematically generalized to include the nonlinear shallow water effect, and it may even be possible to include the response to storms. The developments of new technologies and instrumentations have presented opportunities to study the tidal distortion of the earth; it appears as if the instrumentations will also be able to cope with the distortions of the earth on a geological time scale.

437

California U. [School of Science and Engineering] La Jolla.

REFLECTING OPTICS FOR CALIBRATION OF SPECTRORADIOMETERS, by R. W. Patch. [1965] [4]p. incl. diagrs. tables. (AFOSR-65-1808) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-650 and Advanced Research Projects Agency) AD 625683 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 55: 392-395, Apr. 1965.

The requirements are given for absolute calibration of a spectroradiometer by means of an extended standard source. In some cases the extended source may be used without auxiliary optics, but in many cases a concave mirror is necessary or desirable. For such a mirror, a relation between incident and reflected steradiancy is derived. Brandenberg's focusing relations for a concave spherical mirror are extended and applied to 4 practical cases, and it is shown that no loss in accuracy of calibration will result from the use of such mirrors provided that the source and the mirror are large enough. Experimental verification is given. (Contractor's abstract)

438

California U., Los Angeles.

MATHEMATICAL MODELS OF SYNONYMY, by H. P. Edmundson. [1965] [17]p. incl. diagrs. (AFOSR-65-1387) (AF AFOSR-64-612) AD 621160 Unclassified

Presented at 1965 Internat'l. Conf. on Computational Linguistics, New York, May 19-21, 1965.

A historical summary is made of the concepts of synonymy and antonymy. The roles of part-of-speech and context of a word are considered. The concept of a synonym of a word is shown to require the use of a ternary relation rather than that of a binary relation. Synonymy is defined implicitly, rather than explicitly, by 3 axioms that lead to equivalence relations that partition the set of content words of a language into equivalence classes. Antonymy is defined implicitly by another set of 3 axioms. Several algebraic, geometrical, and topological models of synonymy and antonymy are posed and examined. (Contractor's abstract)

439

California U. [Brain Research Inst.] Los Angeles.

PHYSIOLOGICAL FACTORS IN DECOMPRESSION SICKNESS, by A. T. Cockett, R. M. Nakamura, and R. T. Kado. [1965] [5]p. incl. illus. diagrs. tables, refs. (AFOSR-66-0850) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1387 and National Aeronautics and Space Administration) AD 640806 Unclassified

Also published in Arch. Environ. Health, v. 11: 760-764, Dec. 1965.

A method for the production of experimental decompression sickness -- dysbarism -- is outlined. Results of the experiment indicate that plasma replacement and maintenance of an effective circulating blood volume appear to be the crucial factors in treating moderate decompression with shock. Dextran and whole blood were used to correct the plasma deficit. Hypothermia appears to be useful and may be indicated. Recompression is the treatment of choice.

440

California U. [Brain Research Inst.] Los Angeles.

URINARY BLADDER CALCULI FORMED IN RATS AT ALTITUDE, by A. T. K. Cockett, R. M. Nakamura, and D. S. Miyada. [1965] [4]p. incl. illus. tables, refs. (AFOSR-66-0851) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1387 and National Aeronautics and Space Administration) AD 640772 Unclassified

Also published in Arch. Environ. Health, v. 11: 810-813, Dec. 1965.

A method is outlined for the formation of experimental bladder calculi in male rats. Chemical analysis of bladder calculi formed in rats at an altitude of 18,000 feet for a period of 9 weeks reveals no significant differences from calculi formed in rats at ground levels. Infrared spectral analysis confirms the quantitative chemical findings. There was an increased incidence of Proteus organisms in the altitude group.

441

California U. Brain Research Inst., Los Angeles.

DC ELECTROMAGNETIC BLOOD FLOWMETER, by R. T. Kado and S. T. Schy. [1965] [2]p. incl. diagrs. (AFOSR-66-1130) (AF 49(638)1387) AD 643758 Unclassified

Also published in Digest Sixth Internat'l. Conf on Medical Electronics and Biological Engineering, Tokyo (Japan), 1965, p. 50-51.

This report describes the construction and use of a DC electromagnetic blood flowmeter as a means of measuring blood flow in the intact blood vessel. Consideration was given the blood flowmeter as an apparatus because

the flow of blood itself like the machine is usually unidirectional and secondly, in the majority of the vascular bed, a diastolic component of two was found. The magnet flowmeter was proven useful because of simplicity of construction and may prove fruitful in many areas of cardiovascular research.

442

California U. Brain Research Inst., Los Angeles.

A STEREOTAXIC ATLAS OF THE CHIMPANZEE BRAIN (PAN SATYRUS), by M. R. DeLucchi, B. J. Dennis, and W. R. Adey. [1965] [149]p. incl. illus. diagrs. (AFOSR-65-1503) (AF AFOSR-61-81) AD 620217 Unclassified

The stereotaxic atlas of the chimpanzee brain was designed to provide previously unavailable data on the deep structures of the chimpanzee brain. Extensive illustrative material provides frontal and sagittal sections, as well as a large number of drawings, all of which are accompanied by measurement scales. The greater intelligence of the chimpanzee, and the fact that the complexity of electrical activity of the chimpanzee brain approaches the complex patterns of man have made it highly desirable to be able to manipulate its deep brain system. Analyses of the effects of stimulation, ablation, and recording in the chimpanzee brain are likely to reveal information on brain organization having close relevance to human brain function in health and disease. (Contractor's abstract, modified)

443

California U. Brain Research Inst., Los Angeles.

COMPUTER ANALYSIS OF HIPPOCAMPAL EEG ACTIVITY AND IMPEDANCE IN APPROACH LEARNING: EFFECTS OF PSYCHOTOMIMETIC AND HALLUCINOGENIC DRUGS, by W. R. Adey. [1965] [31]p. incl. illus. diagrs. refs. (AFOSR-65-1572) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-61-81 and Public Health Service) AD 623497 Unclassified

Also published in Pharmacology of Conditioning, Learning, and Retention; Proc. Second Internat'l. Pharmacol. Meeting, Prague (Czechoslovakia) (Aug. 20-23, 1963) ed. by M. Ya. Mikhil'son, V. G. Longo and Z. Votava, New York, Pergamon Press, 1965, pp. 287-317.

Results from the studies of psychotomimetic and hallucinogenic drugs show a close relationship between the presence of certain clearly specified patterns of wave activity in the hippocampal system and the ability to make a discriminative motor performance. The studies are also a result of filtering technique which establishes the digital computer as a narrow-band filter.

444

California U. [Brain Research Inst.] Los Angeles.

ANALYSIS OF BRAIN-WAVE GENERATORS AS MULTIPLE STATISTICAL TIME SERIES, by D. O. Walter and W. R. Adey. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-1586) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-61-81, National Aeronautics and Space Administration, and Public Health Service) AD 624014 Unclassified

Also published in IEEE Trans. Bio-Med. Eng., v. BME-12: 8-13, Jan. 1965.

An illustrative example of the spectral analysis of simultaneously recorded electroencephalograms is presented. The first topic is that of auto-spectral analysis, which is very similar to frequency analysis; then cross-spectral analysis is used to show that the major relationship among three of the traces analyzed is a linear one, while a fourth trace is nonlinearly activated. Two hypotheses suggested by this analysis are tested by methods of multivariate spectral analysis, a recently developed extension of the cross-spectral method. Another extension, generator analysis, whose theory has not previously appeared, is presented both theoretically and in application to the same example. It represents a substantial step toward the goal of identifying and localizing the actual biophysical generators which produced the observed electroencephalograms.

445

California U. [Brain Research Inst.] Los Angeles.

RECENT FINDINGS IN THE PATHOGENESIS OF DECOMPRESSION SICKNESS (DYSBARISM), by A. T. [K.] Cockett, R. M. Nakamura, and J. J. Franks. [1965] [6]p. incl. illus. tables. (AFOSR-65-2833) (AF AFOSR-61-81) AD 622857 Unclassified

Presented in part at annual meeting of the American Coll. of Surgeons, San Francisco, 1963.

Also published in Surgery, v. 58: 384-389, Aug. 1965.

A technique for the production of gaseous bubbles in dogs is presented. Plasma volumes decrease 4% to 38% of control values 4 1/2 to 5 1/2 hr after removal of 7 dogs from the decompression chamber. Red cell volumes do not change. The role of bubble formation with progressive reduction in blood pressure is discussed in the slower deaths of 10 animals. Bone marrow emboli were found on routine histologic sections of the lungs.

446

California U. [Brain Research Inst.] Los Angeles.

ACTIVATION HEAT IN MUSCLE: METHOD FOR DETERMINATION, by C. L. Gibbs and N. V. Ricchiuti. [1965] [2]p. incl. diagr. (AFOSR-65-0963) (AF AFOSR-63-146) AD 619603 Unclassified

Also published in Science, v. 147: 162-163, Jan. 8, 1965.

By varying the interval between 2 stimuli it is possible to measure the activation heat in a skeletal muscle

twitch. The method depends upon finding a range of stimulus intervals where complete mechanical fusion exists and where there is a plateau in the heat production. At 0 C, and when muscles are at normal body length, activation heat represents about 40% of the heat in an isometric twitch.

447

California U. Brain Research Inst., Los Angeles.

A NEUROPHYSIOLOGICAL COMPARISON OF GAMMA-HYDROXYBUTYRATE WITH PENTOBARBITAL IN CATS, by W. D. Winters and C. E. Spooner. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-0938) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-246, and Public Health Service) AD 622837 Unclassified

Also published in Electroencephalog. and Clin. Neurophysiol. Jour., v. 18: 287-296, 1965.

The neurophysiological actions of gamma-hydroxybutyrate (GHB) are compared to those of pentobarbital in cats with chronically inplanted electrodes. Observations are performed on gross behavior, EEG activity, and average response to clicks. Studies indicate that the GHB induced state is one of excitation rather than depression. GHB is not found to act in a manner similar to pentobarbital but appears more closely associated with a convulsant state. The electrical activity and behavior are epileptiform. It is proposed that the clinical efficacy of this agent may be based on the induction of a lack of responsiveness rather than by virtue of specific anesthetic properties.

448

California U. [Brain Research Inst.] Los Angeles.

NORMAL SLEEP PATTERNS IN MACQUE MONKEYS, by M. L. Reite, J. M. Rhodes and others. [1965] [12]p. incl. refs. diagrs. (AFOSR-65-0939) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-246, National Aeronautics and Space Administration, and Public Health Service) AD 622601 Unclassified

Also published in Arch. Neurol., v. 12: 133-144, Feb. 1965.

Normal sleep patterns of the Macaca nemestrina monkeys were studied in 6 subjects for 20 nights. Bipolar EEG records were secured from surface and deep electrodes. Eye movements were monitored by EOG and by closed-circuit TV. Clicks were continuously presented at 4-sec intervals. EEG records were divided into the following stages: awake, drowsy, light, intermediate, deep, and paradoxical. Sleep phases were cyclic, with cycle durations of 75 to 85 min, thus resembling human sleep, but the longest segments of deep sleep occurred in the early part of the night. Paradoxical phases occurred during the latter half of the night. Awakening during the night was usually correlated with an initial shift to fast activity in the pontine reticular formation, followed by changes in other deep structures, and lastly, if at all, in cortical areas. (Contractor's abstract)

449

California U. Brain Research Inst., Los Angeles.

PROLONGED EFFECTS OF LSD ON EEG RECORDS DURING DISCRIMINATIVE PERFORMANCE IN CAT; EVALUATION BY COMPUTER ANALYSIS, by W. R. Adey, R. Porter and others. [1965] [11]p. incl. diagrs. refs. (AFOSR-65-0940) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-246, National Aeronautics and Space Administration, and National Institutes of Health) AD 622846 Unclassified

Also published in Electroencephalog. and Clin. Neurophysiol. Jour., v. 19: 25-35, 1965.

The effects of LSD were studied in relation to changes induced in computed averages of epochs of EEG records during a discriminative task performance in a series of 6 cats repeatedly exposed to LSD over a period of many months. Computed averages of rhythmic hippocampal wave trains during approach performance showed an increase in amplitude and regularity following LSD. This modification was maximal about 4 days after LSD, and decayed to control levels after 5 to 7 days. Findings indicate persistent electrophysiological effects of LSD beyond the period of acute drug action. They showed a differential distribution in different brain regions, with maximal changes in the hippocampus, and smaller effects in the entorhinal cortex and the rostral midbrain reticular formation. Differential susceptibility of hippocampal tissue is discussed in relation to a similar sensitivity to the acute effects of both LSD and psychotomimetic cyclohexamines, and to the pattern of propagation of hippocampal after discharges.

450

California U. Brain Research Inst., Los Angeles.

IMPEDANCE CHARACTERISTICS OF CORTICAL AND SUBCORTICAL STRUCTURES: EVALUATION OF REGIONAL SPECIFICITY IN HYPERCAPNEA AND HYPOTHERMIA, by W. R. Adey, R. T. Kado, and D. O. Walter. [1965] [27]p. incl. diagrs. refs. (AFOSR-65-0965) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-246 and National Institutes of Health) AD 619611 Unclassified

Also published in Exper. Neurol., v. 11: 190-216, Feb. 1965.

Measurements of electrical impedance were made in focal volumes of approximately 1.0 mm^3 of allocortical and subcortical tissue in the cat, with μv signals at 1000 c/sec. The technique allows simultaneous recording of the relative magnitude of resistive and reactive components. Measurements were made with chronically implanted electrodes, and also in acute preparations,

either immobilized with gallamine triethiodide or with an upper cervical spinal transection. The results obtained are presented and discussed.

451

California U. Brain Research Inst., Los Angeles.

THE HIPPOCAMPUS AND THE ORIENTING REFLEX, by M. Radulovacki and W. R. Adey. [1965] [16]p. incl. diagrs. refs. (AFOSR-65-1778) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-246] and National Institutes of Health) AD 626507 Unclassified

Also published in Exper. Neurol., v. 12: 68-83, May 1965.

Averages of hippocampal wave trains are computed from a cat's daily trials in discrimination and in orienting responses. Alerted but nonperforming animals exhibit a wide spectrum of theta wave activity in the range 3 to 7 c/sec on first introduction into the test situation. During T-maze discriminative performances, hippocampal theta waves regularize at 6 c/sec. Orienting behavior is associated with slower and less regular computed averages at 4 to 5 c/sec. Single doses of LSD-25 are followed by prolonged disinhibition of inhibited orienting behavior and by the gradual appearance of a regular EEG average during orientations 5 to 10 days after the drug. Similar results are obtained with CL-400. It is concluded that within a single brain system, there is a clear capacity for participation in related but differing behavioral responses, with induction of greatly differing EEG patterns in discriminative and orienting responses. The possible relation of these wave patterns to the establishment of a behavioral set is discussed.

452

California U. [Brain Research Inst.] Los Angeles.

RECORDING LEAF MOVEMENTS WITH A STRAIN GAUGE, by T. Hoshizaki and K. Yokayama. [1965] [2]p. incl. illus. diagrs. (AFOSR-65-2834) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-246 and National Aeronautics and Space Administration) AD 623494 Unclassified

Also published in Nature, v. 207: 880-881 Aug. 21, 1965.

A small lightweight leaf movement recording system using a strain gauge coupled to an amplifier and a recorder was devised. The need for such a system was dictated by the physical limitations of an orbiting capsule. Such a system is also useful for earthbound experiments. The small size of the sensing unit makes it possible to place several units on a single plant. The monitored plant can easily be placed in a small control chamber and continuous records of several weeks' duration can be obtained when the movements are recorded on a strip chart recorder.

453

California U. Brain Research Inst., Los Angeles.

ELECTROPHYSIOLOGICAL PATTERNS AND CEREBRAL IMPEDANCE CHARACTERISTICS IN ORIENTING AND DISCRIMINATIVE BEHAVIOR, by W. R. Adey. [1965] [16]p. incl. illus. diagrs. refs. (AFOSR-65-2838) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-246, National Aeronautics and Space Administration, and National Institutes of Health) AD 628403 Unclassified

Also published in Proc. Internat'l. Union of Physiological Science, Twenty-third Internat'l. Cong., Tokyo (Japan), (Sept. 1-9, 1965), Amsterdam, Excerpta Medica Foundation, v. 4: 324-339, 1965.

This review was concerned with the gamut of wave and unit activity as they characterize neutronal function from subcellular levels to integrated activity in large volumes of cortical tissue in performing man. It was postulated that extraneuronal compartments may participate in the modulation of the wave process that characterizes intracellular records, and that these wave processes may rank at least equivalently with neuronal firing in the transaction of information, and even more importantly in its deposition and recall.

454

California U. [Brain Research Inst.] Los Angeles.

TRANSPORT OF RENIN ANGIOTENSIN BY RENAL LYMPHATICS, by A. T. [K.] Cockett, R. S. Moore, and R. T Kado. [1965] [2]p. incl. diagrs. (AFOSR-66-0854) (AF AFOSR-63-246) AD 641?80 Unclassified

Also published in Surgical Forums, v. 16: 492-493, 1965.

It is suggested that one important role of the renal lymphatics is the transport of renin angiotensin. Vasopressor levels were significantly higher in the renal lymph than in the renal vein plasma when compared in equal volumes. Renal transport of this vasopressor is of primary importance. Renal vein outflow far exceeds lymph flow. The renal ymphatics probably provide an important avenue to assist in sustaining blood pressure.

455

California U. Brain Research Inst., Los Angeles.

VARIOUS SEIZURE ACTIVITIES FOLLOWING GAMMA-HYDROXYBUTYRATE, by W. D. Winters and C. E. Spooner [1965] [5]p. incl. illus diagrs refs. (AFOSR-66-1120) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-246) and Public Health Service) AD 641381 Unclassified

Also published in Internat'l Jour. Neuropharmacol. v. 4 197-200, 1965.

These studies demonstrate that 0.7 - 1.0 gm/kg of γ-hydroxybutyrate (GHB) induces 2 1/2 c/s electrical epileptiform activity which progresses to spiking with short polyphasic bursts followed by electrical silence. Spontaneous and induced myoclonic jerks appear as the interval of electrical silence lengthens between bursts. Grand mal seizures are induced by tactile and/or auditory stimulation. The occurrence of epileptiform activity and in particular grand mal seizures following GHB suggests that a reappraisal of the clinical usefulness of this drug is in order.

456

California U. [Brain Research Inst.] Los Angeles.

MEASUREMENT OF OXYGEN TENSION AND SATURATION IN THE DIAGNOSIS OF RENAL ISCHEMIC HYPERTENSION, by A. T. [K.] Cockett, D. R. Cannon and others. [1965] [3]p. incl. tables. (AFOSR-66-1417) (AF AFOSR-63-246) AD 641375 Unclassified

Presented at meeting of the Southern California Chapter of the Amer. Coll. of Surgeons, Palm Springs, Calif., Jan. 24, 1965.

Also published in Amer. Surgeon, v. 31: 691-693, Oct. 1965.

Oxygen tension and oxygen saturation data have been obtained in 3 groups of patients undergoing renovascular or renal surgery. In normal kidneys the oxygen saturation and oxygen tension in the renal vein blood are 90 to 97% and 80 to 113 mm Hg, respectively. In renal ischemia the oxygen saturation in the affected renal vein is 60 to 75%. Oxygen tension is about 60 to 75 mm Hg. In other types of patients with intrinsic renal disease, including chronic pyelonephritis, the oxygen tension and oxygen saturation are less predictable.

457

California U. [Brain Research Inst.] Los Angeles.

THE ROLE OF ARTERIAL PULSATION IN EXPERIMENTAL HYDRONEPHROSIS, by A. T. [K.] Cockett, R. M. Nakamura, and B. I. Rein. [1965] [7]p. incl. illus. (AFOSR-66-1891) (AF AFOSR-63-246) AD 641378 Unclassified

Also published in Invest. Urol., v. 2: 548-554, May 1965.

A method for the development of chronic experimental hydronephrosis is outlined. Histologic changes in the ureters and kidneys associated with hydronephrosis are listed. It would appear that two factors, partial ureteral obstruction and the arterial pulse, are important in the genesis of hydronephrosis. Partial ureteral obstruction alone is less predictable. (Contractor's abstract)

458

California U. Brain Research Inst., Los Angeles.

SPECIFIC IMPEDANCE OF CEREBRAL WHITE MATTER, by P. W. Nicholson. [1965] [15]p. incl. diagrs. tables, refs. (AFOSR-66-2105) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-246 and National Institute of Mental Health) AD 642819 Unclassified

Also published in Exper. Neurol., v. 13: 386-401, Dec. 1965.

A method is described for measuring specific impedances in deep brain structures. It was used to determine the impedance in a large fiber tract in the cat internal capsule. The impedance along an axis normal to the fiber direction was ~800 Ω cm and predominantly resistive at frequencies between 20 c/sec and 20 kc/sec. The impedance along the fiber direction was approximately one-ninth of this. Possible mechanisms of current conduction are examined and it is concluded that unless the oligodendrocyte membrane resistance is $\gtrsim 8\ \Omega\ cm^2$ an extracellular space of ~10% is indicated. (Contractor's abstract)

459

California U. Brain Research Inst., Los Angeles.

TETRODOTOXIN AND MANGANESE ION: EFFECTS ON ACTION POTENTIAL OF THE FROG HEART, by S. Hagiwara and S. Nakajima. [1965] [2]p. incl. illus. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-535 and National Institutes of Health) Unclassified

Published in Science, v. 149 1254-1255, Sept. 10, 1965.

Tetrodotoxin, which effectively suppresses the permeability of various tissues to sodium ions, has no effect on the calcium action potential of the fiber of barnacle muscle, which potential is produced by increase in permeability to calcium ions. Manganese ions, however, suppress the action potential. When applied to fiber of frog cardiac ventricle, tetrodotoxin suppresses the rate of rise of the action potential without affecting the overshoot; the suppressive effect of manganese ion is mainly on the overshoot of the action potential. This suggests that, in the action potential of the cardiac ventricle of the frog, the plateau phase is related primarily to the increase in permeability of the membrane to calcium ions. (Contractor's abstract)

460

California U. [Dept. of Astronomy] Los Angeles.

SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. V. MEASUREMENT OF LINE INTENSITIES IN PLANETARY NEBULAE WITH AN ELECTRONIC CAMERA, by L. H. Aller and M. F. Walker. [1965] [14]p. incl. illus. tables, refs. (AFOSR-66-1583) (AF AFOSR-63-83) AD 641447 Unclassified

Also published in Astrophys. Jour., v. 141: 1318-1330, May 1965.

The spectra of several planetary nebulae, IC 351, NGC 1535, NGC 2022, NGC 6309, NGC 6720, NGC 6741, and Anon 21^h29^m = VV 267 have been observed with a Lallemand electronic camera at the coudé focus of the 120-in. reflector in the spectral region between λ 3600 and λ 4400. It is concluded that an image converter can yield as reliable line intensities as can conventional photographic methods. The large scale at the coudé focus enables the observer to measure relative intensities at several points in the nebular image, while the relatively high dispersion makes weaker lines detectable against the continuum of the central star or that of the nebulae itself. Also the linear response of the image tube even for high electronorgraphic plate densities makes possible intensity measurements without the errors introduced by the usual photographic reduction process and considerably extends the range of intensity measurements that can be made as compared with conventional photographic photometry. (Contractor's abstract)

461

[California U. Dept. of Astronomy, Los Angeles].

QUASILINEARIZATION AND ORBIT DETERMINATION, by R. S. Long. [1965] [4]p. incl. tables. (AF AFOSR-63-241) Unclassified

Published in AIAA Jour., v. 3: 1937-1940, Oct. 5.

This paper explains the use of quasilinearization (the generalized Newton-Raphson process) as applied to the problem of determining orbits from various types of observational data, i.e., angular data, range and range-rate. The nonlinear differential equations controlling the orbit are replaced by a set of linear equations whose solutions, obtained numerically, converge to the orbit, at least if the orbit is well determined by the data. Numerical examples show that the convergence is rapid.

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California U. [Dept. of Astronomy] Los Angeles.

SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. IV. THE ORION NEBULA, by J. B. Kaler, L. H. Aller, and I. S. Bowen. [1965] [11]p. incl. tables, refs. (AFOSR-66-1591) [AF AFOSR-65-83] AD 641039 Unclassified

Also published in Astrophys. Jour., v. 141: 912-922, Apr. 1965.

Wavelengths, identifications, and intensities for emission lines of the Orion Nebula are given for the wavelength region λ 3187-λ 5016A. The intensities were corrected to outside the atmosphere by published photoelectric intensities and observation of a standard star. Lines as faint as 0.015 on the scale $H\beta$ = 100 are recorded. (Contractor's abstract)

463

California U. Dept. of Chemistry, Los Angeles.

THE CRYSTAL AND MOLECULAR STRUCTURE OF [3.3] PARACYCLOPHANE, by P. K. Gantzel and K. N. Trueblood. [1965] [11]p. incl. diagrs. tables, refs. (AFOSR-65-2160) (AF 49(638)719) AD 627512 Unclassified

Also published in Acta Cryst., v. 18. 958-968, May 1965.

[3.3] Paracyclophane ($C_{18}H_{20}$) forms monoclinic crystals with a_o = 9.715, b_o = 8.138, c_o = 8.524A, β = 90.69°, and 2 molecules in the unit cell in space group $P2_1/n$. The structure was refined by full-matrix least-squares methods, and the final parameters include small corrections for molecular libration. The aromatic rings are deformed slightly into a symmetrical boat form, the bending being about 6° at each end, the α-carbons are bent further, by an average of nearly 4°. The 2 rings do not lie directly above one another being displaced about 0.5A from such an arrangement. The bond angles in the side chain are slightly larger than the normal values, and the dihedral angles are also slightly greater than those in n-butane. All bond distances are consistent with those found in other hydrocarbons. There are no short non-bonded intermolecular contacts, and the shortest intramolecular ones are only slightly less than the sum of the van der Waals radii, and thus are consistent with the comparatively small observed distortion of the molecule. The distribution of the strain energy in this and similar molecules is discussed. (Contractor's abstract)

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Califronia U. Dept. of Chemistry, Los Angeles.

THE CRYSTAL AND MOLECULAR STRUCTURE OF 1,1'-TETRAMETHYLETHYLENEFERROCENE, by M. B. Laing and K. N. Trueblood. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-2387) [AF 49(638)-719] AD 627955 Unclassified

Also published in Acta Cryst., v. 19: 373-381, Sept. 1965.

1,1'-Tetramethylethyleneferrocene forms monoclinic plates of space group $P2_1/c$, and 4 molecules in the unit cell with a_o = 7.756, b_o = 10.97, c_o = 15.41, and β = 92.63°. The structure was solved from 3-dimensional Patterson and Fourier syntheses, and was refined by block-diagonal least squares. The two 5-membered rings are tilted 23° with respect to one another, but because of the bridge linking them are staggered only by about 9°, in contrast to ferrocene. The strain in the molecule is apparent also in the fact that the dihedral angles in the bridge are only about 26°, and that the exocyclic bonds are bent about 11° from the ring planes. The bond distances in the bridge are slightly greater than normal. The bond distances in the ring and to the iron atom appear normal. (Contractor's abstract)

465

California U. Dept. of Chemistry, Los Angeles.

FORMATION OF A CYCLOPROPANE RING FROM AN α,β--UNSATURATED CARBOXYLIC ACID, by R. T. Uyeda and D. J. Cram. [1965] [1]p. incl. diagrs. (AFOSR-65-2378) (AF AFOSR-63-124) AD 628402 Unclassified

Also published in Jour. Org. Chem., v. 30: 2083, June 1965.

In the course of the preparation of 3-phenyl-1-butanol by reduction of β-methylcinnamic acid with lithium aluminum hydride besides the expected alcohol, considerable quantity of 1-methylphenylcyclopropane was isolated. It is probable that the 2 products have a common precursor, and that the relative yields are controlled by the amount of time the reaction is allowed to go before the reaction mixture is quenched. The scope and limitations of the reaction have not been examined, but in principle, the reaction might be applicable to a broad range of α,β-unsaturated carbonyl compounds.

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California U. Dept. of Chemistry, Los Angeles.

ON THE CLAIM OF A BIMOLECULAR MECHANISM OF PROTOTROPY, by D. J. Cram and R. D. Guthrie. [1965] [2]p. (AFOSR-65-2379) (AF AFOSR-63-124) AD 629640 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87 397-398, Jan. 20, 1965.

Re-examination of evidence for a one-stage mechanism of prototropy, using a methylene-azomethine rearrangement system, indicates that the claim for a bimolecular mechanism is without secure foundation.

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California U. Dept. of Chemistry, Los Angeles.

METALLIC DIAMONDS, PRESSURE-PRODUCED METALS, by A. J. Darnell and W. F. Libby. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-1657) (AF AFOSR-63-245) AD 624175 Unclassified

Also published in Prog. Solid State Chem., v. 2: 1-8, 1965.

The metallic phases of the IVth Group elements and of the binary compounds one and two columns removed from the IVth Group, e.g., boron nitride, aluminum phosphide and zinc selenide are called metallic diamonds. The general nature of the phase diagram is that the melting point of the non-metallic state falls when pressure is applied until the transition pressure is reached, the solid-solid transition to the metallic state then occurs after which the melting point rises again. A technique is described for removing these new materials from the high-pressure apparatus in which they are produced so that their properties can be studied more completely. The technique involves chilling the materials in the metastable form and removing them after pressure is reduced to atmospheric.

468

California U. Dept. of Chemistry, Los Angeles.

NATURE OF THE CHEMICAL REACTIVITY OF RADIOBROMINE ATOMS PRODUCED BY ISOMERIC TRANSITION, by A. R. Kazanjian and W. F. Libby. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-1668) (AF AFOSR-64-245) AD 624366 Unclassified

Also published in Jour. Chem. Phys., v. 42: 2778-2783, Apr. 15, 1965.

The hot-atom chemistry of n-propyl bromide has been examined. By comparing the differences and similarities of the (n, γ) and isomeric transition processes, an over-all theory is evolved which accounts for the identical results produced by both nuclear processes in the solid and liquid alkyl halides. The charge developed by the Auger process following internal conversion causes the molecule to explode and gives a neutral recoiling atom which then reacts as the (n, γ) atoms. The neutralization after rupture is rapid in the solid and liquid. In the gas this is not so, and it has been possible to demonstrate experimentally a difference between the retentions in the gas phase. (Contractor's abstract)

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[California U. Dept. of Chemistry, Los Angeles]

THE NATURE OF THE LONG-RANGE INTERACTION IN HEMOGLOBIN, by W. F. Libby. [1965] [7]p. incl. diagr. [AF AFOSR-64-245] Unclassified

Published in Science in the Sixties; Tenth Anniversary AFOSR Scientific Seminar, Cloudcroft, N. M. (June 14-25, 1965) ed. by D. L. Arm. Albuquerque, Mexico U. Office of Publications, 1965, 200-206.

The strong interaction (2.3 kcal/mol) at long distances (25A) occurring between the iron porphyrins is discussed. It is concluded that the oxygenation of hemoglobin as affected by the heme-heme interaction apparently can be explained by a very long range Van der Waals electronic polarizability interaction which is much stronger for hemoglobin than for oxyhemoglobin. This interaction is due to the electronic level structures of the pi electrons in the prophyrin system, hemoglobin having 2 more pi electrons. The particular molecular orbital treatment used gives approximately the polarizabilities required and the quantum theoretical calculations show a Van der Waal's type of interaction to be entirely conceivable. The experimental evidence seems to fit the theory with a pi electron polarizability of about 4000×10^{-24} cc in hemoglobin and with a much smaller polarizability of the pi electron system in oxyhemoglobin. This seems to require that the 2 vinyl groups contribute and be coplanar with the heme platelets in hemoglobin. The Bohr effect of acids and bases

and the effects of added salt are in keeping with the theory that charge repulsion causes a swelling and a rapid drop in the interaction with consequent increase in oxygen affinity.

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California U. Dept. of Chemistry, Los Angeles.

SPACE CHEMISTRY, by W. F. Libby. [1965] [26]p. incl. illus. diagrs. tables, refs. [AF AFOSR-64-245] Unclassified

Published in Science in the Sixties; Tenth Anniversary AFOSR Scientific Seminar, Cloudcroft, N. M. (June 14-25, 1965) ed. by D. L. Arm. Albuquerque, Mexico U. Office of Publications, 1965, 175-199.

The program of space chemistry at UCLA is aimed at four general areas: high pressure, radiation, high temperature, and vacuum chemistry. Progress has been made only in the first 2 areas although apparatus has been constructed for the third, consisting of 3 plasma torches, one of which goes to the power of half a megawatt. No facilities or progress have as yet been made in vacuum chemistry. In high pressure chemistry, work in organic compounds consists mainly of the study of the effects of high pressure on Coliphage T-4; as a result of being exposed to pressures of 4 kb, the virus was rapidly inactivated by the release of and the uncoiling of DNA. In inorganic chemistry, the problem of artificial metals has been worked on and the production of metals by pressure application to nonmetals followed by subsequent quenching to liquid nitrogen temperature is discussed. A number of new materials have been produced, among them metallic indium antimonide and its alloys with tin. Radiation chemistry has dealt with positive ion chemistry and hot atom chemistry. Gamma ray exposure of both solid and gaseous methane leads to the production of high molecular weight hydrocarbons. Experiments with solutions of hexane in liquid xenon have shown that when ionization takes place, the positive charge reaches the species of lowest ionization potential.

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California U. Dept. of Chemistry, Los Angeles.

REACTION OF THERMAL CARBON ATOMS, by J. L. Sprung, S. Winstein, and W. F. Libby. [1965] [2]p. incl. table. (AFOSR-65-1675) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-245 and Army Research Office (Durham)) Unclassified

Also published in Jour. Amer. Chem. Soc , v. 87: 1812-1813, Apr. 1965

Carbon fragments from carbon vapor were used to bombard 99.999% zone-refined benzene frozen on a liquid nitrogen cooled surface. Gas chromatographic analysis of the irradiated benzene showed toluene and cycloheptatriene to be among the reaction products. It seems most probable that these products result from the reaction of benzene with thermal carbon atoms. It is believed that the present work provides the first example of reaction of C_1 from carbon vapor with an organic substrate. The results of this experiment also provided the first demonstration of a reaction between an organic substrate and carbon atoms produced with an initial kinetic energy below 0.3 ev.

472

California U. Dept. of Engineering, Los Angeles.

ON CONTROL SYSTEM EQUIVALENTS OF SOME DECISION THEORETIC THEOREMS, by D. D. Sworder and M. Aoki. [1965] [15]p. (AFOSR-65-2425) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-68 and Office of Naval Research) AD 628625 Unclassified

Also published in Jour. Math. Anal. and Appl., v. 10: 424-438, Apr. 1965.

The paper shows that theorems almost identical to those in statistical decision theory hold for control systems with unknown parameters in obtaining complete classes of control policies, such that control policies not in the complete set need not be considered in optimizing control systems. The paper also shows that some of the basic assumptions needed for these theorems are satisfied in most control situations. This has many implications in control problems. For example, in discussing adaptive control problems Bellman and Kalaba used the assumption that they consider only control policies with Bayes property in deriving the functional equations of dynamic programming. It can now be shown, however, that the set of Bayes control policies form a complete class of control policies under certain conditions, and if sufficient statistics exist, then the set of control policies utilizing sufficient statistics forms a complete class. Thus, some assumptions which have been made arbitrarily in the past can be removed and/or justified in dealing with control systems with unknown parameters. (Contractor's abstract)

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California U. [Dept. of Engineering] Los Angeles.

CONTROL OF A LINEAR SYSTEM WITH A MARKOV PROPERTY, by D. D. Sworder. [1965] 8p. incl. refs. (AFOSR-66-0390) (AF AFOSR-62-68) AD 640218 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10: 294-300, July 1965.

The theory of games and statistical decisions is applied to the problem of synthesizing a controller for a linear discrete time plant in the presence of uncertainty about the value of certain process parameters. Particular care is taken to describe how these unknown parameters complicate the choice of the properties of an optimal control rule. The theory is illustrated by the study of the characteristics of a second-order system. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

A SUFFICIENT CONDITION FOR THE EXISTENCE OF AN ADMISSIBLE CONTROL FOR A CLASS OF OPTIMIZATION PROBLEMS, by M. D. Schwartz. [1965] 5p. (AFOSR-66-2151) (AF AFOSR-62-68) AD 641200 Unclassified

Presented at Winter annual meeting of the Amer. Soc. Mech. Engineers, Chicago, Nov. 7-11, 1965.

Also published in Trans. Amer. Soc. Mech. Engrs., p. 1-5, Dec. 1965.

This paper considers a sufficient condition for the existence of an admissible control which transfers the state of a system from an initial to a final value subjected to a constraint. The concept of the modified adjoint operator is introduced such that the control satisfies the 2-point boundary value problem and is proportional to the modified adjoint operator. The applicability of the sufficient condition is compared with that of the necessary and sufficient condition by means of several examples. (Contractor's abstract)

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California U. [Dept. of Engineering] Los Angeles.

CONVERSION CONTROL IN A CONTINUOUS REACTOR TRAIN: SYNTHESIS AND COMPUTER SIMULATION, by D. A. Wismer. [1965] [6]p. incl. diagrs. tables. (AFOSR-66-0662) (AF AFOSR-65-699) AD 641058 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10 455-460, Oct. 1965.

A feedforward control scheme is synthesized for control of final product conversion in a train of continuous stirred-tank reactors. The control is achieved by temperature manipulation in the latter reactors and utilizes a continuous conversion measurement within the train. The control scheme is developed in terms of difference equations which are suitable for implementation on a digital control computer.

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California U. [Dept. of Engineering] Los Angeles.

THE ANALYSIS AND SYNTHESIS OF COMPLEX CONTROL SYSTEMS WITH VARIABLE CRITERION FUNCTIONS, by C. T. Leondes and J. A. Payne. [1965] [7]p. incl. diagrs. table. (AFOSR-66-2610) [AF AFOSR-65-699] AD 643299 Unclassified

Also published in Proc. IFAC Tokyo Symposium Systems Engineering for Control System Design (1965) p. 425-432.

In many complex control systems it is not possible to initially specify reasonable values for system performance. The use of optimization with respect to a variable criterion function is one method which can be used during the preliminary design stages for such systems. This paper discusses the formulation of this optimizing problem and certain characteristics of the associated computational problem. Also, a particular computational method which has been successfully applied to this type of problem is presented. As an example of optimization with respect to a variable criterion function, a reentry problem is considered. This problem is that of transferring a lifting type aerospace vehicle re-entering the earth's atmosphere from parabolic to satellite conditions by means of aerodynamic braking. Certain results from a numerical solution of this problem are presented, including the optimal trade-off function between heating and acceleration effects. Some characteristics of the computational process are described. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

THE APPLICATION OF AN ALGORITHM FOR SEQUENTIAL OPTIMIZATION OF CONTROL SYSTEMS, by J. F. Sohler. [1965] [91]p. (AF AFOSR-65-699) AD 621223 Unclassified

The subject of this thesis is the application of an algorithm for optimization of nonlinear control problems. The method used is the development of a digital computer program which applies the algorithm to study problems for verification of the technique. Possible extension of the theoretical developments studied is also investigated. The basic problem involves linearization of the results of a nonlinear solution about a nonoptimal control for the problem. The linear solution is derived by application of Pontryagin's Maximum Principle for an optimal system. A geometric approach to the solution results in a gradient technique for arriving at the optimal control for this phase of the problem. The solution of the gradient technique is accomplished by use of an acceleration scheme to provide rapid convergence to the control improvement. The final nonlinear solution is accomplished by applying the linear optimization technique in the controlled manner to the nonlinear problem.

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California U. Dept. of Engineering, Los Angeles.

SEMIGROUP THEORY AND CONTROL THEORY, by A. V. Balakrishnan. [1965] [7]p. (AFOSR-66-0084) (AF AFOSR-65-700) AD 641171 Unclassified

Also published in Proc. of IFIP Cong. 65, New York (May 24-29) ed. by W. A. Kalenich. Spartan Books, Inc., Washington, D. C., v. 1: 157-163, 1965.

Two classes of problems involving linear partial differential equations are dealt with in this paper. They serve to illustrate the role that semigroup theory plays. Specific examples are used. The scope of the theory and the directions of generalization possible are indicated by the examples given.

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California U. Dept. of Engineering, Los Angeles.

OPTICAL CONTROL PROBLEMS IN BANACH SPACES, by A. V. Balakrishnan. [1965] [29]p. (AFOSR-66-0198) (AF AFOSR-65-700) AD 641165 Unclassified

Presented at Symposium on the Math. Theorem of Optimal Control, University of Mich. Ann Arbor, Mich., Oct. 5-7, 1964.

Also published in SIAM Jour. Control, Series A, v. 3: no. 1, 152-180, 1965.

This paper is concerned with a systematic study of a class of control problems in which the state and input or control variables are allowed to range in Banach spaces. Specifically, the state equation is of the form $\dot{x}(t) = f(x(t), u(t), t)$ where for each t, u(t) and x(t) are Banach space valued. This extension to infinite dimensions is more than of purely mathematical interest. In the first place, control problems involving distributed parameter systems where the state dynamics are described by partial differential equations are conveniently formulated in this way. Secondly, stochastic control problems can also be handled in this way. Thus, the study of control problems in Banach spaces has the merit of providing a measure of unification for a wide range of problems.

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California U. [Dept. of Mathematics] Los Angeles.

TCHEBYCHEFF APPROXIMATION AND RELATED EXTREMAL PROBLEMS, by E. W. Cheney a[illegible] A. Goldstein. [1965] [12]p. (AFOSR-65-1163) (In cooperation with Massachusetts Inst. of Tech., Cambridge, AF AFOSR-62-348) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-77, and Boeing Scientific Research Laboratories) AD 622523 Unclassified

Also published in Jour. Math. and Mech., v. 14: 87-98, Jan. 1965.

Proof is presented for several existence theorems involving convex functionals and the Tchebycheff approximation problem. Conditions are set forth for the supremum and infimum of a convex functional and the existence of a point of minimum norm on a subset of a normed linear space. An abstract problem of Tchebycheff approximation is presented. Given a set X in a linear topological space E and a bounded function λ on X, an element $f \in E^*$ is sought for which the expression $\varphi(f) = \sup_{x \in X} |f(x) - \lambda(x)|$ is an absolute minimum. Such an f is termed a best Tchebycheff approximation to λ.

481

California U. [Dept. of Mathematics] Los Angeles.

APPROXIMATION BY GENERALIZED RATIONAL FUNCTIONS, by E. W. Cheney. [1965] [10]p. (AFOSR-65-2428) (AF AFOSR-63-77) AD 627750 Unclassified

Abstract published in Notices Amer. Math. Soc., v. 11: 461, 1964.

Also published in Approximation of Functions, Proc. of the [Eighth] Symposium, General Motors Research Laboratories, Warren, Mich. (Aug. 31-Sept. 2, 1964), ed. by H. L. Garabedian. Amsterdam, Elsevier, 1965. p. 101-110.

Studies are undertaken into the approximation of continuous functions on a given real interval [a,b] by generalized functions. These are functions of the form p/q where p,q vary in fixed subspaces P,Q, respectively, q being subject to the restriction $q(x) > 0$ on [a,b]. Results are sought which correspond to the theorems of existence, uniqueness and characterization in the more familiar case in which p and q are polynomials in x. Theorems which are stated and proved include a characterization theorem (given in the form of two alternation conditions, one necessary and the other sufficient), two uniqueness theorems and a theorem concerning continuity (this being an extension of a theorem of Maehly and Witzgall). These results, and those which will be built upon them, should prove to be of great value in the construction of approximations. (Math. Rev. abstract)

482

California U. [Dept. of Mathematics] Los Angeles.

ON THE LEFSCHETZ FIXED POINT FORMULA, by R. J. Brown. [1965] [10]p. incl. diagrs. (AFOSR-65-1408) (AF AFOSR-63-90) AD 621536 Unclassified

Also published in Amer. Jour. Math., v. 87: 1-10, Jan. 1965.

The Lefschetz fixed point formula is proved defining a fixed point index $I_f(x)$ equivalent to the degree index of Weier. The following theorem is proved: Let M be a closed orientable topological n-manifold and let $f: M \to M$ be a map with fixed points $x_1, \ldots, x_r$, then

$\sum_{j=1}^{r} I_f(x_j) = (-1)^n \Lambda_f$. The singular cohomology theory is used with integer coefficients.

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California U. [Dept. of Mathematics] Los Angeles.

MINIMAX DESIGNS IN TWO DIMENSIONAL REGRESSION, by P. G. Hoel. [1965] [10]p. incl. diagrs. (AFOSR-65-1964) (AF AFOSR-63-459) AD 626505 Unclassified

Also published in Ann. Math. Stat., v. 36: 1097-1106, Aug. 1965.

This paper studies the problem of how to space observations in regression so as to minimize the variance of an

estimate of the regression function value at an arbitrary point in the domain of observations. Necessary and sufficient conditions are obtained for such a "minimax" design, in 2-dimensional polynomial regression where the regression function possesses a product structure, 1-dimensional trigonometric and 2-dimensional spherical harmonics regression. Particular designs of the latter type are constructed.

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California U. [Dept. of Mathematics] Los Angeles.

OPTIMUM DESIGNS FOR POLYNOMIAL EXTRAPOLATION, by P. G. Hoel. [1965] 11p. (AFOSR-66-0014) (AF AFOSR-63-459) AD 641679 Unclassified

Also published in Ann. Math. Stat., v. 36: 1483-1493, Oct. 1965.

The problem of choosing k + 1 points and assigning weights to them to obtain the minimum variance of an "interior extrapolated value of a polynomial of degree K" is solved.

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California U. - Dept. of Physics, Los Angeles.

RADIO-FREQUENCY BREAKDOWN IN A DC PARABOLIC POTENTIAL FIELD, by T. A. Karras and E. Lindman, Jr. [1965] [5]p. incl. diagrs. (AFOSR-65-1121) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-567 and National Aeronautics and Space Administration) AD 620485 Unclassified

Also published in Jour. Appl. Phys., v. 36: 18-22, Jan. 1965.

Electrons that are confined in a Penning discharge geometry by electric and magnetic fields are observed to gain energy from a superimposed rf field. By shaping the electrodes in the form of hyperboloids of revolution the prebreakdown motion can be accurately described by the Mathieu equation. Resonances are predicted when the frequency of the electron in the electrostatic well is a multiple of half the rf frequency. Between resonances the Mathieu equation predicts runaway energy gain at considerably higher values of the rf voltage, but breakdown is observed at values much lower than the prediction due to energy gain through collisions with gas atoms. The collision resets the phase of the motion and allows the electron to continually gain energy from the rf field. Breakdown curves calculated for the regions between resonances are found to agree with the experimental ones.

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California U. Dept. of Physics, Los Angeles.

FREQUENCY MODULATION OF LARGE CAVITIES, by K. B. Rajangam, F. Hai, and K. R. MacKenzie. [1965] [3]p. incl. diagrs. (AFOSR-65-2147) (AF AFOSR-64-567) AD 629025 Unclassified

Also published in Rev. Scient. Instr., v. 36: 794-796, June 1965.

A model study is described in which a rotating capacitor is coupled to a large re-entrant cavity. A nominal frequency range of 3 to 1 is achieved with a single-plate six-bladed rotor. On a possible full-scale cavity with a range of approximately 9 to 3 mc, the data are scaled to a voltage of 5 kv peak for rf power requirements of 1 to 4.4 kw. (Contractor's abstract, modified)

487

California U. [Dept. of Physics] Los Angeles.

EFFECT OF THE rf VOLTAGE ON THE PUMPING RATE OF AN ION SPUTTER PUMP (Abstract), by R. E. Rowberg and K. R. MacKenzie. [1965] [1]p. [AF AFOSR-64-567] Unclassified

Presented at meeting of the Amer. Phys. Soc., Columbia U., New York, June 23-25, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 598, June 23, 1965.

The electrodes of an ion sputter pump are constructed to conform to the requirements of an rf transfer discharge geometry. By applying rf and dc voltages simultaneously, an increase in pumping speed (1.5 at 5 x 10^{-5} Torr to 2 at 5 x 10^{-6} Torr) is observed over the rate with dc alone. The pump consists of 2 grounded Ti cathodes and a split stainless anode, all contained in a stainless chamber. At the operating frequency of 25 mc/sec and a field of 2 kG, the maximum effect is observed when the rf is 100 v and the dc is 4.7 kv.

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California U. [Dept. of Physics] Los Angeles.

MEASURED CHARACTERISTICS OF A PHOTOIONIZATION PLASMA SOURCE (Abstract), by J. Hyman, Jr. and K. R. MacKenzie. [1965] [1]p. [AF AFOSR-64-567] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 28-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 476. Apr. 26, 1965.

A high-energy photon beam emanating from a high-voltage spark discharge is transmitted through a low-pressure gas (P ~ 10^{-2} Torr) to create a column of ion pairs by quantum photoionization. The degree of ionization of the resulting plasma has been measured at $n_+/n_0 \sim 10^{-4}$. The ion number density ~ directly with the density of the gas being ionized. The plasma creation time is of the order of 5 μsec, after which the plasma column expands radially with a measured radial crest velocity of greater than 10^5 cm $(sec)^{-1}$. The plasma disperses by radial diffusion with an approximate e-folding time of 100 μ. The plasma potential and density, and the kinetic energy of the electrons emitted in the photoionization process are measured with plasma-probe

techniques at various radial positions and at various times after formation of the plasma. Results of measurements taken with both He and Ar are presented, along with a discussion of experimental techniques.

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California U. Dept. of Chemistry, Riverside.

THERMODYNAMICS OF THE LIQUID-LIQUID CRITICAL MIXING REGION, by H. H. Schmidt and J. Opdycke. Final rept. Mar. 1958-Dec. 1963. Feb. 1965, 38p. incl. diagrs. tables, refs. (AFOSR-64-1758) (AF 49-(638)284) AD 625455 Unclassified

An improvement was made upon the apparatus used for heat capacity measurements and the measurements were refined to the extent that they can now reasonably be expected to give data of the high order of precision required for crucial tests of theories. The bulk of the report is devoted to a description of the apparatus developed, the art involved in its operation, and the results obtained on 2 particular critical systems. An attempt was made to measure the partial vapor pressure and hence the fugacity of components in a liquid-liquid near-critical mixture as a function of composition.

490

California U. [Dept. of Mathematics] Riverside.

ON A NECESSARY AND SUFFICIENT CONDITION THAT AN INFINITELY DIVISIBLE DISTRIBUTION BE ABSOLUTELY CONTINUOUS, by H. G. Tucker. [1965] [16]p. incl. refs. (AFOSR-66-0204) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-328 and National Science Foundation) AD 632886 Unclassified

Also published in Trans. Amer. Math. Soc., v. 118, 316-330, June 1965.

The characteristic function f of an infinitely divisible distribution F is uniquely represented as $f(u) =$

$$\exp\left\{iyu - \sigma^2 u^2/2 + \int_{-\infty}^{\infty}\left(e^{iux} - 1 - \frac{iux}{1+x^2}\right) dM(x)\right\}$$

by the function M(x),

$$M(x) = \int_{-\infty}^{x} \frac{1+\tau^2}{\tau^2}\, dG(\tau) \qquad (x < 0),$$

$$= -\int_{x}^{\infty} \frac{1+\tau^2}{\tau^2}\, dG(\tau) \qquad (x > 0),$$

where $G(\tau)$ is the spectral function of the Lévy-Khinchin representation such that $\sigma^2 = G(+0) - G(-0) \geq 0$. The author presents some propositions on Lebesgue properties (absolute continuity, continuous singularity and discreteness) of F in terms of M-functions, and proves the following theorem: "A necessary and sufficient condition that F be absolutely continuous is that at least one of the following five conditions hold: (i) $\int_{-\infty}^{\infty} dM_{ac}(x) = \infty$; (ii) $\sigma^2 > 0$; (iii) $F^{(d)}$ is absolutely continuous; (iv) $F^{(cs)}$ is absolutely continuous; (v) $F^{(d)}$ is continuous singular, $F^{(cs)}$ is continuous but not absolutely continuous, and $F^{(d)} * F^{(cs)}$ is absolutely continuous", where M_{ac}, M_{cs}, and M_d are the absolutely continuous, the continuous singular, and the discrete components of M, respectively, and $F^{(i)}$ denotes the infinitely divisible distribution function produced by the M-function M_i, i = ac, cs, d. (Math. Rev. abstract, modified)

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California U. [Dept. of Mathematics] Riverside.

SETS OF UNIQUENESS ON THE GROUP 2^ω, by R. B. Crittenden and V. L. Shapiro. [1965] [15]p. incl. refs. (AFOSR-65-2131) [AF AFOSR-64-694] AD 630397 Unclassified

Also published in Ann. Math., v. 81: 550-564, May 1965.

One of the principal results of this paper is a uniqueness theorem for Walsh series, the analogue of the theorem of de la Vallée Poussin for trigonometrical series. Theorem 1: Suppose that the Walsh series $S(x) = \Sigma\, a_k \psi_k(x)$ converges, except possibly on a countable subset of [0, 1], to a finite function f(x) contained in $L^1[0,1]$. Then S(x) is the Walsh Fourier series of f(x). The result affirms a conjecture of Fine (Trans. Amer. Math. Soc., v. 65: 372-414, 1949). (Another proof of this theorem has been given previously by Arutjunjan and Talaljan (Izv. Akad. Nauk SSSR Ser. Mat., v. 28: 1391-1408, 1964) by an approach somewhat different from the one given in this paper.) Theorem 1 is a consequence of a more general uniqueness theorem for a class of formal character series for the group 2^ω, the countable product of cyclic groups of order 2. The set of Walsh functions $\{\psi_k(x)\}_{k=1}^{\infty}$ may be associated in a natural way with the set of continuous characters $\{\bar{\psi}_k(\bar{x})\}_{k=1}^{\infty}$ of 2^ω. A series $\bar{S}(\bar{x}) = \Sigma_{k=1}\, a_k \bar{\psi}_k(\bar{x})$ is said to be in the class $\mathcal{A}$ if the partial sums of order 2^n, $\bar{S}_{2^n}(\bar{x})$, satisfy the condition that $\lim_{n\to\infty} \bar{S}_{2^n}(\bar{x})/2^n = 0$ for each $\bar{x}$ in 2^ω. (Thus, for example, it may be shown that every series with coefficients tending to zero belongs to the class $\mathcal{A}$.) Theorem 2: A necessary and sufficient condition that a Borel set Z^* of Haar measure zero on G be a set of uniqueness for the class $\mathcal{A}$ is that Z^* be a countable set. Theorem 3: Let $Z^* \subset G$ be a countable set and $\bar{S}(\bar{x})$ be a series in the class $\mathcal{A}$. Suppose that (1) $\limsup_{n\to\infty} \bar{S}_{2^n}(\bar{x})$ is finite on $G - Z^*$, and (2) there exists a function $f(\bar{x})$ in $L^1(G)$ such that $\limsup_{n\to\infty} S_{2^n}(x) \geq f(\bar{x})$ on $G - Z^*$. Then $\bar{S}$ is the Fourier series of a function in $L^1(G)$. (Math. Rev. abstract)

492

California U. [Dept. of Mathematics] Riverside.

U (ε) SETS FOR WALSH SERIES, by V. L. Shapiro. [1965] 4p. (AFOSR-66-1195) [AF AFOSR-64-694] AD 641860 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 867-870, Oct. 1965.

Let ϵ_n be a monotonic sequence of positive numbers with limit zero, and φ_n the sequence of Walsh functions. The author shows that there exist sets E in [0, 1) of measure arbitrarily close to one, such that $\lim_{n\to\infty} \sum_{k=0}^{n} C_k \varphi_k(x) = 0$ for $x \in [0, 1) \setminus E$, with $|C_k| \leq \epsilon_k$, $k = 0, 1, \ldots$, implies $C_k = 0$, $k = 0, 1, \ldots$. (Math. Rev. abstract)

493

California U. Dept. of Physics, Riverside.

SPIN WAVE-SPIN WAVE SCATTERING IN A HEISENBERG FERROMAGNET, by R. G. Boyd and J. Callaway. Jan. 1965, 42p. (Technical rept. no. 3) (AFOSR-65-1185) (AF AFOSR-64-523) AD 613606 Unclassified

Also published in Phys. Rev., v. 138: A1621-A1629, June 14, 1965.

The scattering of one spin wave from another in a perfect simple cubic Heisenberg ferromagnet with nearest neighbor exchange is studied. Two spin waves interact through the portions of the Heisenberg exchange hamiltonian and the magnetic dipole-dipole hamiltonian which are non-diagonal with respect to the spin wave basis. The exchange and dipole interactions are considered separately, ignoring interference of the 2 scattering processes. Principal interest has been centered in the exchange interaction, for which an exact cross section can be derived. The dipole cross section in Born approximation is calculated for the purpose of comparing orders of magnitude. The part of the dipole interaction which changes the number of spin waves, processes not permitted by the exchange hamiltonian, are omitted. The Zeeman energy in an external field is omitted since it commutes with the Heisenberg exchange hamiltonian and the part of the dipole interaction considered; and hence is a constant of motion.

494

California U. [Dept. of Physics] Riverside.

MEASUREMENT OF OPTICAL ABSORPTION IN AN ELECTRIC FIELD, by L. M. Lambert. [1965] [4]p. incl. diagrs. (AFOSR-65-2535) [AF AFOSR-64-523] AD 627960 Unclassified

Also published in Phys. Rev., v. 138: A1569-A1572, May 31, 1965.

Optical absorption by semiconductors and insulators in electric fields has been of interest for several decades. Recently, Franz and Keldysh have independently presented theories which permit an estimation of the magnitude of effects observed. More recently, Callaway developed a more elaborate formulation which permits accurate computation of absorption coefficients. It is the purpose of this work to present the results of an investigation of Callaway's theory. Optical absorption in oriented single crystals of semi-insulating gallium arsenide was investigated over the temperature range 300 to 85 K using non-ohmic contacts and a synchronized pulse-train generator. The Cary 14R recording spectrophotometer was used with a spectral purity between 5 to 9A in the IR no. 1 mode of operation. The fields used varied between 1×10^4 and 1×10^5 v/cm. (Contractor's abstract)

495

California U. Dept. of Physics, Riverside.

OPTICAL ABSORPTION IN AN ELECTRIC FIELD IN SEMI-INSULATING GALLIUM ARSENIDE, by L. M. Lambert. [1965] [11]p. incl. illus. diagrs. refs. (AFOSR-65-2574) [AF AFOSR-64-523] AD 629150 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1409-1418, Sept. 1965.

Optical absorption by semiconductors and insulators in electric fields has been of interest for several decades. Recently, Franz and, independently, Keldysh have presented theories which permit an estimation of the magnitude of effects observed. More recently, Callaway developed a more elaborate formulation which permits accurate computation of absorption coefficients. It is the purpose of this work to present the results of an investigation of Callaway's theory. Optical absorption in oriented single crystals of semi-insulating gallium arsenide was investigated over the temperature range 300°K to 85°K using non-ohmic contacts and a synchronized pulse train generator. The Cary 14R recording spectrophotometer was used with a spectral purity between 5A to 9A in the IR no. 1 mode of operation. The fields used varied between 1×10^4 to 1×10^5 v/cm. (Contractor's abstract)

496

California U. Dept. of Physics, Riverside.

MULTIPLE-SCATTERING METHODS IN THE THEORY OF SOLIDS, by J. Callaway. [1965] [15]p. incl. refs. (AFOSR-65-2593) [AF AFOSR-64-523] AD 629151 Unclassified

Also published in Phys. Rev., v. 140: A818-A832, Oct. 18, 1965.

The formalism of solid-state scattering theory is applied to the construction of the t matrix for a pair of electrons interacting through a repulsive potential of finite range. Expressions for t are obtained in suitable limits for 3 cases: (1) a potential acting only at a single site and in a single band, (2) a potential acting at a single site but

connecting a pair of bonds, and (3) a potential acting in a single band but extending to first neighbors. The results are applied to the determination of an optical potential which can be used in a study of the range of excited electrons in metals, and to the determination of the ground-state energy of a low-density system. The ground-state energy is examined as a function of spin alignment, leading to the development of criteria for the occurrence of ferromagnetism in the low-density limit. It is shown that for repulsive, finite-range interactions, ferromagnetism does not occur for very low densities, whatever the band structure is. (Contractor's abstract)

497

California U. [Dept. of Mathamatics] Santa Barbara.

DIAGONAL PRODUCTS IN DOUBLY STOCHASTIC MATRICES, by M. Marcus and H. Minc. [1965] [5]p. (AFOSR-65-2341) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-432] and National Science Foundation) AD 629597 Unclassified

Also published in Quart. Jour. Math. (Oxford), v. 16: 32-34, Mar. 1965.

Earlier it was proven that, if A = (a i j) is a doubly stochastic n-square matrix with h eigenvalues of modulus 1, then $\max_{\sigma \in S_n} \sum_{i=1}^{n} a_{i\sigma(i)} \geq h$. This report deals with the proof of a product analogue of the above equation.

498

California U. [Dept. of Mathematics] Santa Barbara.

PERMANENTS, by M. Marcus and H. Minc. [1965] [15]p. incl. refs. (AFOSR-65-2350) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-698 and AF AFOSR-63-432, and National Science Foundation) AD 629817 Unclassified

Also published in Amer. Math. Monthly, v. 72: 577-591, June-July 1965.

This paper is concerned with a unified theory for the permanent function. The permanent function appears naturally in any combinatorial setting in which a count of the number of systems of distinct representatives of some configuration is required. For example, the permanent is the appropriate function for studying the classical problem of determining the total number of derangements of n distinct items. The permanent function is regarded herein as an analytic expression for the induced inner product in the symmetry class of completely symmetric tensors. Some of the major new results involving the function are obtained via this technique. Included in this paper is an extensive history of the development of the subject over the last 153 years.

499

California U. [Dept. of Mathematics] Santa Barbara.

A SUBDETERMINANT INEQUALITY, by M. Marcus and H. Minc. [1965] 4p. (AFOSR-66-0668) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-432 and National Science Foundation) AD 641554 Unclassified

Also published in Pacific Jour. Math., v. 15: 921-924, 1965.

Let A be an n-square positive semi-definite hermitian matrix and let $D_m(A)$ denote the maximum of all order m principal subdeterminants of A. The inequality $(D_m(A))^{1/m} \geq (D_{m+1}(A))^{1/(m+1)}$, $m = 1, \ldots, n-1$, is proven and the case of equality is discussed in detail. This result is closely related to Newton's and Szász's inequalities. (Contractor's abstract)

500

California U. [Dept. of Mathematics] Santa Barbara.

MATRIX RATIONAL COMPLETIONS SATISFYING GENERALIZED INCIDENCE EQUATIONS, by E. C. Johnsen. [1965] [12]p. (AFOSR-65-2069) [AF AFOSR-65-698] AD 627631 Unclassified

Presented at International Cong. of Mathematicians. Stockholm(Sweden), Aug. 18, 1962.

Also published in Canad. Jour. Math., v. 17: 1-12, 1965.

A generalization is made of former results for a v, k, λ configuration with incidence equation $AA^T = (k - \lambda) I + \lambda J = B$. For u's rational, $u = (u_1, u_2, \ldots, u_v)$, $uu^T = v$, define $B(u) = \lambda u^T + (k - \lambda)I$. $\mathfrak{B}$ denotes the class of all B(u). It is shown that all matrices in $\mathfrak{B}$, or none, are rationally congruent to the identity I, denoted $\mathfrak{B} \sim I$ or $\mathfrak{B} \sim I$.

501

California U. [Dept. of Mathematics] Santa Barbara.

MATRIX APPLICATIONS OF A QUADRATIC IDENTITY FOR DECOMPOSABLE SYMMETRIZED TENSORS, by M. Marcus. [1965] [5]p. (AFOSR-65-2100) (AF AFOSR-65-698) AD 630516 Unclassified

Also published in Bull. Amer Math. Soc., v. 71: 360-364, Mar. 1965.

Necessary relations are stated that prevail among coordinates of decomposable tensors in an arbitrary symmetry class of tensors. It is also indicated how these relations can be used to unify and extend a large class of matrix inequalities that includes as special cases the classical Hadamard, Schur, Fan, and Fischer results The main result relating two orthonormal bases in a symmetry class of tensors V_λ^m is as follows Let v_1, ...

v_n and $e_1, \ldots, e_n$ be two orthonormal bases in an n-dimensional unitary space V. Then for each $\omega \in \Delta$ and each t, $1 \leq t \leq n$, $\sum_{i=1}^{n} m_i(\omega)\,(e_i, v_t)^2 = \sum_{\nu \in \bar{\Delta}} m_{t(\nu)}$

$\frac{h}{\nu(\omega)} \left| e^{*}_{\omega}, \frac{h}{\nu(\gamma)} \right|^2 \nu_{\nu}^{*} \Big|^2$, where ω denotes a sequence $(\omega_1, \ldots, \omega_m)$, Δ is the set of all ω whose character χ is identically 1 on the subgroup H over which V_{λ}^{m} is defined, h is the order of H, $\nu(\omega)$ is the product of the factorials of the multiplicities of the distinct integers appearing in ω, and $m_i(\omega)$ denotes the multiplicity of occurrence of i in ω. The proofs are outlined.

502

California U. [Dept. of Mathematics] Santa Barbara.

GENERALIZED MATRIX FUNCTIONS, by M. Marcus and H. Minc. [1965] [16]p. (AFOSR-66-0199) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-432 and AF AFOSR-65-698, and National Science Foundation) AD 632887
Unclassified

Also published in Trans. Amer. Math. Soc., v. 116: 316-329, Apr. 1965.

Let H be a subgroup of the symmetric group S_m, and let χ be a character of H of degree 1, i.e., a homomorphism from H to the multiplicative group of non-zero complex numbers. Then $d_{\chi}(A) = \sum_{\sigma \in H} \chi(\sigma) \prod_{i=1}^{m} a_{i,\sigma(i)}$, while $A = (a_{ij})$ is an m x m matrix, defines a generalized matrix function. Examples: determinants and permanents H = S_m, $\chi \equiv 1$). The authors generalize the Cauchy-Binet theorem and other results in multilinear algebra from determinants to generalized matrix functions, and obtain various inequalities for $d_{\chi}(A)$. Their main result states that $|d_{\chi}(A)| \leq (1/m) \sum_{i=1}^{m} |r_i|^m$ if A is a normal m x m matrix with eigenvalues $r_1, \ldots, r_m$. (Math. Rev. abstract)

503

[California U. Dept. of Mathematics, Santa Barbara].

AN EXTENSION OF THE CLASS OF ALTERNATIVE RINGS, by D. L. Outcalt. [1965] [12]p. (AFOSR-66-0491) [AF AFOSR-65-698] AD 627943
Unclassified

Presented at the Amer. Math. Soc., Aug. 30, 1963.

Also published in Canad. Jour. Math., v. 17: 130-141, 1965.

Let R denote a non-associative ring of characteristic not 2 or 3 satisfying the identity (x, y, z) = (y, z, x) where the associator (a, b, c) is defined by (a, b, c) = (ab)c - a(bc). R is shown that if R is either simple or primitive, then R is a Cayley-Dickson algebra or associative; and if R is semi-simple, then R is a subdirect sum of Cayley-Dickson algebras and primitive, associative rings.

504

California U. [Dept. of Mathematics] Santa Barbara.

HARNACK'S AND WEYL'S INEQUALITIES, by M. Marcus. [1965] 4p. (AFOSR-66-0665) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-698 and National Science Foundation) AD 641074
Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 864-866, Oct. 1965.

This paper is concerned with extending the classical Harnack inequality by making it depend on the inequalities of Weyl, relating the singular values and the eigenvalues. The techniques for proving this result are fairly standard and depend on maintaining convex functions on the polyhedron of doubly stochastic matrices.

505

California U. [Dept. of Psychology] Santa Barbara.

PREVIOUS EXPERIENCE WITHIN THE DYAD AND COOPERATIVE GAME BEHAVIOR, by A. A. Harrison and C. G. McClintock. [1965] [5]p. incl. diagrs. tables. (AF 49(638)794)
Unclassified

Published in Jour. Personality and Social Psychol., v. 1: 671-675, June 1965.

The present study was an attempt to explain cooperation within the dyad in terms of reinforcement theory. Two groups of 10 dyads each received monetary gains while engaging in a cooperative reaction-time game; 2 similar groups were not rewarded, but sustained losses. Immediately following this reaction-time game, 1 of the rewarded groups and 1 of the nonrewarded groups played a series of 60 consecutive Prisoner's Dilemma games, a task in which one may either cooperate or compete. The other rewarded and nonrewarded groups of dyads returned after an interval of 1 wk. to participate in the Prisoner's Dilemma. A comparison of Ss who were rewarded during the reaction-time game with Ss who had no previous experience within the dyad indicated that the rewards received during the initial task increased the probability of a cooperative response during the Prisoner's Dilemma game, and that this effect persevered over time. The results also indicated that losses sustained during the reaction-time game did not increase or decrease the number of cooperative responses in the group tested immediately but did increase such responses in the group tested 1 wk later. (Contractor's abstract)

506

California U. [Dept. of Psychology] Santa Barbara.

SOME EFFECTS OF VARIATIONS IN OTHER STRATEGY UPON GAME BEHAVIOR, by C. G. McClintock, P. Gallo, and A. A. Harrison. [1965] [7]p. incl. diagr. tables. (AF 49(638)794) Unclassified

Published in Jour. Personality and Social Psychol., v. 1: 319-325, Apr. 1965.

Internationalist and isolationist Ss played a 2-part modification of the Prisoner's-Dilemma-type game. Though they did not know it, they were actually playing against E, rather than each other. In the 1st part of the experiment, Ss had little control over the payoff matrix. In the 2nd part, Ss had virtually total control over the payoffs. During the 1st part of the experiment, E played a "cooperative" strategy against 1/2 of the Ss and a "competitive" strategy against the other 1/2. The results indicated that neither the strategy played against Ss nor the personality of Ss influenced the number of cooperative choices. However, a significant 3-way interaction indicated that internationalists are more sensitive to changes in their opponents' strategies. (Contractor's abstract)

507

California U. [Dept. of Psychology] Santa Barbara.

AN EXPERIMENTAL AND CONCEPTUAL EXAMINATION OF SEVERAL ASPECTS OF INTERPERSONAL BEHAVIOR, by C. G. McClintock. Final rept. Jan. 1965, 119 p. incl. diagrs. tables, refs. (AFOSR-65-0311) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)794 and AF AFOSR-62-347) AD 611180 Unclassified

This report considered 6 major theoretical approaches to the study of small group behavior. They included leadership behavior, cohesiveness, risk-taking behavior, game playing behavior, and social psychological theory and research. Heterogeneity was discovered in the conceptual approaches, while there is an existence of some commonalities. The results indicated a tendency among all the hypotheses classified to use the same sized socila units for the independent and dependent variable of a given hypothesis. The independent and dependent levels of social processes were also found to be at similar levels. There was also a tendency to employ the individual more often as the acting social unit and as the level of social process on the dependent side of a hypothesized relationship. It was noted that the present analysis was based upon a sample of empirical studies selected to represent various conceptual and theoretical approaches to the study of small group behavior.

508

Cambridge Language Research Unit (Gt. Brit.).

A SEQUENTIAL LOGIC FOR INFORMATION STRUCTURING, by E. W. Bastin, A. F. Parker-Rhodes, and D. S. Linney. Final rept. May 1, 1965, 51p. incl. diagrs. tables. (AFOSR-65-1883) (AF EOAR-64-63) AD 625488 Unclassified

This study deals with the formulation of information systems whereby the binary hierarchical algebra utilized is consistent with current pure-mathematical publication standards. This formulation has been obtained and the resulting conclusions are presented in the papers bound in this report.

509

[Cambridge Language Research Unit (Gt. Brit.)]

MATHEMATICS OF A HIERARCHY OF BROUWERIAN OPERATIONS, by T. Bastin. [1965] 29p. (Bound with its AFOSR-65-1883, AD 625488) [AF EOAR-64-63] Unclassified

This paper develops an algebraic system in which a set of operations upon a second set of quantities can themselves be treated as operands for another set. The required algebraic system essentially has a hierarchical structure in respect to the operator/operand relationship.

510

[Cambridge Language Research Unit (Gt. Brit.)]

AN OPERATIONAL HIERARCHY, by A. F. Parker-Rhodes. [1965] 10p. incl. tables. (Bound with its AFOSR-65-1883, AD 625488) [AF EAOR-64-63] Unclassified

This paper describes an unusual algebraic structure, which arises in connection with the following problem. Consider an experimental situation without any means of investigating it except by performing a sequence of operations, each of which restricts the range of operations which can follow it, in such a way that the sequence eventually terminates. The problem is to find out what can be done about the whole class of situations thus characterized.

511

[Cambridge Language Research Unit (Gt. Brit.)]

THE THEORY OF THE YELLOW LINE, by D. S. Linney. Apr. 1965, 11p. incl. diagrs. (Bound with its AFOSR-65-1883, AD 625488) [AF EOAR-64-63] Unclassified

This report contributes to the logical aspect of the mathematics of binary hierarchical algebra. A system is proposed which presents the problem as the objective element and the solution as the subjective element.

512

Cambridge Language Research Unit (Gt. Brit.).

A CALCULUS FOR A BOOTSTRAP DYNAMICS, by E. W. Bastin. Jan. 1965, 30p. incl. diagrs. table. (AFOSR-66-0415) (AF EOAR-65-78) AD 637560
Unclassified

An outline and conceptual basis are presented for a calculus in which the elements are a finite set of similar entities capable of undergoing interactions, and the process of bringing 2 elements into consideration together constitutes a new element that is of the same kind as the original ones and is capable itself of being brought into consideration with the members of the first set. The elements form a hierarchy and under certain conditions can be simply ordered so that the sets are finite and their order calculable. The simple ordering is used to describe a bootstrap system for interactions between particles and to define the physical quantity of time. A relationship between levels in the hierarchy expresses the recursive nature of each decision by using the total possible number of decisions at each level as the algebraic basis for the set at the next more complex level. The system accounts for dynamic processes in terms of discrete interactions. Its non-formal expression is related to concepts of information transfer

513

Cambridge Language Research Unit (Gt. Brit.).

ESSENTIALLY FINITE CHAINS, by J. C. Amson and A. F. Parker-Rhodes. Sept. 13, 1965, 12p. incl. tables. (AFOSR-66-0423) (AF AFOSR-65-78) AD 637840
Unclassified

A sequence whose terms begin with a specific term (the originator) and whose subsequent terms are determined by a specific iteration procedure (the formulator) such that each inherits the structure of its precessor, is called a chain. Examples are given to clarify the meaning of "essentially." The paper examines a number of instances in which an essentially infinite chain becomes essentially finite, and gives the necessary conditions on the dimensionality of the originator for the chains to be essentially finite and specifies the number at which the chain terminates. Where G is a group and F is the process of selecting any proper subgroup of G, the modification to F seems largely independent of the nature of G, except that G should have finite dimension, which permits explication in a setting of finite abelian groups and their endomorphisms.

514

Cambridge U. Cavendish Lab. (Gt. Brit.).

GROWTH OF BURNING TO DETONATION IN LIQUIDS AND SOLIDS, by F. P. Bowden. Aug. 1965, 7p. (Rept. no. 7) (AFOSR-65-1269) (AF EOAR-64-18) AD 640138
Unclassified

Studies were made of the growth of reaction from initiation through burning to explosion in a homogeneous thin film of nitroglycerine which is enclosed between 2 flat solid surfaces and initiated at its center by an electric spark. Processes leading to fragmentation, deflagration and detonation were followed at μsec framing rates. This report illustrates the importance of habit imperfections in determining the sites at which deflagration starts. The theoretical work was concerned with studies of the explosion process from the viewpoint of thermal explosion theory, and covered initiation by hot spots of various geometries corresponding to initiation by light, hot wires, plates and spheres and the arrival.

515

Cambridge U. Cavendish Lab. (Gt. Brit.).

GROWTH OF BURNING TO DETONATION IN LIQUIDS AND SOLIDS, by F. P. Bowden. May 1965, 5p. (Rept. no. 6) (AFOSR-65-1774) (AF EOAR-64-18) AD 640137
Unclassified

A detailed investigation is being made of deflagration and grwoth to detonation in liquids and solids with special reference to the role of small discontinuities in promoting sensitivity, and the Deflagration, Detonation Transition. The various aspects of the work are discussed separately.

516

Cambridge U. Cavendish Lab. (Gt. Brit.).

CAVITIES AND MICRO MUNRO JETS IN LIQUIDS: THEIR ROLE IN EXPLOSIONS, by F. P. Bowden and M. P. McOnie. [1965] 4p. incl. illus. refs. (AFOSR-66-0116) [AF EOAR-65-24] AD 631103
Unclassified

Also published in Nature, v. 206: 380-383, Apr. 24, 1965.

Strong evidence supported the assumption that the initiation of explosion in liquids by impact or by shock is essentially a thermal process. A small region of the explosive was heated to a temperature at which fast reaction can occur. If the shock is very powerful, the compressive heating of the liquid itself may raise the temperature to a sufficient value. The shock pressure necessary for this may be very high. Pressures of this magnitude are reached in high velocity detonation and serve to sustain the reaction. For mechanical impact and moderate shocks, this is no longer true. It is necessary for some discontinuity, cavity or bubble to be present in the liquid so that the energy of the shock can be concentrated in this region and a localized hot spot can be formed. These discontinuities also influence the growth of explosion and its transformation to detonation. They may be present originally in the liquid or they may be formed by the initiating shock or by the developing explosion.

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Cambridge U. Cavendish Lab. (Gt. Brit.).

GROWTH OF BURNING TO DETONATION IN LIQUIDS

AND SOLIDS, by F. P. Bowden. Annual summary rept., no. 8, Nov. 1964-1965, 5p. (AFOSR-66-0406) (AF EOAR-65-24) AD 628915 Unclassified

A high-speed photographic study has been made of the initiation of explosive liquids (using sparks and impact) and of single crystals of explosive solids (using shock and hot wires). The physical homogeneity of the material has been shown to have a marked effect on its sensitivity. Studies of the fracture of inert solids has shown the importance of geometry on the fragmentation process. Various branches of classical explosion theory have been extended. (Contractor's abstract)

518

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

DISPERSION THEORY AND THE NUCLEAR MANY-BODY PROBLEMS, by C. D. Froggatt. [1965] [13]p. incl. diagrs. (AFOSR-65-1757) (AF EOAR-63-79) AD 626356 Unclassified

Also published in Nuclear Phys., v. 61: 303-315, Jan. 1965.

The Hartree self-consistency equations are derived as the non-relativistic, no-recoil limit of the dispersion analysis of nuclear electromagnetic form factors described by Eden and Goldstone. A class of internucleon potentials is found, for which the iterative solution of these equations is convergent and retains the essential analyticity properties of dispersion theory. (Contractor's abstract)

519

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

THE PROBLEM OF CAUSALITY IN S-MATRIX THEORY, by R. J. Eden and P. V. Landshoff. [1965] [21]p. incl. diagrs. refs. (AFOSR-65-1782) (AF EOAR 63-79) AD 625357 Unclassified

Also published in Ann. Phys., v. 31: 370-390, Feb. 1965.

The problem is considered of introducing space and time concepts into scattering theory with a view to stating a causality principle from which it may be possible to derive analytic properties of S-matrix elements. Problems are raised related to: (1) partial localization of interactions in space so that noninteracting terms can be separated out; (2) partial localization in time so that initial and final states can be separated and macroscopic time become meaningful; (3) the use of negative energy states in superpositions to form wave packets; (4) approximations to multiparticle S-matrix elements and their relevance to simple scattering processes, and limiting procedures that may relate experiments to the conventional S-matrix elements.

520

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

UNITARITY AND THE EVALUATION OF DISCONTINUITIES. III, by D. I. Olive. [1965] [24]p. incl. diagrs. refs. (AFOSR-65-1864) (AF EOAR-63-79) AD 626827 Unclassified

Also published in Nuovo Cimento, Series X, v. 37: 1422-1445, June 1965.

A discussion is presented which summarizes some of the evidence of the S-matrix theory scheme of singularity structure. A study is presented of the normal threshold model or approximation in which the normal thresholds are the only singularities considered. The internal consistency of the model is investigated by studying a discontinuity scheme for the model, its various properties, and its relation to the physical unitarity relations and crossing. The workings of the multiparticle unitarity equations are shown in their role of evaluating the total discontinuity.

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Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

AN ANTISYMMETRIC FORMULATION OF THE OPTICAL MODEL POTENTIAL AND THE EFFECT OF THE NUCLEAR FORCE RANGE, by F. J. Bloore. [1965] [13]p. incl. diagr. table, refs. (AFOSR-65-1865) (AF EOAR-63-79) AD 626104 Unclassified

Also published in Nuclear Phys., v. 66: 217-229, Apr.-May 1965.

It is at first sight plausible that the comparatively large range of the nucleon-nucleon force may considerably reduce the central strength of the real part U of the optical potential in light nuclei below the value obtained inside heavy nuclei. This effect is strongly exhibited in the prescription $U = \langle 0|V|0\rangle$ which arises from a formulation of the scattering problem which treats the incident particle as distinguishable. However, this prescription overestimates U by a factor 5. An antisymmetric formulation is presented which suggests a new non-local form for the potential U. In this formulation the factor 5 is removed. This non-local potential is discussed for infinite nuclear matter and for a finite nucleus. A local potential equivalent to the non-local potential for the finite nucleus is introduced by means of the Born approximation but the results are inconclusive. (Contractor's abstract)

522

Cambridge U. Dept of Applied Mathematics and Theoretical Physics (Gt. Brit.).

HIGH-ENERGY BEHAVIOR AT FIXED ANGLE FOR THE FIVE-POINT FUNCTION IN PERTURBATION

THEORY, by J. V. Greenman. [1965] [11]p. incl. diagrs. (AFOSR-65-1866) (AF EOAR-63-79) AD 626359 Unclassified

Also published in Jour. Math. Phys., v. 6: 660-670, Apr. 1965.

The validity of the d-line method used by Halliday in studying the high-energy behavior at fixed angle of the 4-point function is examined in detail. This is carried out within the context of determining the high-energy behavior at fixed angle for the 5-point function. The leading asymptotic behavior of the sum of all planar 5-point graphs in a Φ^3 theory at fixed angle is s^{-2}. (Contractor's abstract)

523

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

A MODEL REQUIRING LIE GROUP SYMMETRIES, by J. C. Polkinghorne. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-2183) (AF EOAR-63-79) AD 625358 Unclassified

Also published in Ann. Phys., v. 34: 153-160, Aug. 1965.

Cutkosky's model of vector mesons in mutual interaction is rediscussed and extended by the introduction of further particles. The dynamical picture used is one based on the generation of Regge poles in scattering amplitudes in perturbation theory. It is found that particles of spin less than one must belong to representations of the Lie group of which the vector mesons form the adjoint representation. It is also found that the strength of the interaction of the lower spin particles is determined by the strength of the mutual interaction of the vector mesons, at least in the approximation discussed. (Contractor's abstract)

524

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

ANALYTIC PROPERTIES OF PARTIAL-WAVE AMPLITUDES FOR PRODUCTION PROCESSES, by J. G. Cordes. [1965] [12]p. incl. diagrs. table. (AFOSR-65-2784) (AF EOAR-63-79) AD 629244 Unclassified

Also published in Nuovo Cimento, Series X, v. 39: 157-168, Sept. 1, 1965.

The singularities present on the physical sheet in a partial-wave projection of the 5-point function, due to normal thresholds in crossed channels, are determined. The problem of obtaining cut-plane analyticity in a single variable for the partial-wave amplitude is discussed.

525

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

SINGULARITIES AND DISCONTINUITIES OF THE TRIANGLE GRAPH, AS A FUNCTION OF INTERNAL MASS, by I. J. R. Aitchison and C. Kacser. [1965] 13p. incl. diagrs. refs. (AFOSR-66-0482) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-79 and National Science Foundation) AD 630519 Unclassified

The triangle graph for 3-body production or decay processes is considered as a function of an internal mass. The discontinuities of the graph with respect to this variable are of special importance, since they form the kernel of the integral equation which determines all rescattering effects due to competing 2-body final-state interactions. The main part of the kernel is given by one particular discontinuity, and this is recalculated here by dispersion methods which are basically well understood. The result agrees with that previously found by the use of Cutkosky's rules supplemented by some techniques of homology theory. It is gratifying that the result can be obtained by relatively straightforward methods: and that Cutkosky's rules can indeed be used for calculating the discontinuity in an internal mass variable. A by-product of the calculation is a prescription for calculating the discontinuity of the graph in a given channel from a single-variable representation of it in a crossed channel Applications to 3-particle processes are mentioned. (Contractor's abstract)

526

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

ON THE COMPLETE UNITARITY EQUATIONS FOR PION-PION SCATTERING, by M. M. Broido. [1965] 7p. incl. diagrs. refs. (AFOSR-66-0808) (AF EOAR-63-79) AD 639310 Unclassified

Also published in Jour. Math. Phys., v. 6: 1702-1708, Nov. 1965.

The off-the-mass-shell equations for pion-pion scattering in the lowest approximation of the complete unitarity formalism of Taylor are discussed. It is shown that if the vertex-function renormalization constant is taken to be zero, the equations have no (nonzero) solution. These equations are equivalent to certain bootstrap equations, which thus also have no solution. Both systems are discussed in the case where the renormalization constant is not put equal to zero. (Contractor's abstract)

527

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

HIGH-ENERGY BEHAVIOUR OF FEYNMAN AMPLITUDES, by B. Hamprecht. [1965] 19p. incl. diagrs. refs. (AFOSR-66-0809) (AF EOAR-63-79) AD 639312 Unclassified

Also published in Nuovo Cimento, Series X, v. 40: 542-559, Nov. 1965.

A method that is more general than existing ones is

developed for the determination of the coefficient of the leading term in the high-energy expansions of an arbitrary Feynman integral. Some of the discussion is restricted to the case of heavy bosons having a ϕ^3-interaction, but it can be generalized to cover other types of Feynman integrals as well. (Contractor's abstract)

528

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

MIXING OF REGGE POLES AND CUTS IN A FIELD-THEORY MODEL, by A. R. Swift. [1965] [10]p. incl. diagrs. refs. (AFOSR-66-0812) (AF EOAR-63-79)
AD 639318 Unclassified

Also published in Jour. Math. Phys., v. 6: 1472-1481, Oct. 1965.

The Regge poles generated by ladder diagrams in $\lambda\phi^3$ theory are mixed with the moving cuts generated by a class of nonplanar graphs containing an internal ladder. Since the contribution from the cut-generating diagram is of order $t^{-2}\ln mt$, where t is the asymptotic variable, the t^{-2} behavior of the pure ladder graphs is examined and the trajectory of the Regge pole near $l = -2$ is calculated. The Mellin transform method is used throughout. The transformed amplitude corresponding to a single cut insertion is given by a product of the form pole-cut-pole, where it is only the second Regge trajectory that mixes with the cut. The cut itself depends on the leading trajectory. This result substantiates the predictions as to form of other work based on unitarity, but differs in that the cut and pole depend on different trajectory functions. Finally, multiple insertions of the cut diagrams are shown to generate an amplitude with 2 moving poles on each sheet of the cut. (Contractor's abstract)

529

Cambridge U. [Dept. of Applied Mathematics and Theoretical Physics] (Gt. Brit.).

THREE PARTICLE SINGULARITIES IN SCATTERING AMPLITUDES, by D. Branson. [1965] [22]p. incl. diagrs. refs. (AFOSR-66-1491) (AF EOAR-63-79)
AD 639313 Unclassified

Also published in Ann. Phys., v. 35: 351-372, Dec. 1965

As a preliminary to a study of the 3 particle case, a detailed discussion is given, within the framework of the S-matrix postulates of unitarity and analyticity, of methods of defining "reduced" 2-particle scattering amplitudes that lack the 2-particle singularity; the extension to the multichannel case is briefly described. The same methods are used to remove one, 2-, and 3-particle physical threshold singularities from a 3-particle scattering amplitude. Using a causality argument, a derivation is given of the $i\epsilon$ prescription for all these singularities. (Contractor's abstract)

530

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

ON POLYNOMIAL SYSTEMS IN A BANACH RING, by J. G. Taylor. [1965] [4]p. (AF EOAR-63-79)
Unclassified

Published in Jour. Math. Phys., v. 6: 1148-1151, July 1965.

Equations on Banach rings (algebras) which are of polynomial form are defined and discussed. Proof is offered for a local uniqueness theorem for the homogeneous case, and an existence and local uniqueness theorem for the nonhomogeneous case. In order to apply these results to the equations of Lagrangian quantum field theory it is necessary to extend the concept of a ring to that of an n-ring. The resulting theory is applied to a simple model equation arising in quantum field theory. (Contractor's abstract)

531

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

A PROOF OF NAKANISHI'S INEQUALITY, by J. B. Boyling. [1965] [3]p. incl. diagr. (AF EOAR-63-79)
Unclassified

Published in Jour. Math. Phys., v. 6: 1469-1471, Oct. 1965.

Nakanishi's conjectured inequality for the coefficients of the external masses and invariants in the Feynman denominators for scattering processes is proved by a determinantal method suggested by the analogy between Feynman diagrams and electrical networks. (Contractor's abstract)

532

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

THE RELATION BETWEEN THE REAL PARTS OF THE NUCLEON AND THE DEUTERON OPTICAL POTENTIALS, by F. J. Bloore. [1965] [7]p. incl. diagrs (AF EOAR-63-79) Unclassified

Published in Nuclear Phys., v. 68: 298-304, June 1965

A relation is given between the real parts of the optical model potentials for nucleons and deuterons in infinite nuclear matter. These potentials are expressed in terms of the nucleon-nucleon potential using a formalism in which the identity of the constituent particles is taken into account in a properly antisymmetric way. It is confirmed that the potential experienced by a deuteron of incident energy E is almost twice the potential experienced by a nucleon of incident energy 1/2 E. When reasonable internucleon force parameters are used, the theoretical nucleon potential turns out to be rather too small (Contractor's abstract)

533

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

STRONG COUPLING CALCULATION FOR THE SCATTERING OF NEUTRONS BY CARBON, by F. J. Bloore and S. Brenner. [1965] [17]p. incl. diagrs. table, refs. (AF EOAR-63-79) Unclassified

Published in Nuclear Phys., v. 69: 320-336, July 1965.

The validity of the optical model and distorted wave approximation for the scattering of nucleons from a nucleus when the elastic and inelastic channels are strongly coupled is considered. The strong coupling method is applied to the scattering of 14-mev neutrons from carbon and the results show that the coupling terms affect the shapes of both the elastic and inelastic differential cross sections. No systematic search for a best fit was made as the complex potential used contains no spin-orbit term. A good fit to the data was obtained at forward angles and the results suggest that, with a spin-orbit term included, the method could yield satisfactory results at all angles. (Contractor's abstract)

534

Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

HIGH-ENERGY BEHAVIOUR OF PRODUCTION AMPLITUDES IN PERTURBATION THEORY, by J. C. Polkinghorne. [1965] [9]p. incl. diagrs. (AFOSR-65-1846) (AF EOAR-65-36) AD 626108 Unclassified

Also published in Nuovo Cimento, Series X, v. 36: 857-865, Apr. 1965.

A unified method for extracting the high energy behavior of production amplitudes in perturbation theory is developed with the aid of Mellin transforms. A wide range of limits is evaluated including that possible in the physical region. Although the remaining limits are not physically realizable they are important because they would determine subtraction procedures in an eventual dispersion theory of production processes.

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[Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.)]

THE FROISSART-GRIBOV CONTINUATION AND REGGEON UNITARITY CONDITIONS. I, by J. C. Polkinghorne. [1965] [7]p. incl. diagrs. refs. (AF EOAR-65-36) Unclassified

Published in Jour. Math. Phys., v. 6: 1960-1966, Dec. 1965.

An identity is derived which is useful in the discussion of unitary integrals. It is used to discuss single Regge pole insertions in the Froissart-Gribov continuation and with the help of perturbation-theory models a derivation is given of reggeon unitarity conditions. The general form suggested by Gribov, Pomeranchuk, and Ter-Martirosyan is confirmed. Finally cancellation mechanisms are discussed and their relation to the mechanism generating Regge poles is emphasized. (Contractor's abstract)

536

Cambridge U. Dept. of Zoology (Gt. Brit.).

BIOLOGICAL CLOCKS AND THEIR INTERACTION IN INSECTS, by J. Harker. Final rept. Nov. 1, 1965 [35]p. incl. illus. diagrs. tables, refs. (AFOSR-66-1478) (AF EOAR-64-14) AD 635770 Unclassified

The research described in this report falls into four sections: (a) Histological investigations into the activity of the neurosecretory cells in the cockroach suboesophageal ganglion show that no clear changes occur in the stainable secretory material in these cells to parallel the animal's circadian locomotor activity cycle. The nuclei of some of these cells showed a possible circadian cycle of change in volume. (b) A method of bioassaying pharmacologically active extracts of cockroach tissues was set up. After initial trials it was considered that the necessary further development of the apparatus was not warranted. (c) Operations on the nervous system of cockroaches confirmed that the clock mechanism controlling the activity cycle could function without direct nervous connection between the sub-oesophageal ganglion and the corpora cardiaca. (d) The rate of development of Drosophila pupae is affected by factors following a circadian rhythm. The form of the rhythm is determined by both light-on and light-off signals, but the timing of the rhythm is determined by the two signals acting independently of each other. The circadian rhythm of eclosion of Drosophila cultures is shown to be the result of the summation of different individual rhythms of development at earlier stages. (Contractor's abstract)

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Canterbury U. [Dept. of Chemistry] Christchurch (New Zealand).

GAS PHASE REACTIONS, by L. F. Phillips. [Final rept.] Mar. 1965, 3p. (AFOSR-65-0676) (AF AFOSR-6, 264) AD 615176 Unclassified

Study is made of selected gas-phase reactions of atoms, ions, and simple molecules and radicals, with particular reference to the chemistry of the upper atmosphere. Both photometric and mass-spectrometric investigations include the photo-dissociation of thallium iodide by recombining nitrogen atoms, the excitation of lead atoms by recombining H and OH, and the excitation of thallium atoms by recombining H atoms. The mass-spectrometric work includes kinetic studies of ion-molecule reactions in flames and of atom reactions involving carbon-compound species (such as methane) which are present in the upper atmosphere, and also electron impact studies of short-lived species

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Canterbury U. Dept. of Chemistry, Christchurch (New Zealand).

THE LIFETIME OF THE A. $^3\Sigma^+_u$ STATE OF N_2, by L. F. Phillips. [1965] [6]p. incl. diagrs. table, refs. (AFOSR-65-1440) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-264 and the New Zealand Research Comm.) AD 622738 Unclassified

Also published in Canad. Jour. Chem., v. 43: 369-374, Feb. 1965.

The decay of the blue emission from the active nitrogen-iodine flame has been measured at iodine pressures down to 1.4×10^{-4} torr. Extrapolation of the decay rate to zero iodine pressure yields a value of 0.89 ± 0.41 s^{-1} for the first-order rate constant in absence of iodine, corresponding to a mean lifetime of 1.1 s for the A. $^3\Sigma^+_u$ state of N_2. The rate constants for the reactions $N + I_2 \rightarrow NI + I$ and $N_2(^3\Sigma^+_u) + I_2 \rightarrow N_2(^1\Sigma^+_g) + I_2^*$ are $(2.6 \pm 0.3) \times 10^{-14} \exp(-68 \pm 34/RT)$ and $(8.3 \pm 1.2) \times 10^{-14}$ cm^3 $molecule^{-1}$ s^{-1} respectively. (Contractor's abstract)

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Canterbury U. Dept. of Chemistry, Christchurch (New Zealand).

MASS-SPECTROMETRIC STUDIES OF ATOMIC REACTIONS. V. THE REACTION OF NITROGEN ATOMS WITH NO_2, by L. F. Phillips and H. I. Schiff. [1965] [4]p. incl. tables. (AFOSR-65-2383) (AF AFOSR-63-264) AD 629665 Unclassified

Also published in Jour. Chem. Phys., v. 42: 3171-3174, May 1, 1965.

The reaction of N atoms with NO_2 was studied in a fast flow system, using a mass spectrometer to monitor the composition of the reaction mixture. The rate constant for removal of NO_2 by N was found. By a combined mass-spectrometric and photometric method the relative contributions of the different primary reactions were determined as follows (errors shown are standard deviations): $N + NO_2 \rightarrow N_2O + O$ (0.43 ± 0.04), $N + NO_2 \rightarrow 2NO$ (0.33 ± 0.07), $N + NO_2 \rightarrow N_2 + O_2$ (0.16 ± 0.12), $N + NO_2 \rightarrow N_2 + 2O$ (0.13 ± 0.11).

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Canterbury U. Dept. of Chemistry, Christchurch (New Zealand).

DIRECT OBSERVATION OF $A^3\Sigma^+_u$ NITROGEN MOLECULES IN THE N-I_2 FLAME, by D. I. Walton, M. J. McEwan, and L. F. Phillips. [1965] 2p. (AFOSR-66-0590) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-264 and New Zealand Research Comm.) AD 632773 Unclassified

Also published in Canad. Jour. Chem., v. 43: 3095-3096, Nov. 1965.

The reaction of active nitrogen with iodine produces an energetic metastable species. In this paper, direct evidence that this species is the A-state triplet sigma nitrogen molecule obtained by observing absorption of the nitrogen first positive bands by the reaction flame.

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Canterbury U. Dept. of Chemistry, Christchurch (New Zealand).

USE OF THE Li-LiOH METHOD FOR MEASURING THE CONCENTRATION OF HYDROGEN IN LOW-TEMPERATURE FLAMES, by M. J. McEwan and L. F. Phillips. [1965] [2]p. incl. table. (AFOSR-66-1016) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-264 and New Zealand Research Comm.) AD 635444 Unclassified

Also published in Combustion and Flame, v. 9: 420-421, Dec. 1965.

The concentration of H atoms in flames has been measured with an accuracy of 5 to 10%. The method is based on the equilibrium between H atoms and LiOH. The proportion of free Li in the flame is measured by atomic absorption, rather than emission, in order to obtain good results even in flames cooler than 1600°K. Values of the equilibrium constant are listed for various temperatures.

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Carnegie Inst. of Tech. [Dept. of Computer Science] Pittsburgh, Pa.

SYNTAX ANALYSIS BY A PRODUCTION LANGUAGE, by A. Evans, Jr. 1965, 159p. incl. tables, refs. (AFOSR-67-0254) (SD-146) AD 625465 Unclassified

Proofs that 2 specific translation algorithms operate correctly are presented. Suggestions are given for the application of the techniques developed to translation algorithms considerably more complex than those given.

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Carnegie Inst. of Tech. [Dept. of Computer Science] Pittsburgh, Pa.

DESIGN OF THE G-21 MULTI-PROCESSOR SYSTEM, by J. T. Quatse. [1965] [34]p. incl. diagrs. (AFOSR-67-0257) (SD-146) AD 804037 Unclassified

During the summer of 1963, a multi-processor version of the CDC (Control Data Corp.) G-20 (the G-21) was developed for the Computation Center of Carnegie

Institute of Technology. The purpose was to double the memory capacity and processing speed of the existing G-20 system. Since then, the system has continued to evolve as the needs of the Computation Center continue to grow. The purpose of this paper is to describe the memory control electronics which underlie memory time-sharing. The important related engineering problems are discussed in the terms of the current G-21 system.

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Carnegie Inst. of Tech. [Dept. of Computer Science] Pittsburgh, Pa.

SOME STUDIES IN GAME PLAYING WITH A DIGITAL COMPUTER, by T. G. Williams. July 1965 [131]p. incl. diagrs. tables. (AFOSR-67-0258) (SD-146) AD 634821 Unclassified

The program described in this dissertation is designed to play a large number of common board and card games. To play a game in this system, it is necessary to describe the objects used in playing the game and the rules of the game to the system. Each object used in the game is represented by a symbol. The properties of that object are kept on a property list associated with that symbol. The rules of the game are represented by a sequence of "if-then" statements. Each situation and each action is described in terms of a primitive function of the system. This system contains a fairly efficient general searching routine which will perform most of the searching necessary for any of the common board games. This routine contains some useful automatic methods for using the results of past searches to reduce the amount of searching actually done. An analysis of the concepts needed to play various classes of games shows that only a few fundamental abilities are needed to play most of the common games. These abilities are included in the system. (Contractor's abstract, modified)

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[Carnegie Inst. of Tech. Dept. of Computer Science, Pittsburgh, Pa.]

SOL-20, by G. J. Hansen. Apr. 1965 [47]p. (AFOSR-67-2516) (SD-146) AD 660885 Unclassified

This manual is a supplement to the original article A FORMAL DEFINITION OF SOL by Knuth and McNeley. The version of SOL described here, known as SOL-20, was implemented by procedures written in Algol-20 and G-20 machine languages. It is the purpose of this documentation to describe in detail exact differences and changes in syntax between SOL and SOL-20. With some limitations, the full power of ALGOL-20 (the local Carnegie-Mellon University version of the international language ALGOL-60) is available for programming in SOL-20. A SOL-20 program is written using SOL-20 system procedures which implement SOL declarations, expressions, relations and statements

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Carnegie Inst. of Tech. [Dept. of Computer Science] Pittsburgh, Pa.

PARAMETER IDENTIFICATION IN CONTINUOUS DYNAMIC SYSTEMS, by A. Lavi and J. C. Strauss. [1965] [13]p. incl. tables, refs. (SD-146) Unclassified

Presented at Symposium on Automatic Control; Systems Science, Cybernetics; Human Factors, New York, Mar. 22-26, 1965.

Published in IEEE Internat'l. Conv. Rec., Pt. 6, 49-61, 1965.

A practical computational procedure is developed for the identification of the unknown stationary parameters in a nonlinear differential equation model of a continuous dynamic system. This procedure employs the quasilinearization technique of Bellman and Kalaba to reduce the implicit nonlinear multipoint boundary value problem to a convergent sequence of linear problems. A solution is presented for the resulting linear multipoint boundary value problem which employs multiple linear regression to suppress data noise and alleviate uniqueness difficulties. An example of the application of the identification procedure to the nonlinear pendulum equation is presented and discussed. In addition, an appendix is included which states and proves several basic theorems on the convergence properties of the quasilinearization technique.

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Carnegie Inst. of Tech. [Dept. of Mathematics] Pittsburgh, Pa.

UNIFORMLY NON-$1_n^{(1)}$ ORLICZ SPACES, by K. Sundaresan. [1965] [8]p. (AFOSR-66-2024) (AF AFOSR-62-414) AD 643056 Unclassified

Also published in Israel Jour. Math., v. 3: 139-146, Sept. 1965.

A characterization of uniformly non-$1_n^{(1)}$ Orlicz space is obtained intrinsically in terms of the Young function determining the Orlicz space. It is shown that a uniformly non-$1_n^{(1)}$ Orlicz space is reflexive. (Contractor's abstract)

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Carnegie Inst. of Tech. Dept. of Mathematics, Pittsburgh, Pa.

A DIFFERENTIAL INEQUALITY, by Z. Nehari. [1965] [6]p. (AFOSR-65-2152) (AF AFOSR-64-647) AD 629866 Unclassified

Also published in Jour. D'Anal. Math., v. 14: 297-302, 1965.

The purpose of this report is to prove the following result. Let $u = u(x_1, \ldots, x_n)$ have three continuous derivatives for $r < R, r^2 = x_1^2 + \ldots + x_n^2, r \geq 0$), and let $n(\text{grad } u, \text{grad } \Delta u) + (\Delta u)^2 \geq 0$ and $-u\Delta u \leq c < \infty$, where Δ denotes the n-dimensional Laplace operator. If S_ρ denotes the n-sphere of radius ρ about the origin, A_ρ its area and dS_ρ its surface element then

$$\frac{nu^2(0)}{R^2} + (\text{grad } u)^2_{r=c} \leq c + \frac{n}{R^2 A_1} \int_{S_1} u^2(R)dS_1.$$

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Carnegie Inst. of Tech. [Dept. of Mathematics] Pittsburgh, Pa.

NON-OSCILLATION CRITERIA FOR N-TH ORDER LINEAR DIFFERENTIAL EQUATIONS, by Z. Nehari. [1965] [9]p. (AFOSR-66-0722) (AF AFOSR-64-647) AD 632330 Unclassified

Also published in Duke Math. Jour., v. 32: 607-616, Dec. 1965.

This report deals with proof of the differential equation $Ly + \rho(x)y = 0$ where we get a positive result for its solutions where there is no infinity of zeros in $(0, \infty)$. Such a result make the equation non-oscillatory.

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Carnegie Inst. of Tech. [Dept. of Mathematics] Pittsburgh, Pa.

LOW FREQUENCY ACOUSTIC OSCILLATIONS, by R. C. MacCamy. [1965] 8p. (AFOSR-66-2138) (AF AFOSR-64-547) AD 642976 Unclassified

Also published in Quart. Appl. Math., v. 23: 247-255. Oct. 1965.

The paper concerns interior and exterior Dirichlet and Neumann problems in the plane for the equation $\Delta u + k^2 u = 0$, (E). The solution to the equation corresponds to low frequency oscillations. Many of the resulting problems can be solved explicitly using conformal mapping.

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Carnegie Inst. of Tech. [Dept. of Mathematics] Pittsburgh, Pa.

RESULTS FOR A QUASI-LINEAR HYPERBOLIC EQUATION, by R. C. MacCamy and V. J. Mizel [1965] 2p. (AFOSR-66-2154) (AF AFOSR-64-647) AD 643151 Unclassified

Also published in Proc. Symposium Appl. Math., v. 17: 90, 1965.

The following main results are obtained from solutions of the equation (E) $u_{++} = C^2(u_x) U_{xx}$ on the semi-infinite strip S. Whenever the inequality (I) $\max_{0 \leq x \leq L} |f(x)| < \int_0^\infty C(\xi)d\xi$ holds, (E) has no smooth (C^2) solution satisfying (A), (B), (C) and defined on all of S. In particular (E) unlike $u_{tt} = u_{xx}$ has no smooth periodic solution satisfying (A), (B), (C) and (2) whenever (I) is violated there exists on certain subregions of S a unique smooth stable solution of (E) satisfying (A), (B), (C).

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Carnegie Inst. of Tech. [Dept. of Mathematics] Pittsburgh, Pa.

PAIRS OF CARLEMAN-TYPE INTEGRAL EQUATIONS, by R. C. MacCamy. [1965] 5p. (AFOSR-66-2196) [AF AFOSR-64-647] AD 643431 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16. 871-875, Oct. 1965.

This note concerns systems of equations of the type

$$f(x) = \frac{a(x)}{\pi} \int_{-1}^{+1} f(t)(x-t)^{-1} dt - g(x), \quad |x| < 1.$$ The integral is the Cauchy principal value. Assume that $g(x)$ is analytic for x in a region R containing the line segment $\text{Im}X=0$, $-1 \leq x \leq +1$. The idea is illustrated by confining the problem to 2 equations and to the case of a constant matrix a. Let H denote the class of vector-valued functions $f = (f_1, f_2)$ such that the f_i are Holder continuous on $-1 < x < +1$ and satisfy, $f_1(x) = 0(1 \mp x)^{-1+E}$ as $x \to \pm 1$ for some $E > 0$. The main theorem states that: (1) if $\det(I-ia) \neq 0$ the system of singular equations possess a solution $f \in H$. (2) If $\det(I-ia) = 0$ the system of singular equations possess no solution unless $f \cdot g = 0$.

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Carnegie Inst. of Tech. [Dept. of Mathematics] Pittsburgh, Pa.

MIXED BOUNDARY-VALUE PROBLEMS IN THE PLANE, by J. A. Voytuk and R. C. MacCamy [1965] 4p. (AFOSR-66-2218) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-647 and National Science Foundation) AD 643429 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 276-280, Apr. 1965.

This note presents an existence theorem based on integral equations. The method is an extension of the solution of the Dirichlet problem by simple layers.

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Carnegie Inst. of Tech. [Dept. of Physics] Pittsburgh, Pa.

DECAY OF Cs^{129} (Abstract), by J. L. Power, S. Jha, and B. Paliniak. [1965] [1]p. [AF AFOSR-63-278] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 441, Apr. 26, 1965.

The decay of 31-h Cs^{129}, made by (α, 2n) on beryllium iodide and subsequent chemical separation, has been studied by a γ-ray spectrometer, a coincidence scintillation spectrometer, and a Ge(Li) spectrometer. The following γ-rays have been detected: 40, 92, 174, 280, 320, 370, 410, 540, 580, 910, and 950 kev and perhaps also 620, 680, 740, 780, 820, and 865 kev (complex). These values of the γ-ray energies, combined with the results of coincidence studies, suggest levels in Xe^{129} at 320, 410, 580, 950 kev and perhaps also at 660, 780, and 860 kev. The ratio of the intensities of the 370- and 410-kev γ-rays have been estimated to be about 1.7. The results of the measurement of the conversion coefficient of the γ-rays and that of lifetime measurement of the 410-kev state, now in progress, are discussed.

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Carnegie Inst. of Tech. [Dept. of Physics] Pittsburgh, Pa.

DECAY OF I^{133} (Abstract), by S. Johnston and B. Patnaik. [1965] [1]p. [AF AFOSR-63-278] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 441, Apr. 26, 1965.

The radiations of 21-h I^{133} have been studied with the help of a γ-ray spectrometer, a coincidence scintillation spectrometer, and a Ge(Li) spectrometer. γ-Rays having energies of 530, 620, 710, 860, 1050, 1240, and 1300 kev have been detected. In coincidence with electrons of energy greater than 980-kev, 530- and 670-kev γ-rays were detected. γ-Rays of energies 530, 670, 860, and 1240 kev were observed in coincidence with electrons having an energy greater than 600 kev. These, results and the results of γ-γ coincidence studies tentatively suggest levels in Xe^{133} at 530, 680, 1240, 1390, and 1580. A decay scheme, based on these results and studies in progress is presented.

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Carnegie Inst. of Tech. [Dept. of Physics] Pittsburgh, Pa.

DECAY OF La^{132} (Abstract), by G. Julian and S. Jha. [1965] [1]p. [AF AFOSR-63-278] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 82-83, Jan. 27, 1965.

4.5-h La^{132} has been made by the (p, xn) reaction on natural Ba with about 100-mev protons and the chemical separation of La from the Ba target. The radiations from La^{132} have been studied with Li-doped germanium detector and NaI(Tl) scintillation detectors. The positron spectrum was found to have an end point of 3.5 mev. The following γ-rays were detected: 470, 570, 660, 870, 1040, 1220, 1600, 1920, 2120, 2450, 2680, and 3000 kev. In coincidence with the positrons of energy greater than 2 mev, γ-rays having the energy 470, 570, 680, 820, and 1040 kev were observed. In coincidence with the 470-kev γ-ray, 570-, 660-, 890-, 1020-, 1230-, 1660-, and 2000-kev γ-rays were observed. 470- and 890-kev γ-rays were observed in coincidence with the 660-kev γ-ray. A decay scheme is presented.

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Carnegie Inst. of Tech. [Dept. of Physics] Pittsburgh, Pa.

INELASTIC α-PARTICLE SCATTERING STUDIES OF EVEN-EVEN Se ISOTOPES (Abstract), by R. W. Bercaw, J. S. Vincent, and S. Jha. [1965] [1]p. [AF AFOSR-63-278] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 541, Apr. 26, 1965.

The inelastic scattering of 42.0-mev α particles by the isotopes of selenium, 76, 78, 80, and 82, has been measured with 100-kev over-all energy resolution by means of silicon detectors. The energies of the 1st excited state of Se^{76}, Se^{78}, and Se^{80} were found to be in good agreement with earliest measurements by (p, p'), Coulomb excitation, and other measurements. In Se^{82}, the 1st excited state was found at 0.65 ± 0.05 mev in disagreement with the earlier Coulomb-excitation measurement. The Blair phase relation supports the 2^+ assignment for these levels in all these isotopes. A strong inelastic peak whose diffraction patterns is in phase with the elastic group was found in these isotopes at 2.45, 2.55, 2.70 and 3.05 mev, respectively, indicating that these levels are of the 1st octupole vibrational type.

558

Carnegie Inst. of Tech. Metals Research Lab., Pittsburgh, Pa.

OPTICAL PROPERTIES OF METALS AND ALLOYS, by W. R. Bitler. Final rept. Aug. 4, 1965 [57]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1843) (AF 49-(638)478) AD 625371 Unclassified

The object of this investigation was to determine the optical absorption coefficients of Cu, Ni, and a series of Cu-Ni alloys. Technical difficulties were encountered in analyzing the samples for thickness and composition by the x-ray fluorescence method. These difficulties were resolved by the following changes in procedure. flash evaporation permitting the evaporation of previously prepared alloys of known composition, epitaxial deposition on halide substrates, and subsequent

examination by electron diffraction and transmission microscopy. Three separate papers giving detailed descriptions of the work are attached.

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Case Inst. of Tech. Dept. of Chemistry, Cleveland, Ohio.

DICHLORO(PHTHALOCYANINO)SILICON, by M. K. Lowery, A. J. Starshak and others. [1965] [1]p. (AFOSR-65-0370) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)773, National Science Foundation, and Office of Naval Research) Unclassified

Also published in Inorg. Chem., v. 4: 128, Jan. 1965.

This report gives 2 convenient syntheses for dichloro-(phthalocyanino)silicon, $PcSiCl_2$, based on the use of ortho-cyanobenzamide and 1,3-diminosoindoline. In addition, the techniques are given for the recrystallization of the $PcSiCl_2$ and its facile conversion to $PcSi(OH)_2$.

560

Case Inst. of Tech. [Dept. of Mathematics] Cleveland, Ohio.

ANALYSIS OF CATEGORICAL DATA, by G. E. Haynam and F. C. Leone. [1965] 7p. incl. diagrs. tables. (AFOSR-66-2671) [AF AFOSR-63-280] AD 644377 Unclassified

Presented at meeting of the Internat'l. Assoc. Statistics in the Physical Sciences, Berne (Switzerland), Sept. 16, 1964.

Also publisned in Biometrika, v. 52: 654-660, 1965.

The usual method of testing a hypothesis concerning categorical data is to compute a statistic T, which is distributed approximately as χ^2. Acceptance or rejection depends, of course, upon the critical value(s) of χ^2. The exact distribution of T under several different null hypotheses has been computed for both one-way and two-way classifications. These results have been compared with those obtained from the χ^2 approximation, in order to determine when the approximation is valid. Further, the exact power of the T test has been computed for a one-way classification with fixed alternatives. These results are compared with those obtained from a non-central χ^2 approximation. Comparison of true and approximate distributions under the null hypothesis have been made. This research attempted to enlarge the information available on the accuracy of approximations to the null and non-null distributions of T.

561

Case Inst of Tech. [Dept. of Mechanics] Cleveland, Ohio.

MELTING ABLATION ABOUT DECELERATING SPHERICAL BODIES, by S. Ostrach and D. C. McConnell. [1965] [22]p. incl. illus. diagrs. table, refs. (AFOSR-65-0924) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-194 and National Aeronautics and Space Administration) AD 617013 Unclassified

Presented at AIAA Second Aerospace Sciences Meeting, New York, N. Y., Jan. 25-27, 1965.

Also published in AIAA Jour., v. 3: 1883-1889, Oct. 1965.

The transient melting ablation of a glassy material is studied both analytically and experimentally. The purpose of the present investigation is to extend the analyses of Ostrach and coworkers by examining in more detail the initial period of melting, by re-examining the thermal boundary condition at the gas-liquid interface, and by considering a spherical body because of its relevance to the tektite problem; tektites are thought to have been spherical originally. Presented herein are a perturbation analysis, which starts from the initial state of conduction; and a long-time analysis, which starts from time-independent ablation. The results of these analyses are then compared with the results of experiments conducted in a vertical wind tunnel; the vertical wind tunnel makes possible the simulation of the deceleration force that acts upon a re-entry body. On the basis of this comparison, it is concluded that the analysis accurately predicts the salient features of the ablation process; and on the basis of experimental observation, a possible mode of melt-wave development is suggested. The paper concludes with comments upon the relationship of this work to the question of the origin of tektites. (Contractor's abstract)

562

Case Inst. of Tech. [Dept. of Mechanics] Cleveland, Ohio.

THE THERMAL STABILITY OF COMPLETELY CONFINED FLUIDS INCLUDING MAGNETOHYDRODYNAMIC EFFECTS, by M. Sherman and S. Ostrach. June 1965 [262]p. incl. diagrs. tables, refs. (AFOSR-65-1455) (AF AFOSR-65-194) AD 621523 Unclassified

The current research concerns the determination of the conditions needed to induce a state of convective motion in a fluid where a constant temperature gradient is directed parallel to a body force. The fluid is contained in a rather arbitrary region bounded by rigid walls. The principle of exchange of stability is established for arbitrary regions with a generalized thermal boundary condition on the bounding walls. The thermal stability problem is reduced to an eigenvalue problem for the critical Rayleigh number (the stability criterion) and then is reformulated as a variational principle. A method is developed for estimating upper and lower bounds to the critical Rayleigh number for regions in which the critical Rayleigh number cannot be calculated exactly. An extension of the thermal stability problem to include magnetohydrodynamic effects is presented. Here the fluid and the bounding walls are electrical conductors. A constant magnetic field is applied to the configuration. (Contractor's abstract, modified)

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Case Inst. of Tech. [Dept. of Mechanics] Cleveland, Ohio.

A STUDY OF CYCLONIC TWO-FLUID SEPARATION, by M. T. Lawler and S. Ostrach. June 1965 [138]p. incl. illus. diagrs. tables, refs. (Rept. no. FTAS-TR-65-2) (AFOSR-65-1523) (AF AFOSR-65-194) AD 621524 Unclassified

This study presents a consideration of some of the problems of a 2-phase flow theory in an effort to consider the problem of the separation of a 2-phase fluid mixture in a cyclone separator. A simplified model is proposed and estimates of the rate of discharge of the heavier component are obtained. The discharge mechanisms are discussed and the model indicates the importance of secondary flows in the heavy fluid discharge. It indicates that, at most, the secondary flows are only aided by gravity (not due solely to gravity, as it was previously thought). An experimental separator was designed and built. It was operated in an inverted position to indicate that the secondary flow could overcome an unfavorable body force. Tests were run on this cyclone when operating in a normal position to determine the effect of the variation of certain geometric factors and operating conditions on the flow and separation of a 2-phase mixture. Separation efficiency and pressure drop information is presented for a wide range of operating conditions and geometric configurations. (Contractor's abstract)

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Case Inst. of Tech. [Dept. of Mechanics] Cleveland, Ohio.

NATURAL CONVECTION IN A HORIZONTAL CYLINDER AT LARGE PRANDTL NUMBERS, by E. R. Menold and S. Ostrach. Nov. 1965 [187]p. incl. diagrs. tables, refs. (AFOSR-65-2239) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-194] and National Science Foundation) AD 475885 Unclassified

This work deals with the natural convection of a fluid confined within an infinite horizontal cylinder, at large Prandtl numbers and unit order Grasshof numbers. The fluid motion is generated by means of a cosine temperature distribution imposed circumferentially on the cylinder wall. An arbitrary phase angle is included in this distribution in order to investigate a variety of heating configurations ranging from the heated-from-the-side to the heated-from-below case. The governing equations are solved using a technique only recently applied to problems of this nature, known as the "modified Oseen linearization". The mathematical simplifications inherent in a large Prandtl number analysis make it possible to scrutinize carefully this technique, and both its simplifications and shortcomings are discussed. Key assumptions in the analysis are carefully examined and ambiguities appearing in earlier work are pointed out. An experimental investigation of natural convection phenomena in a viscous silicone oil confined in a horizontal cylinder is made, and the results are compared with theory. The experimental equipment was designed so that a cosine temperature distribution could be maintained on the cylinder wall.

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Case Inst. of Tech. Dept. of Physics, Cleveland, Ohio.

CYCLOTRON MASSES FOR THE THIRD ZONE SURFACE IN ALUMINUM, by C. O. Larson and W. L. Gordon. [1965] [3]p. incl. tables. (AFOSR-65-2550) (AF AFOSR-64-536) AD 629832 Unclassified

Also published in Phys. Ltrs., v. 15: 121-123, Mar. 1965.

Representative cyclotron masses and de Haas-van Alphen periods attributed to the third zone Fermi surface in aluminum were presented. The masses were obtained from the temperature dependence of the amplitude of the de Haas-van Alphen oscillations and, where comparison was possible, showed good agreement with cyclotron resonance measurements of other investigators.

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Case Inst. of Tech. [Dept. of Physics] Cleveland, Ohio.

MAGNETIC BREAKDOWN IN THE LONG DHVA PERIODS IN ZINC, by J. R. Lawson and W. L. Gordon. [1965] [5]p. incl. diagrs. (AFOSR-67-0434) [AF AFOSR-64-536] AD 647441 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Phys., Columbus, Ohio, (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9 (Pt. B): 854-858, 1965.

The effect of magnetic breakdown on the amplitude of the long period de Haas-van Alphen (DHVA) oscillations in zinc has been studied with a torque magnetometer in magnetic fields up to 10 kgauss and in the temperature range 4.2°K to 2°K.

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Case Inst. of Tech. [Dept. of Physics] Cleveland, Ohio.

THE FERMI SURFACE OF ALUMINUM AND DILUTE ALUMINUM-ZINC ALLOYS, by J. P. G. Shepherd, C. O. Larson and others. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-67-0435) [AF AFOSR-64-536] AD 647438 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Phys., Columbus, Ohio. (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Pre , v. LT9 (Pt. B): 752-758, 1965.

The third zone portion of the Fermi surface of aluminum and several dilute alloys was studied by de Haas-van Alphen (DHVA) method using a torque magnetometer.

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Case Inst. of Tech. [Dept. of Physics] Cleveland, Ohio.

OBSERVATION OF CYCLOTRON RESONANCE IN MAGNESIUM, by T. G. Eck and M. P. Shaw. [1965] [2]p. incl. diagrs. (AFOSR-67-0436) [AF AFOSR-64-536] AD 647439 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Phys., Columbus, Ohio, (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9 (Pt. B): 759-760, 1965.

Azbel-Kaner cyclotron resonances were observed at 24 Gcps and 2°K in a single crystal of magnesium with a residual resistance ratio of 8500. The normal to the specimen surface was within 1° of <10-10>. Three distinct subharmonic series were seen for most orientations of the magnetic field in the sample surface.

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Case Inst. of Tech. [Dept. of Physics] Cleveland, Ohio.

CYCLOTRON RESONANCE INVESTIGATION OF THE FERMI SURFACE OF CADMIUM, by M. P. Shaw and T. G. Eck. [1965] [4]p. incl. diagrs. (AFOSR-67-0437) [AF AFOSR-64-536] AD 647437 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Phys., Columbus, Ohio, (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9 (Pt. B): 761-764, 1965.

Azbel-Kaner cyclotron resonances at 24 GHz and 2 K have been studied in cadmium for magnetic field directions in the 3 principal crystallographic planes.

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Case Inst. of Tech. [Systems Research Center] Cleveland, Ohio.

SOME PROBLEMS OF FINITE REPRESENTABILITY, by E. Altman and R. Banerji. [1965] [13]p. incl. refs (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-125, and National Science Foundation) Unclassified

Also published in Inform. and Control, v. 8: 251-263, June 1965.

It has been pointed out that context-free grammars of a certain class have the property that a one-one mapping exists between the structural descriptions of its sentences and the sentences generated by a finite state grammar. Given a grammar, it is decidable whether it belongs to this specific class or not. The grammars of this class can be divided into a countable hierarchy of increasing complexity.

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Case Inst. of Tech. [Systems Research Center] Cleveland, Ohio.

TOWARDS A FORMAL LANGUAGE FOR DESCRIBING OBJECT CLASSES, by R. B. Banerji. [1965] 7p. (AFOSR-66-0420) (AF AFOSR-65-125) AD 632774 Unclassified

Also published in Proc. Second Congress on the Information System Science, Hot Springs, Va. (Nov. 22-25, 1964) Washington, Spartan Books, Inc., 1965, 451-457.

Progress is reported toward the development of a formal language for problem solving that is able to recognize analogies between different universes of discourse to make the description of classes in one universe succinct by the use of names of objects in another universe. The level of attainment in generating short descriptions of concepts by the combination of statements by Boolean operators alone is summarized. A language is described that was generated on the allowance of a few additional freedoms (like permitting objects to be terms) and the addition of variables to the language. The language permits the succinct description of a larger class of concepts and enables the description of the class of all numerals (e.g., in the ternary notation) within set-theoretic framework.

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Case Inst of Tech. [Systems Research Center] Cleveland, Ohio.

A SYNTHESIS TECHNIQUE FOR NETWORKS CONSISTING OF LOGICAL FUNCTIONS FEEDING A LINEAR SUMMATION ELEMENT, by E. L. Gose [1965] [3]p. incl. diagrs tables (AFOSR-65-1590) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-751 and National Institutes of Health) AD 623500 Unclassified

Also published in IEEE Trans Electron. Comput., v. EC-14 254-256, Apr 1965

Two synthesis techniques for a class of networks for producing real functions of binary inputs are considered, one in which the functions f_i are "ands" and the other in which they are exclusive "ors" The purpose of the present note is to present a synthesis technique which is more general than the 2 preceding techniques. It is valid for the realization of real, including Boolean, functions no matter what f_i are used. The output of the network is the weighted sum of 2^n functions f_i of the input vector $x = (x_1, x_2, \ldots, x_n)$. The network can be represented by $D = FW$ where D is the vector of output values, W is the vector of weights necessary for the realization of the function D, and F is the $2^n \times 2^n$ matrix of elements $f_i(x_j)$. A solution $W = F^{-1}D$ exists if F has an inverse, which it will if none of the functions f_i are linear combinations of the others. An example of the technique is presented.

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Case Inst. of Tech. [Systems Research Center] Cleveland, Ohio.

AN ADAPTIVE NETWORK FOR PRODUCING REAL FUNCTIONS OF BINARY INPUTS, by E. E. Gose. [1965] 14p. incl. diagrs. tables. (AFOSR-65-2686) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-751, Ford Foundation, and Office of Naval Research) AD 629836 Unclassified

Also published in Inform. and Control, v. 8: 111-123, Apr. 1965.

An adaptive network which can produce any real-valued function of its binary inputs is presented. The network can synthesize any boolean function as a special case. The appropriate values of the adjustable parameters may be calculated by the network itself, or they may be calculated by a simple linear operation. The parameters form a uniformly distributed memory for the input-output function. (Contractor's abstract)

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Catholic U. of America. [Dept. of Mathematics] Washington, D. C.

ON A LINEAR FORM WHOSE DISTRIBUTION IS IDENTICAL WITH THAT OF A MONOMIAL, by R. G. Laha and E. Lukacs. [1965] [8]p. (AFOSR-65-1963) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-437 and National Science Foundation) AD 626386 Unclassified

Also published in Pacific Jour. Math., v. 15: 207-214, 1965.

The following theorem is proved. Let $\{X_j\}$ be a finite or denumerable sequence of independently and identically distributed nondegenerate random variables and let $\{a_j\}$ be a sequence of real numbers such that the sum $\Sigma_j a_j X_j$ is distributed as αX_1 and (2) $\Sigma_j a_j^2 = \alpha^2$. Then the common distribution of the X_j is normal. The proof is constructed by considering a representation of ln g(t) where $g(t) = f(t) f(-t)$ and f(t) is the characteristic function corresponding to the common distribution of the random variable.

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Catholic U. of America. [Dept. of Mathematics] Washington, D. C.

ON LINEAR FORMS AND STOCHASTIC INTEGRALS, by R. G. Laha and E. Lukacs. [1965] [13]p. (AFOSR-67-1969) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-437 and National Institutes of Health) Unclassified

Also published in Bull. Inst. Internat'l. Stat., v. 41: 828-840, 1965.

The author proves that if $\{X_j\}$ is a finite or infinite sequence of equidistributed independent random variables with finite variance $\sigma^2 > 0$, $\{a_j\}$ is a sequence of reals such that $\Sigma a_j X_j$ exists, and $\alpha \neq 0$ is real, then $\Sigma a_j X_j$ and αX_1 are equidistributed if and only if the X_j are normal, $\Sigma a_j = \alpha$, and $\Sigma a_j^2 = \alpha^2$. A similar theorem is then established for second order random functions. (Math. Rev. abstract)

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Catholic U. of America. [Dept. of Physics] Washington, D. C.

APPLICATION OF THE METHOD OF TWO-TIME GREENS FUNCTION TO THE SPIN-1/2 HEISENBERG FERROMAGNET, by T. Moritz and T. Tanaka. [1965] [11]p. incl. refs. (AFOSR-65-1118) (AF AFOSR-63-445) AD 620831 Unclassified

Also published in Phys. Rev., v. 137: A648-A658, Jan. 18, 1965.

The temperature dependence of spontaneous magnetization at low temperature is studied by treatment of the higher order Green's function. The equation of motion for this higher order function is solved in the approximation which will lead to correct results up to terms of order T^3. It is found that the correction to the magnetization consists of a term of order T^4 and a divergent term and that the correlation function consists of a term of order T^3 and a divergent term. A method extracting a significant part from this divergent term is found by analyzing a system of 2 interacting 1/2 spins. By this method, it is shown that the T^3 term in the magnetization is completely eliminated and that the correlation function $\langle S_j^- - S_j^- - S_k^+ S_1^+ \rangle$ vanishes identically.

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Catholic U. of America [Dept. of Physics] Washington, D. C.

STATISTICAL MECHANICS OF AN ASSEMBLY OF QUASIPARTICLES, by T. Morita and T. Tanaka. [1965] [9]p. incl. refs. (AFOSR-65-2780) (AF AFOSR-63-445) AD 629616 Unclassified

Also published in Phys. Rev., v. 138: A1088-A1096, May 17, 1965.

Low-lying excitations in a liquid or a solid are considered to have a long lifetime and to obey the Bose or Fermi statistics. They will be called 'quasiparticles' in general. The low-lying energy levels of the system are considered to be characterized by a set of occupation numbers of the quasiparticles. The expressions for the grand partition function and the distribution function (the average occupation number) of the quasiparticles have the same structure as that for the classical lattice gas, under a nonuniform external field and with two-, three,..., body interactions. Therefore the virial expansion formula for the classical lattice gas

can be applied to the system of quasiparticles. The resulting expression for the distribution function of the quasiparticles is either a Fermi or a Bose distribution function with an effective energy. The expression for the entropy in terms of the distribution function is the same as that for an ideal gas. This shows that Landau's formula for the distribution function of quasiparticles for a Fermi liquid is valid under conditions which are more general and more practical than those given by Landau. Finally the situation in the Husimi-Temperley model is discussed in comparison with that in the Ising model from the point of view of the present formulation.

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Catholic U. of America. [Dept. of Physics] Washington, D. C.

APPLICATION OF THE METHOD OF QUASIPARTICLES TO THE HEISENBERG FERROMAGNET, by T. Morita and T. Tanaka. [1965] [7]p. (AFOSR-65-2781) (AF AFOSR-63-445) AD 627628 Unclassified

Also published in Phys. Rev., v. 138: A1403-A1409, May 31, 1965.

In recent articles by the present authors, the virial expansion formula was generalized to an assembly of quasiparticles, and the result was applied to a general discussion of the effect of the n-spin-wave interaction on the low-temperature spontaneous magnetization of the Heisenberg ferromagnet. The method, which may be called the method of quasiparticles, seems to give the simplest way of calculating the low-temperature expansion of the spontaneous magnetization. In this paper, (i) the Dyson T^4 term for the Heisenberg ferromagnet is rederived by this method, and (ii) the corresponding expression for the Heisenberg ferromagnet with 3 exchange integrals J_s, J_f, and J_b is derived, for cubic lattices. The result is used to calculate the T^4 term in the spontaneous magnetization for the Heisenberg ferromanget with first- and second-nearest-neighbor exchanges. This suggests a method of calculating the T^5 and T^6 terms in the expansion for these cases and the T^4 term for the Heisenberg ferromagnet with a longer range exchange interaction. (Contractor's abstract)

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Catholic U. of America. Dept. of Physics, Washington, D. C.

FIRST ORDER TRANSITIONS IN SIMPLE MAGNETIC SYSTEMS, by R. A. Farrella and P. H. E. Meijer. [1965] [24]p. incl. diagrs. tables. (AFOSR-65-2805) (AF AFOSR-63-445) AD 629615 Unclassified

Also published in Physica, v. 31: 725-748, May 1965.

The dependence of the critical parameters on the compressibility and the rate of change of the exchange constant is calculated for an Ising-like interaction (long range order only) for spin 1/2, 3/2, 21/2 and ∞. The transition curve consists of a single line in the H-T plane. The complete phase diagram is shown for spin equal to three halves. The same model is studied for a 2 sublattice antiferromagnet with nearest and second nearest neighbor interactions. This model predicts transitions from the paramagnetic to the ferromagnetic state as the temperature is decreased. At a certain field one finds that the substance goes directly from the paramagnetic state to the ferromagnetic state. The phase diagram shows a triple point. An attempt was made to fit the experimental data available for dysprosium. The application of these same ideas to a 2 sublattice ferromagnet is discussed, and it is shown that no triple point exists in this case.

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Catholic U. of America. [Dept. of Physics] Washington, D. C.

APPLICATION OF THE METHOD OF T. TWO-TIME GREEN'S FUNCTION TO THE HEISENBERG FERROMAGNET. II, by T. Morita and T. Tanaka. [1965] [8]p. (AFOSR-65-2816) (AF AFOSR-63-445) AD 628400 Unclassified

Also published in Phys. Rev., v. 138: A1395-A1402, May 31, 1965.

The method of the two-time Green's function is applied to the Heisenberg ferromagnet. The equations of motion for the lowest order and the next higher order Green's functions are solved in an approximation which leads to the first nonvanishing contribution of the spin-wave interaction to the spontaneous magnetization at low temperatures. It is shown that this contribution is of order T^4 and is the same as Dyson's-result. (Contractor's abstract)

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Catholic U. of America. [Dept. of Physics] Washington, D. C.

EFFECT OF N-SPIN-WAVE INTERACTION ON THE LOW-TEMPERATURE SPONTANEOUS MAGNETIZATION, by T. Morita and T. Tanaka. [1965] [3]p. (AFOSR-65-2866) (AF AFOSR-63-445) AD 629080 Unclassified

Also published in Jour. Math. Phys., v. 6: 1152-1154, July 1965.

For a Heisenberg model of a ferromagnet, it is known that the commutator of the Hamiltonian $\mathcal{H}$ and the operator $S_0^- = \Sigma_j S_j^-$ is proportional to S_0^-. From this fact, a conjecture is made on the low-lying energy levels of two, three, ..., n-spin-wave problems. With the aid of the conjecture and the assumption that there is no low-lying n-spin-wave bound state, it is concluded that the contributions to the low-temperature expansion of the spontaneous magnetization due to two-, three-, ..., n-spin-wave problems are of $O(T^4)$, $O(T^{13/2})$, ..., $O(T^{5n/2-1})$, respectively. (Contractor's abstract)

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Catholic U. of America. [Dept. of Physics] Washington, D. C.

VIRIAL EXPANSION FOR BOSE AND FERMI FLUIDS, by T. Morita and T. Tanaka. [1965] [4]p. [AF AFOSR-63-445] Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Phys., Columbus, Ohio. (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9 (Pt. A): 104-107, 1965.

Low-lying excitations in a liquid or a solid are considered to have a long life-time and to obey the Bose or Fermi statistics. They will be called "quasi-particles," in general, in the following. The low-lying energy levels of the system are assumed to be characterized by a set of occupation numbers of the quasi-particles. The expressions for the grand partition function and the distribution function (the average occupation number) of the quasi-particles have the same structure as that for the classical lattice gas, under a nonuniform external field and with 2, 3, etc., body interactions. Therefore, the virial expansion formula for the classical lattice gas can be applied in order to evaluate the partition function for the system of quasi-particles. The result is greatly simplified by assuming that the energy corrections due to the simultaneous excitations of $2, 3, \ldots,$ n quasi-particles are of $0(V^{-1})$, $0(V^{-2}), \ldots, 0(V^{-(n-1)})$, respectively, where V is the volume of the system. The resulting expression for the distribution function of the quasi-particles is either Fermi or Bose distribution function with an effective energy. The expression for the entropy in terms of the distribution function is the same as that for an ideal gas. This shows that Landau's formula for the distribution function of quasi-particles for a Fermi liquid is valid under conditions which are more general and more practical in actual applications.

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Catholic U. of America. [Dept. of Physics] Washington, D. C.

ALPHA-PARTICLE CONTINUUM STATES, by P. Szydlik and C. Werntz. [1965] [10]p. incl. diagrs. refs. (AFOSR-65-1821) (AF AFOSR-64-566) AD 625681 Unclassified

Also published in Phys. Rev., v. 138: B866-B875, May 24, 1965.

The 2-channel collision matrix for the $t + p \leftrightarrow {}^3He + n$ system is obtained by calculating the amplitudes for isotopic spin 0 and 1 for the scattering of a nucleon and an A = 3 nucleus and combining these amplitudes in the proper linear combinations. The isotopic-spin amplitudes are obtained by making a resonating-group approximation for the continuum wave functions. It is found that with an equivalent central potential representing the nucleon-nucleon force the theory predicts the existence of two isotopic spin-0 bound excited states. These states, a 0^+ and a 1^-, are related to 2 experimentally observed structures in the cross sections. The good agreement of the theoretical and experimental cross sections in an energy region above the experimental peaks is used to establish the semiquantitative correctness of the pure isotopic-spin amplitudes obtained. (Contractor's abstract)

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Catholic U. of America. [Dept. of Physics] Washington, D. C.

EXCHANGE MAGNETIC MOMENT IN THREE-BODY NUCLEI (II), by J. G. Brennan, W. M. Frank and D. Padgett. [1965] 4p. incl. tables. (AFOSR-66-0804) (AF AFOSR-64-566) AD 641767 Unclassified

Also publishec in Nucl. Phys., v. 73: 445-448, 1965.

Meson exchange effects which arise in static Chew-Low theory include terms which can connect S state to D state components of the 3-body wave function. Using a modified Pease-Feshbach 3-body wave function, such meson exchange contributions were determined. The result, -0.03 nuclear magnetons, is of the right sign and magnitude to bring the total meson exchange moment into close agreement with that predicted by Sachs. (Contractor's abstract)

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Catholic U. of America. [Dept. of Physics] Washington, D. C.

EXCHANGE MAGNETIC MOMENT IN THREE-BODY NUCLEI (I), by D. W. Padgett, W. M. Frank, and J. G. Brennan. [1965] [21]p. incl. refs. (AFOSR-66-0805) (AF AFOSR-64-566) AD 641768 Unclassified

Also published in Nuclear Phys., v. 73: 424-444, Nov. 1965.

Meson exchange effects are considered in an attempt to explain the nuclear magnetic moment anomaly of the 3-body system. The exchange magnetic moments were calculated for the case of 2-body one-meson exchange and 3-body 2-meson exchange in the ground state of the 3-body system by the methods of static Chew-Low theory. The ground state was assumed to be pure space symmetric ${}^2S_{\frac{1}{2}}$ state. An adjustable hard core radius r_c was used in the form of a cut-off of the radial integrals for interparticle distance less than r_c. The absolute value of the total exchange moment was 0.4, 0.3 and 0.2 n. m. for hard core radii 0.3, 0.4 and 0.5 fm, respectively. The 2-body one-meson exchange process for the hard core radius of 0.4 fm accounts for 0.2 n. m. which is 2/3 of the value reported by Villars. The remaining 0.1 n. m. results from the 3-body 2-meson exchange process. (Contractor's abstract)

586

Catholic U. of America. Dept. of Physics, Washington, D. C.

COLLECTIVE NUCLEAR VIBRATIONS INDUCED BY HIGH-ENERGY NEUTRINOS, by H. Uberall. [1965] [6]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-566] and Office of Naval Research) Unclassified

Published in Phys. Rev., v. 137: B502-B507, Feb. 8, 1965.

Neutrino absorption in nuclei leading to states of collective vibration ("giant dipole") is investigated. The collective states are described schematically by using the Goldhaber-Teller model and its generalization to spin-isobaric spin vibrations. (Contractor's abstract)

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Catholic U. of Chile. Lab. of Physiology, Santiago.

VASOPRESSOR AND OXYTOCIC ACTIVITIES IN HUMAN HYPOTHALAMUS, POSTERIOR AND ANTERIOR LOBES OF THE PITUITARY GLAND, by L. Barnafi and H. Croxatto. [1965] [11]p. (AFOSR-65-2845) (AF AFOSR-61-58) AD 629559 Unclassified

Also published in Acta Endocrinol., v. 48: 177-185, 1965.

The distribution and individual variation of vasopressor and oxytocic activities in the hypothalamus, posterior and anterior lobe of the pituitary gland of 13 women and 15 men were studied. The results showed great individual variation of vasopressor and oxytocic activities in the posterior and anterior lobes, whereas in the hypothalamus a relatively constant hormonal activity was found. No significant sex differences were noted with respect to the content of the vasopressor and oxytocic activities in the hypothalamus and posterior lobe. In the anterior lobe of the female, a higher vasopressor activity was found than in males. No relationship could be established between the distribution of these activities and the pathological condition preceding death.

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Catholic U. of Chile. [Lab. of Physiology] Santiago.

PEPTIDE NEUROHUMORS IN THE BRAIN, by H. Croxatto. Final rept. Jan. 1965, 6p. incl. refs. (AFOSR-65-0671) (AF AFOSR-63-447) AD 614741 Unclassified

In the human hypothalamus there exist significant amounts of peptide substances displaying neurohypophysical activity. In the antero hypophysis, free of neurohypophysial tissue, there exist peptides having oxytocin- and vasopressin-like activity. From diverse areas of the brain, it is possible to obtain extracts capable of inducing depletion of the ovarian ascorbic acid in rats prepared according to the Parlow test. LH activity is found to be present in the hypothalamus of human beings.

589

Centre d'Enseignement et de Recherches des Industries Alimentaires et Chimiques, Brussels (Belgium).

[NEW MUTANTS IN THE REGULATION OF RNA SYNTHESIS] Nouveaux mutants de regulation de la synthèse de l'arn, by R. Lavalle. [1965] 4p. incl. diagrs. (AFOSR-66-0742) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-16 and National Science Foundation) AD 639851 Unclassified

Also published in Bull. Soc. Chim. Biol., v. 47: 1567-1570, Dec. 1965.

Three new mutants of E. coli have been found which can continue to synthesize appreciable quantities of RNA in the absence of an essential amino acid. These mutants are different from the "relaxed" strain 58161. The properties of RNA synthesis by these mutants are discussed.

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Centre National de la Recherche Scientifique, Paris (France).

THE EFFECTS OF pO_2 CHANGES ON NEURONAL SYNAPTIC AND ANTIDROMIC EXCITABILITY (GIANT NEURONS OF APLYSIA FASCINATA), by G. G. Nahas, R. B. Cook, and N. Chalazonitis. [1965] 10p. incl. illus. diagrs. (AFOSR-66-0745) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-114, Institut Oceanographique de Monacomb, and National Institutes of Health) AD 639321 Unclassified

Also published in Bull. Inst. Oceanog. (Monaco), v. 65: No. 1350, 1-10, 1965.

The effects of changes in oxygen tension pO_2 on neuronal function have been studied at different reference levels of O_2 concentration: (1) physiological levels corresponding to the normal chemoreception; and (2) unphysiological or even pathological levels which are either low (as in the case of high altitude or anoxia) or high (as in the case of hyperoxia or hyperbaric oxygenation). A study was made of the effects of changes in pO_2 on neuronal excitability of Aplysia fascinata over a wide range of pO_2 from 20 to 600 mm Hg. Special attention was given to neuronal activity at pO_2 of 25 mm Hg which is the average normal pO_2 present in the blood of Aplysia fascinata.

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Centre National de la Recherche Scientifique, Paris (France).

[LOW FREQUENCY OSCILLATIONS OF THE MEMBRANE POTENTIAL IN APLYSIA NEURONS] Les oscillations de basse fréquence du potentiel de membrane somatique (neurone d'Aplysia), by A. Arvanitaki and N. Chalazonitis. [1965] [12]p. incl. illus. diagrs. refs.

(AFOSR-66-0750) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-114 and National Institutes of Health) AD 639324
Unclassified

Also published in Compt. Rend. Seances Soc. Biol., v. 159: 1179-1190, 1965.

The conditions responsible for slow wave low frequency neurons of a sinusoidal type and the variations of synaptic activability generated by them were investigated. The passage of current through the membrane and the ensuing bioelectric activity was made possible by introducing 2 microelectrodes into the neurons. The preparation was mounted in a closed chamber permitting the inlet and outlet of oxygen and carbon dioxide. The temperature of the chamber was controlled. Slow periodic changes of the somatic membrane potential reflect the variations in the instantaneous activability of the neurons whether they manifest themselves in the form of autoactivity or in synaptic transmission.

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Centre National de la Recherche Scientifique, Paris (France).

[PERIODIC CHANGES OF MEMBRANE POTENTIAL AND RESISTANCE AS RELATED TO pO_2 CHANGES IN THE IDENTIFIABLE GEN TYPE NEURON (APLYSIA)] Evolutions périodiques du potentiel et de la résistance de la membrane du neurone identifiable "Gen" d'Aplysia en fonction de la pression partielle de l'oxygène, by A. Arvanitaki and N. Chalazonitis. [1965] [7]p. incl. illus. diagrs. (AFOSR-66-0752) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-114 and National Institutes of Health) AD 633334
Unclassified

Also published in Compt. Rend. Seances Soc. Biol., v. 159: 1377-1383, 1965.

The neuron preparation was placed in a chamber which allowed a controlled amount of gaseous mixture and a constant temperature to be applied to itself. Results indicated that neurons of the "Gen" type are usually autoactive in air and at temperatures of 24°C. When a mixture of 80% oxygen and 20% nitrogen replaces the air hyperoxia was evident. After plotting the variations of the experiment, it became evident that an increase in membrane potential was observed as hyperoxia increases. Simultaneously, the direct excitability of the membrane decreases. Thus the membrane potential and the excitability changes as functions of the extracellular partial pressure of oxygen.

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Centre National de la Recherche Scientifique, Paris (France).

[INTERACTIONS BETWEEN THE SLOW WAVE OF NEURONAL MEMBRANE POTENTIAL AND POST-SYNAPTIC EXCITATORY POTENTIAL IN THE "BRANCHIAL" NEURON OF APLYSIA] Interactions entre onde lente du potentiel del la membrane neuronique et potentiels post-synaptiques d'excitation (Neurone "branchial" d'aplysia), by A. Arvanitaki and N. Chalazonitis. [1965] 11p. incl. illus. refs. (AFOSR-66-0753) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-114 and National Institutes of Health) AD 639320
Unclassified

Also published in Compt. Rend. Seances Soc. Biol., v. 159: 1783-1793, 1965.

The isolated ganglion of the Aplysia was exposed to a mixture of nitrogen and oxygen gases. Under microscopic observation two microelectrodes were introduced into a neuron. Each of the two nerve trunks (pleurobranchial and pleuro-genital) were mounted with a pair of excitation electrodes thus submitting the neurons to synaptic control. Changes in membrane conductance are discussed. In all cases examined, the ascending phase of the oscillatory potentiality was accompanied by an increase in synaptic activability, there was also a direct relation with a decrease in synaptic activability.

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Centre National de la Recherche Scientifique, Paris (France).

SMALL pCo_2 CHANGE AND NEURONAL SYNAPTIC ACTIVATION, by N. Chalazonitis and G. G. Nahas. [1965] [3]p. incl. illus. (AFOSR-66-1010) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-114, Institut Oceanographique Monaco, and National Institutes of Health) AD 635450
Unclassified

Also published in Nature, v. 250: 1016-1017, Mar. 1965.

Observations suggest that small changes in carbon dioxide tension affect the instantaneous excitability of the soma and thus the efficiency of its excitatory synaptic activation. Such changes in carbon dioxide tension occur spontaneously in most aerobic species and could, therefore, markedly contribute to basic neuronal regulations.

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Centre National de la Recherche Scientifique, Paris (France).

[SPECTROPHOTOMETRIC MEASURES OF THE OXYGEN SATURATION OF THE HEMOPROTEIN OF APLYSIA DEPILANS] Mesures spectrophotometriques de la saturation en oxygene de l'hemoproteine d'Aplysia depilans, by M. Gola and N. Chalazonitis. [1965] 6p. incl. diagrs. refs. (AFOSR-66-0744) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-114 and National Institutes of Health) AD 639326
Unclassified

Also published in Compt. Rend. Seances Soc. Biol., v. 157: no. 8/9, 1777-1782, 1965.

The hemoprotein was extracted from the buccal muscle of Aplysia and dissolved in a special saline solution of ph7.5, identical with that of the hemolymph. (The

blood of Aplysia contains hemocyanin.) The degree of oxygen saturation of the haemoprotein at various O_2 (oxygen tension) levels was determined spectrophotometrically. Half-saturation occurred at pO_2 equal 13mm Hg; 90% saturation at approximately 80mm Hg.

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Centre National de la Recherche Scientifique, Paris (France).

[SIMULTANEOUS RECORDING OF INTRACELLULAR pO_2 AND SPONTANEOUS ELECTRICAL ACTIVITY IN THE GIANT NEURON OF APLYSIA DEPILANS] Enregistrements simultanes de la pO_2 intracellulaire et de l'autoactivite electrique du neurone géant. (Aplysia depilans), by N. Chalazonitis and M. Gola. [1965] 9p. incl. illus. diagrs. refs. (AFOSR-66-0746) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-114 and National Institutes of Health) AD 639329 Unclassified

Also published in Compt. Rend. Seances Soc. Biol., v. 159: 1770-1778, 1965.

Intracellular variations in pO_2 (oxygen tension) of less than 5 mm Hg are sufficient to cause significant changes in membrane potential and frequency of discharge, suggesting that under physiological conditions small fluctuations in pO_2 in the central nerves can act as a regulating influence on certain neurons.

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Chicago U. [Committee on Mathematical Biology] Ill.

INVESTIGATIONS IN THE FIELD OF RELATIONAL BIOLOGY, by R. Rosen. Final rept. Oct. 1, 1963-Mar. 31, 1965, 4p. (AFOSR-66-0956) (AF AFOSR-64-9) AD 634283 Unclassified

The studies reported herein are concerned with the structure and properties of a class of relational models of simple organisms. Some important problems relating to the behavior of these systems in altering environments are related to the properties of associated sequential machines and thence to control problems in dynamical systems. Questions of realizability of these abstract systems are considered in some detail, and the formulation of a general optimality principle, which would allow us to relate the abstract model to specific physicochemical realizations (i.e., real organisms) is discussed. Some implications of this study, both for important problems in biology, and for the study of nonbiological (i.e., engineering or extraterrestrial) realizations of biological organizations are described.

598

Chicago U. Committee on Mathematical Biology, Ill

A NEURAL NET MODEL FOR ESCAPE LEARNING, by H. D. Landahl. [1965] [12]p. incl. diagrs (AFOSR-66-0748) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-370 and Public Health Service) AD 632744 Unclassified

Also published in Bull. Math. Biophys., Special Issue, v. 27: 317-328, 1965.

An escape learning situation is discussed in terms of a neural model in which a stimulus can result in a conditioned excitement and a specific conditioned response. By using the simplest relations between the strengths of conditioning and the number of reinforcements and by introducing a distribution of fluctuations occurring regularly in time, one can calculate the probabilities of various responses, as well as the various latencies, in successive trials. Consequences of the model for various experimental situations are discussed. (Contractor's abstract)

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Chicago U. Committee on Mathematical Biology, Ill.

A CONVERGENCE THEOREM FOR LINEAR THRESHOLD ELEMENTS, by H. M. Martinez. [1965] [7]p. (AFOSR-66-0749) (AF AFOSR-64-370) AD 632736 Unclassified

Also published in Bull. Math. Biophys., v. 27: 153-159, June 1965.

"Linear threshold element" is the generic term for a device, natural or artificial, of the input-output type which (1) has a finite number k of input lines and one output line, (2) forms a linear combination $a_1x_1+a_2x_2+\ldots+a_kx_k$ of the input k-tuple $(x_1, x_2, \ldots, x_k)$ and compares it with a threshold quantity θ; and (3) yields one of two outputs depending on whether the linear combination does or does not exceed the threshold θ. Such elements find wide use as means for realizing linear discriminant functions and as analogs for certain features characterizing neurons. Adaptive classification of inputs into one of two categories, as designated by the two outputs, can sometimes be achieved by the suitable adjustment, based on experience, of the parameters $a_1, a_2, \ldots, a_k$ and θ. One such adjustment rule having the characteristics of a steepest descent algorithm is here investigated. Established is a theorem giving the necessary and sufficient conditions that the mean values of the adjusted parameters converge to a solution of the equations required for minimizing the mean square error relative to a quantity associated with classification performance when the element is exposed to a stationary sequence of independent inputs. (Contractor's abstract)

600

Chicago U. Committee on Mathematical Biology, Ill.

SOME COMMENTS ON RE-ESTABLISHABILITY, by R Rosen. [1965] [4]p. incl. diagrs. (AFOSR-66-0755) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-9 and Public Health Service) AD 629854 Unclassified

Also published in Bull. Math. Biophys., Special Issue, v. 27: 11-14, 1965.

The present note consists of 2 separate but related parts. In the first, a new graph-theoretic proof is presented that an (M, R)-system must always contain a nonreestablishable component. The second considers some questions concerning the relation between re-establishability and the time-lag structure in (M, R)-systems. It is supposed that the reader is familiar with the terminology of the author's previous work on (M, R)-systems, particularly R. Rosen, Bull. Math Biophys., v. 20: 245-260, 1958.

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Chicago U. [Dept. of Mathematics] Ill.

CATEGORICAL ALGEBRA, by S. MacLane. [1965] [67]p. incl. diagrs. refs. (AFOSR-65-1042) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-520] and National Science Foundation) AD 624371 Unclassified

Also published in Bull. Amer. Math. Soc., v. 71: 40-106, Jan. 1965.

A discussion is presented of developments which use categories and functors. Attention is given to the ubiquity of adjoint functors, the utility of abelian categories, a unified categorical treatment of types of algebras, relative homological algebra via adjoint functors, differential graded objects, and universal algebra via suitable very small categories. Definitions are formed, and propositions and theorems are proposed and proved. Transformations and morphisms are emphasized.

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Chicago U., Dept. of Mathematics, Ill.

A FAMILY OF SPECTRAL OPERATIONS, by T.-C. Kuo. [1965] [4]p. incl. diagr. (AFOSR-65-2119) (AF AFOSR-64-520) AD 629032 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 53: 658-661, Mar. 1965.

This paper considers the category $\mathcal{C}$ whose objects are epic simplicial maps $f: X \to Y$, where X and Y are simplicial sets (i.e., semisimplicial complexes), Y being regular, and whose morphisms are appropriate pairs of maps. Filtering X by the inverse images of the skeleta of Y gives rise to a spectral sequence E_r for the mod 2 cohomology which is functorial in $\mathcal{C}$, and a spectral operation is defined to be a natural transformation of functors $E_r^{p,q} \to E_t^{a,b}$. A universal example for spectral operations is constructed consisting of an object in the category and a cochain which acts as a fundamental class. The spectral sequence for the universal example is computed for $r < q < 2$ in terms of the cohomology of Eilenberg-MacLane spaces $K(Z_2, n)$. (Math. Rev. abstract)

603

Chicago U. [Dept. of Mathematics] Ill.

AUTONOMOUS CATEGORIES AND DUALITY OF FUNCTORS, by F. E. J. Linton. [1965] [35]p. incl. diagrs. refs. (AFOSR-65-2645) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-520 and National Science Foundation) AD 627626 Unclassified

Also published in Jour. Algebra, v. 2: 315-349, Sept. 1965.

In the category $\mathcal{T}$ of based topological spaces and based maps, let $X \wedge A$ be the smashed product and let $\wedge A$ be the functor $\wedge A(X) = X \wedge A$. Given a functor $F: \mathcal{T} \to \mathcal{T}$, consider the collection of natural transformations from F to $\wedge A$, written $\mathrm{Nat}(F, \wedge A)$. If this collection is a set, then it may, in a natural way, be given the structure of a based space, and a new functor $DF: \mathcal{T} \to \mathcal{T}$ is defined by $DF(A) = \mathrm{Nat}(F, \wedge A)$, with an obvious effect of DF on based maps. DF is called the functor dual to F; it turns out, for example, that $D\Sigma = \Omega$, $D\Omega = \Sigma$, where Σ, Ω are the suspension and loop space functors, respectively, and that $D^3 = D$. In the category of modules over a commutative ring, a similar duality may be defined using the tensor product instead of the smashed product. A careful study is made, in a very general setting, of this duality. The role played by the smashed product and the tensor product in the examples above is as left adjoint of $\mathrm{Hom}(A,)$, where $\mathrm{Hom}(A, Y)$ may itself be structured as an object of the category. Thus the set of based maps from A to Y in $\mathcal{T}$ may be structured as a based space, and one then has a natural homeomorphism $\eta_A(X, Y)$: $\mathrm{Hom}(X \wedge A, Y) \cong \mathrm{Hom}(X, \mathrm{Hom}(A, Y))$. So the first essential for this duality in a category $\mathcal{C}$ is that there exist a functor from $\mathcal{C}$ to the category of sets and a lift of the Hom functor (from $\mathcal{C} \times \mathcal{C}$ to sets) to a functor to $\mathcal{C}$. Such a category $\mathcal{C}$ is a special case of an enriched category; it has been variously described as a self-enriched category or an autonomous category. Given an autonomous category, one then seeks a left adjoint of $\mathrm{Hom}(A,)$; but, in view of the enrichment, one can ask for the natural equivalence η_A to be an equivalence of $\mathcal{C}$-objects or of sets. The next problem is that of structuring the collection corresponding to $\mathrm{Nat}(F, \wedge A)$ as an object of $\mathcal{C}$; this raises certain set-theoretical problems which are studied and a theorem is proved establishing the existence of dual functors under suitable hypotheses. (Math. Rev. abstract, modified)

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Chicago U. [Dept. of Mathematics] Ill.

THE OBSTRUCTION TO THE LOCALIZABILITY OF A MEASURE SPACE, by F. E. J. Linton. [1965] [4]p. incl. refs. (AFOSR-66-0250) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-520 and National Science Foundation) AD 632883 Unclassified

Also published in Bull. Amer. Math. Soc., v. 71: 353-356, Mar. 1965.

This paper is to formulate the concept of localizability (in the sense of Segal) in terms of homological algebra. Let m be a finite measure on a ring R of subsets of X such that R contains the union of any disjoint sequence $\{E_n\} \subset R$ for which $\Sigma\, m(E_n) < \infty$. A set $K \subset X$ is measurable [null] if $K \cap E \in R$ $[m(K \cap E) = 0]$ whenever $E \in R$. The measure space (X, R, m) is said to be localizable if the algebra of measurable sets modulo null sets is complete as a partially ordered set. A boolean ring A may be regarded as an A-module, and an ideal J in A as a sub-A-module. The connecting homomorphism $d_{A,J}$: $\mathrm{Hom}_A(A, A/J) \to \mathrm{Ext}_A^1(A, J)$ between the group of A-module homomorphisms $A \to A/J$ and the group of A-module extensions $0 \to J \to ? \to A \to 0$ is called the obstruction to the localizability of the boolean ring A over its ideal J. The main theorem asserts that (X, R, m) is localizable if and only if $d_{R,I}$ vanishes where I is the ideal of null sets in R. (Math. Rev. abstract)

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Chicago U. [Dept. of Mathematics] Ill.

A FAMILY OF SPECTRAL OPERATIONS, by T.-C. Kuo. [1965] [26]p. incl. diagrs. refs. (AFOSR-66-2618) (AF AFOSR-64-520) AD 643130 Unclassified

Also published in Topology, v. 4: 215-240, 1965.

Consideration is given to the category $\mathcal{S}$ whose objects are surjective semi-simplicial maps f: X → Y (and Y satisfies a certain regularity condition). The usual spectral sequence of a map defines functors E_r^{pq}: $\mathcal{S} \to \mathcal{A}$ (abelian groups), and the natural transformations Θ among these are studied. A semi-representability theorem is proven: There is an object $P_r^{pq} \in \mathcal{S}$ and an element $\xi_r^{pq} \in E_r^{pq}(P_r^{pq})$ from which every $\chi \in E_r^{pq}(f)$ is induced, but the way to induce it may not be unique. This reduces problems about Θ's to problems about P_r^{pq}. Also proven are theorems of the bar-construction-, W-construction-, and Eilenberg-Zilber-type which simplify these objects. Results of H. Cartan are used to compute the spectral sequence of P_r^{pq} with Z_p-coefficients, in particular, it is shown that the differentials d^t vanish for $t \geq 2$. For most applications one would need more information about the ambiguity in inducing χ from ξ. This problem is pointed out but not dealt with. (Math. Rev. abstract)

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Chicago U. [Dept. of Mathematics] Ill.

ON SCHWARZSCHILD'S CRITERION FOR THE STABILITY OF GASEOUS MASSES, by N. R. Lebovitz. [1965] [14]p. (AFOSR-65-2072) [AF AFOSR-65-712] AD 627478 Unclassified

Also published in Astrophys. Jour., v. 142: 229-242, July 1, 1965.

A serious obstacle to a deduction of Schwarzschild's criterion for the stability of gaseous masses by way of the linear-stability theory has been the cumbersome nature of the system of differential equations defining the characteristic frequencies and modes of oscillation. However, a recent discovery of a variational principle equivalent to the system of differential equations appears to overcome this obstacle (S. Chandrasekhar, Astrophys. Jour., v. 139: 664, 1964). Here this variational principle is used to show that all the characteristic frequencies are real if Schwarzschild's criterion is satisfied. The demonstration is given for a wide class of equilibrium configurations. The validity of Schwarzschild's criterion is clearly indicated by the results, though inferring stability from the reality of the characteristic frequencies requires a completeness theorem which has not yet been proved.

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Chicago U. [Dept. of Mathematics] Ill.

ON THE ONSET OF CONVECTIVE INSTABILITY, by N. R. Lebovitz. [1965] [4]p. (AFOSR-66-0103) (AF AFOSR-65-712) AD 631381 Unclassified

Also published in Astrophys. Jour., v. 142: 1257-1260, Oct. 1, 1965.

It is shown that for non-trivial neutral modes of disturbance to exist in a spherical mass of gas it is a necessary and sufficient condition that the Schwarzschild discriminant vanishes in a finite radial subinterval of the configuration. A further mathematical justification is given for the physical arguments used to derive the Schwarzschild criterion.

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

QUASI-FREE PROTON-PROTON SCATTERING IN LIGHT NUCLEI AT 460 MEV, by H. Tyrén, S. Kullander and others. [1965] [143]p. incl. diagrs. tables, refs. (AFOSR-65-1678) (AF AFOSR-64-13) AD 624318 Unclassified

Quasi-free proton-proton scattering is studied in a number of light nuclei at 460 mev using two large identical magnetic spectrometers with 2-directional focusing and a multi-channel electronic detector system. The experiments are done in a symmetric geometry. Summed energy spectra and angular correlation distributions of separated components of the spectra are presented. The experimental results for the lighter nuclei are analyzed by comparing them with theoretical ones obtained on the basis of the distorted wave impulse approximation. Information on the radii and occupation numbers of the 1s and 1p orbitals in the nuclei considered is obtained. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill

NEUTRON MONITOR MASS ABSORPTION

COEFFICIENTS AT CHICAGO AND CLIMAX DURING SOLAR CYCLE 19 (1954-1963), by M. A. Forman. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-1820) (Sponsored jointly by Air Force Geophysical Research Directorate; and Air Force Office of Scientific Research under AF AFOSR-64-251) AD 625600 Unclassified

Also published in Jour. Geophys. Research, v. 70: 2469-2473, June 1, 1965.

The dependence of the neutron monitor mass absorption coefficient on 11-yr changes in the primary cosmic-ray spectrum was investigated for the monitors at Chicago, Ill. and Climax, Colo., using a modified single regression method. The analysis of hourly intensity and pressure values for 733 days at Chicago and 1000 days at Climax during the period 1954-1963 revealed no significant variation at either station. The mean value of the coefficient at Chicago is -0.938 ± 0.007%/mm Hg; at Climax it is -1.010 ± 0.006%/mmHg. This difference is significant and depends on the altitude characteristics of the nucleonic component. These results are compared with earlier work. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

ELECTRONIC PROPERTIES OF SEMICONDUCTORS AT LIQUID HELIUM TEMPERATURES, by H. Fritzsche. Final rept. Feb. 1965, 9p. (AFOSR-65-0435) (AF AFOSR-62-178) AD 612132 Unclassified

The research effort was devoted to the 3 least studied and least understood transport phenomena in semiconductors at low temperatures which involve the interaction of impurities. These are: (a) impurity conduction, (b) the transition from nonmetallic to the metallic state, and (c) the so-called metallic state of degenerate semiconductors. This work tries to illuminate the detailed physical phenomena which are so important for the increasing number of low temperature solid state devices such as tunnel diodes and junction lasers.

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Chicago U. Inst. for the Study of Metals, Ill.

HIGH-STRESS PIEZORESISTANCE AND MOBILITY IN DEGENERATE Sb-DOPED GERMANIUM, by M. Cuevas and H. Fritzsche. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-1376) (AF AFOSR-62-178) AD 622853 Unclassified

Also published in Phys. Rev., v. 137: A1847-A1855, Mar. 15, 1965.

The resistivity of germanium containing between N = 3×10^{17} and 10^{19} antimony atoms/cc was measured at 1.2°K under uniaxial compressions of up to 10^{10} dyn cm^{-2}. These stresses are high enough to effect an observable saturation in the piezoresistance, i.e., to transfer all electrons to a single conduction-band valley ([111] compression) or to 2 valleys ([110] compression). Two distinct ranges are observed in degenerate germanium: for $N < 10^{18}$ cm^{-3} the mobility increases with N and shows impurity-band effects; for $N > 10^{18}$ cm^{-3} the mobility decreases and ionized-impurity scattering is the dominant scattering process. The latter range is $N > 3 \times 10^{18}$ cm^{-3} for large [111] compression. The resistivity was measured for current flowing parallel and perpendicular to the stress direction. The mobility anisotropy was found to be $\mu_\perp / \mu_\parallel = 3.9 \pm 0.1$ for $N > 4 \times 10^{18}$ cm^{-3}. This indicates that the mean free path is nearly isotropic. The mobility for electrons in 1, 2, and 4 valleys is compared with Csavinszky's partial-wave treatment of impurity scattering. The change of screening with the number of valleys was taken into account. Csavinszky's theory overestimates the N dependence and the magnitude of the scattering. This is attributed to the failure of the individual-scattering assumption.

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Chicago U. Inst. for the Study of Metals, Ill.

EFFECT OF UNIAXIAL COMPRESSION ON IMPURITY CONDUCTION IN p-GERMANIUM, by F. H. Pollak. [1965] [14]p. incl. diagrs. tables, refs. (AFOSR-65-1924) (AF AFOSR-62-178) AD 626803 Unclassified

Also published in Phys. Rev., v. 138: A618-A631, Apr. 19, 1965.

The effect of uniaxial compression along [100] and [111] on impurity conduction was investigated in Ga-doped p-Ge in the concentration range $3 \times 10^{15} < N_A < 9 \times 10^{16}$ cm^{-3} for compensation K = 0.04 and in the range $9 \times 10^{14} < N_A < 4 \times 10^{16}$ cm^{-3} for K = 0.40. The experiments were performed between 300° and 1.2°K. The largest stress applied was 6.8×10^9 dyn cm^{-2}. The analysis of the experimental results deals primarily with the high-stress region ($X > 4 \times 10^9$ dyn cm^{-2}) in which the 2 valence bands, which in the absence of stress are degenerate at k = 0, are nearly decoupled so that the effect of the lower band on the acceptor wave function is treated as a perturbation. In the low-concentration region, inclusion of nonspherical charge distributions, together with the acceptor wave functions calculated from the effective-mass approximation, accounts for the observed stress dependence of the resistivity. At intermediate concentrations a linear relation between the impurity-conduction activation energy ϵ_2 and the acceptor ionization energy ϵ_1 is established. The investigation of the stress dependence of the transition from nonmetallic to metallic conduction yields the stress dependence of the effective Bohr radius. The form of this stress dependence indicates the importance, at high concentrations, of the potential-energy term in the effective-mass Hamiltonian. This term can be neglected at low concentrations. (Contractor's abstract, modified)

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Chicago U., [Inst. for the Study of Metals] Ill.

HIGH STRESS BIREFRINGENCE OF PURE AND DEGENERATE n-TYPE Ge (Abstract), by A. Feldman. [1965] [1]p. [AF AFOSR-62-178] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 344, Mar. 24, 1965.

The stress birefringence B of pure and degenerate n-type Ge has been measured at liquid-He temperatures using wavelengths λ of 1.8-2.5 μ and uniaxial compression x of up to 8.5×10^9 dyn cm^{-2} along [111]. B is considered the sum of a lattice contribution B_l and a free electron contribution B_f. $B_l = B$ for pure Ge. The simple degenerate model predicts a saturation of B_f when all electrons are transferred to a single valley. In As-doped Ge, $N \approx 2 \times 10^{18}$ donors cm^{-3}, incomplete saturation is observed. Values for $m_c(1/m_\perp - 1/m_\parallel)$ are obtained that differ from pure Ge. Q_{44}, the stress optical constant for pure Ge equals $\partial B_l/\partial x$. Q_{44} is observed to be linear in λ^{-1} below 77°K.

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Chicago U. Inst. for the Study of Metals, Ill.

HIGH-STRESS PIEZORESISTANCE IN DEGENERATE ARSENIC-DOPED GERMANIUM, by M. Cuevas and H. Fritzsche. [1965] [8]p. incl. diagrs. table, refs. (AF AFOSR-62-178) Unclassified

Published in Phys. Rev., v. 139: A1628-A1635, Aug. 30, 1965.

The resistivity of germanium containing between $N = 4 \times 10^{17}$ and 10^{19} arsenic atoms per cc was measured at 1.2°K under uniaxial compressions of up to 10^{10} dyn cm^{-2}. The piezoresistance fails to saturate near the stress at which one expects essentially all electrons to have been transferred to a single conduction band valley ([111] compression) or to 2 valleys ([110] compression). Saturation is approached at much higher stresses. The resistivity was measured for current flowing parallel and perpendicular to the stress direction. For $N \sim 10^{18}$ cm^{-3}, the mobility anisotropy was found to be $\mu_\perp/\mu_\parallel$ 4 ± 0.4, 5 ± 0.6, and 6 ± 0.5 for the 4-, 2-, and 1-valley cases, respectively. The mobility ratio $\mu_\parallel$(Sb), $\mu_\parallel$(As) increases from about 1.5 to 1.9 as the electrons are transferred from 4 valleys to 1 valley. Evidence for the presence of tail states in As-doped germanium and the significance of the large central impurity cell potential of As donors for the interpretation of the piezoresistance are discussed. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

PRESSURE DEPENDENCE OF PHONON ASSISTED INTERBAND TUNNELING, by H. Fritzsche and J. J. Tiemann [1965] [5]p. incl. diagr. table, refs (AFOSR-65-1183) (AF AFOSR-63-148) AD 621411 Unclassified

Also published in Proc. Seventh Internat'l Conf. on the Physics of Semiconductors, Paris (France) (July 19-24, 1964), Paris, Dunod, 1965 p. 599-603

Previous studies have shown general agreement between experimental results and the theories of Keldysh and Kane for interband tunneling. In the present study, a structure is examined in the bias dependence of the relative change of tunneling current with hydrostatic pressure in Sb-doped germanium tunnel junctions at 4.2 K. It is shown that this effect cannot be explained by the Keldysh-Kane theory. Evidence suggests that some characteristic properties of the TA and LA phonons are not incorporated correctly in the theory.

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Chicago U., Inst. for the Study of Metals, Ill.

THEORY OF INDIRECT INTERBAND TUNNELING IN SEMICONDUCTORS, by J. J. Tiemann and H. Fritzsche [1965] [4]p. incl. diagr. table. (AFOSR-65-1375) (AF AFOSR-63-148) AD 622920 Unclassified

Also published in Phys. Rev., v. 137, A1910-A1913, Mar. 15, 1965.

The theory of phonon-assisted tunneling by Keldysh and Kane is extended to incorporate the phonon interaction in a manner that is consistent with the requirements of crystal symmetry. Perturbation theory is used to evaluate the tunneling matrix element. The unperturbed wave functions are taken to be the approximate eigenstates of the pure crystal in a weak uniform field, as presented by Kane. The electron-phonon interaction is treated as the perturbation. Although the magnitude of the tunnel current agrees with experiment, the observed difference between the pressure coefficients of the transverse acoustical and the longitudinal acoustical phonon-assisted tunnel currents is not reproduced by the theory. It is concluded that Kane's reflected wave functions are not sufficiently good approximations for the calculation of phonon-assisted tunneling in germanium. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

PHONON ENERGIES IN GERMANIUM FROM PHONON-ASSISTED TUNNELING, by R. T. Payne [1965] [13]p. incl. diagrs. tables, refs. (AFOSR-65-1899) (AF AFOSR-63-148) AD 626508 Unclassified

Also published in Phys. Rev., v. 139 A570-A582, July 19, 1965.

The line shapes of the peaks in the bias dependence of the second derivative of the phonon-assisted tunnel current with respect to voltage are reported for Sb-doped germanium tunnel junctions between 4.2 and 1.15°K. The antimony concentration is 5 x 10^{18} cm^{-3}. The phonon energies at the point L in the Brillouin zone, determined to an accuracy of ± 0.1%, are E(TA) = 7.766, E(LA) = 27.58, E(LO) = 30.62, and E(TO) = 36.15 in mev. This accuracy verifies the assumptions made in determining the pressure dependence of these phonon energies previously reported by the author. The major contribution to the line shapes is kT broadening. Minor contributions arise from a small bias dependence of the tunnel current per energy interval and from the phonon dispersion near L. Approximate values for the curvatures of the phonon spectrum at L are determined. A lower limit of 1.6 x 10^{-11} sec is found for the lifetimes of these phonons. From double phonon emission processes the energy of the optic phonon at Γ is found to be 37.3 ± 0.2 mev. (Contractor's abstract)

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Chicago U., Inst. for the Study of Metals, Ill.

HIGH-SENSITIVITY PIEZOREFLECTIVITY, by W. E. Engeler, H. Fritzsche and others. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-1900) [AF AFOSR-63-148] AD 626082 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 1069-1072, June 28, 1965.

A high-sensitivity piezoreflectance technique is described which promises to be useful in the study of the energy band structure of solids. This technique utilizes oscillatory applied strain and synchronous detection at a frequency that is high in comparison with fluctuations in the photodetectors and other sources of instability. The resulting improvement in stability allows measurements to be made of relative reflectivity changes as small as 3 x 10^{-6}. Results of measurements are presented for Ge, Si, and Cu. The experimental data can be used to determine interband transition energies and deformation potentials, and can provide information about the location of the transitions in the Brillouin zone

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Chicago U., Inst. for the Study of Metals, Ill.

EFFECT OF STRESS ON THE EXCESS AND HUMP CURRENT IN Sb-DOPED GERMANIUM DIODES, by S. Fujita, H. Fritzsche, and J. J. Tiemann. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-1901) (AF AFOSR-63-148) AD 626080 Unclassified

Also published in Jour. Phys. Soc. Japan, v. 20: 1443-1447, Aug. 1965.

The effects of uniaxial compression and of hydrostatic pressure on the excess and hump current in germanium tunnel diodes have been studied experimentally at 4.2 K. The diodes were formed by alloying indium doped with 3 8% gallium on (100) and (110) faces of germanium bars containing an antimony concentration of 5 x 10^{18} cm^{-3}. The first order change of the current with stress was measured at fixed forward bias voltages. The experiments show that the excess current involves tunneling from the conduction band valleys to gap states on the p-type side of the junction. A large negative stress-induced current change is associated with a current component which is sometimes observed as a hump in the I-V characteristic between 0.5 and 0.65 v bias. A sharp increase of the pressure coefficient marks the onset of the ordinary injection current at 0.74 v. The effect of shear stress on the injection current was found to be zero to first order in the stress. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

STRESS EFFECTS ON IMPURITY-INDUCED TUNNELING IN GERMANIUM, by H. Fritzsche and J. J. Tiemann. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-1902) (AF AFOSR-63-148) AD 626081 Unclassified

Also published in Phys. Rev., v. 139: A920-A923, Aug. 2, 1965.

The effects of uniaxial compression and of hydrostatic pressure on the impurity-induced interband tunneling current in germanium tunnel junctions have been studied experimentally at 4.2°K. The diodes were formed on (100) and (110) faces or arsenic-doped germanium bars. The stress coefficients of the tunnel current were measured at fixed forward and reverse bias voltages. The experiments show that the part of the electron wave function responsible for impurity-induced tunneling is not associated with a particular conduction-band valley. Some structure in the bias dependence of the shear stress coefficients near zero bias remains unexplained. This structure does not appear in the hydrostatic-pressure coefficient. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

EXPERIMENTAL INVESTIGATION OF THE ELECTRONIC PROPERTIES OF SOLIDS, by H. Fritzsche. Final technical rept. Dec. 1965, 13p. incl. refs. (AFOSR-65-2727) (AF AFOSR-63-148) AD 629495 Unclassified

Research progress is reported in the following fields. (1) study of the Hall effect in liquid metals and alloys; (2) study of very impure semiconductors; (3) optical infrared studies of semiconductors; (4) investigation of the electronic band structure of solids; (5) the use and development of ultrasonic attenuation techniques.

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Chicago U., Inst. for the Study of Metals, Ill.

A SIZE EFFECT IN NEARLY FREE ELECTRON METALS, by B. G. Smith. [1965] [2]p. incl. diagr.

(AFOSR-66-1303) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-148 and National Aeronautics and Space Administration) AD 641290 Unclassified

Also published in Phys. Ltrs., v. 18 210-211, Sept. 1, 1965.

In the conventional development of the nearly free electron theory of metals the basis set of free electron eigenfunctions is determined by the assumption of periodic boundary conditions in a lattice of infinite dimensions. This clearly unrealistic choice is justified by the intuitive argument that processes of experimental interest will occur in the bulk of the crystal and should therefore not depend upon the particular boundary conditions employed. Intuition does not support this argument for small crystals, e.g., thin films, for which boundary conditions must be more carefully chosen. In this letter is elaborated a consequence of using stationary instead of traveling wave electronic functions.

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Chicago U. Inst. for the Study of Metals, Ill.

THE USE OF PRESSURE IN THE STUDY OF IMPURITY STATES IN SEMICONDUCTORS, by H. Fritzsche. [1965] [12]p. incl. diagrs. refs. (AFOSR-66-0131) (AF AFOSR-63-148) Unclassified

Published in Physics of Solids at High Pressures, Proc. First Internat'l. Conf., Tucson, Ariz. (Apr. 20-23, 1965), ed. by C. T. Tomizuka and R. M. Emrick. New York, Academic Press, 1965, p. 184-195.

Experimental results are reported for the effect of pressure on the resistivity of Ge doped with Sb and As. Interband tunnelling is also considered, and the results are interpreted in terms of the band structure of Ge.

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Chicago U. Inst. for the Study of Metals, Ill.

EXPERIMENTAL STUDY OF LUMINESCENCE AND EXCITATION TRAPPING IN VINYL POLYMERS, PARACYCLOPHANES, AND RELATED COMPOUNDS, by M. T. Vala, Jr., J. Haebig, and S. A. Rice. [1965] [12]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-369], National Science Foundation, and Public Health Service) Unclassified

Published in Jour. Chem. Phys., v. 43: 886-897, Aug. 1, 1965.

The results of an experimental investigation of luminescence and energy trapping in the polymeric systems atactic and isotactic polystyrene and atactic polyvinylnaphthalene are presented. It is shown that the anomalous emission bands observed at 3350A in the polystyrenes and at 4100A in atactic polyvinylnaphthalene are transitions from an excimer state formed by the interaction of nearby chromophores on the same polymer chain. In support of this interpretation, the spectra of a number of model compounds in the diphenylalkane and paracyclophane series are presented and analyzed. The role of charge-transfer-state contribution to the splitting in rigidly helical isotactic polystyrene is investigated and conclusions concerning the microscopic conformations of the polymer chromophores are drawn In addition, the possibility of excitation energy trapping due to conformational changes of the chromophore groups is discussed. (Contractor's abstract)

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Chicago U., Inst. for the Study of Metals, Ill.

NUCLEAR MAGNETIC RESONANCE IN MOLTEN SALTS. II. CHEMICAL SHIFTS IN THALLIUM HALIDE-ALKALI HALIDE MIXTURES, by S. Hafner and N. H Nachtrieb. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-0889) (Sponsored jointly by Advanced Research Projects Agency, and Air Force Office of Scientific Research under AF AFOSR-64-624) AD 619184 Unclassified

Also published in Jour. Chem. Phys., v. 42: 631-636, Jan. 15, 1965.

The resonance frequency of the Tl^{205} nucleus in molten solutions of the thallous halides with the corresponding alkali metal halides vary linearly with the mol fraction of the added alkali halide. The direction of the chemical shift depends upon the radius of the alkali cation, being upfield for lithium and sodium halides and downfield for the halides of potassium, rubidium, and cesium relative to the pure thallous halide. For a given mol fraction of alkali halide, δ_{Tl} is a linear function of the alkali cation radius. The results provide information on the nature of the interactions between cations and anions in molten salts. The covalent interaction between Tl^+ and halide ions is decreased by alkali metal ions of small radius and increased by those of large radius. (Contractor's abstract)

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Chicago U., Inst. for the Study of Metals, Ill.

[DETERMINATION OF THE CLOSEST APPROACH OF IONS IN IONIC MELTS BY MEANS OF NUCLEAR RESONANCE] Bestimmung des kleinsten Ionenabstandes in ionischen Schmelzen mittels Kernresonanz, by N H. Nachtrieb and S. Hafner. [1965] [4]p. incl. diagr. refs (AFOSR-65-1674) (AF AFOSR-64-624) AD 624333 Unclassified

Also published in Zeitschr. Naturforsch., v. 20a: 321-324, 1965.

At constant magnetic field the resonance frequencies of nuclei in ionic salts increase linearly with temperature in both the crystalline and molten states. The linear temperature-dependence of the chemical shift is ascribed to the excitation of higher paramagnetic electronic states which accompanies the increasing overlap of cation and anion wave functions; both are proportional to the linear increase in the mean squared vibrational amplitudes of ions with temperature. The magnitude of the break in

the chemical shift at the melting point, coupled with a knowledge of the change in the coordination number and the variation in the wave function overlap with internuclear separation, leads to an estimate of the distance of closest approach of neighboring ions in the molten state. For an assumed value of F = 0.9, where F = $(Z_L/Z_S)/(\Delta E_L/\Delta E_S)$, the distance of closest cation-anion approach decreases by 0.18 A as crystalline TlCl melts to form the liquid salt. The overlap of Tl^+ and Cl^- ions in crystalline TlCl at room temperatures is 0.012 on the basis of the NMR frequency of Tl^{205+} and is estimated to be 0.017 from machine calculations based on analytic wave functions for the ground states of the ions. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

SEARCH FOR A CHARGE-TRANSFER STATE IN CRYSTALLINE ANTHRACENE, by R. S. Berry, J. Jortner and others. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-1219) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-781, National Science Foundation, and Petroleum Research Fund) AD 621538 Unclassified

Also published in Jour. Chem. Phys., v. 42: 1535-1541, Mar. 1, 1965.

The calculation of the location of the charge-transfer state in crystalline anthracene is examined. Also reported are the results of spectroscopic experiments designed to find the transition from the ground state to the charge-transfer state. No experimental evidence could be found for this transition, and it is thereby concluded that: (1) The charge-transfer state lies above the first exciton state in anthracene, and (2) the polarization energy in the charge-transfer state is much less than that calculated on the basis of classical considerations. A brief discussion of the nature of the polarization in aromatic crystals is presented, especially with respect to the second conclusion.

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Chicago U. Inst. for the Study of Metals, Ill.

REFLECTION STUDIES OF EXCITONS IN LIQUID AND SOLID XENON, by D. Beaglehole. [1965] [3]p. incl. diagr. (AFOSR-66-0310) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781 and Public Health Service) AD 629813 Unclassified

Also published in Phys Rev. Ltrs., v. 15: 551-553, Sept. 27, 1965.

Reflectivity measurements have been made on liquid and solid xenon at various temperatures to study the effects of lattice order on the optical excitations. The exciton lines are found to broaden on making the transition from solid to liquid phase but otherwise the reflectivity spectra are remarkably similar. This result suggests that all the excitons at both high and low energy have essentially an atomic origin, little influenced by crystalline order.

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Chicago U. Inst. for the Study of Metals, Ill.

EXCITED ELECTRONIC STATES OF CRYSTALLINE BENZENE, by R. Silbey, S. A. Rice, and J. Jortner. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-66-0322) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Public Health Service) AD 629811 Unclassified

Also published in Jour. Chem. Phys., v. 43. 3336-3343, Nov. 1, 1965.

In the present paper, the excited electronic states of crystalline benzene are examined with the use of exciton theory. Ion-pair exciton states are considered and it is shown that these may play a considerable role in determining the observed spectra. Their effects on the lowest triplet state is also considered. The results of the analysis are in agreement with the available experimental data and are also consistent with analysis of the spectrum of crystalline napthalene.

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Chicago U. Inst. for the Study of Metals, Ill.

MOLECULAR RYDBERG TRANSITIONS IN RARE-GAS MATRICES—EVIDENCE FOR INTERACTION BETWEEN IMPURITY STATES AND CRYSTAL STATES, by E. S. Pysh, S. A. Rice, and J. Jortner. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-66-0323) [AF AFOSR-65-781] AD 629812 Unclassified

Also published in Jour. Chem. Phys., v. 43: 2997-3004, Nov. 1, 1965.

As a first step in characterizing molecular Rydberg states in the solid state, the absorption spectra arising from acetylene and benzene inpurity states in solid krypton and argon in the far-ultraviolet region have been obtained. The first member of the acetylene Rydberg series, which appears at 8.155 ev in the gas phase, is observed to be shifted to 8.67 ev in a krypton matrix and to 9.01 ev in an argon matrix. These large energy shifts are discussed, particularly with reference to the optical spectra of rare-gas solids and rare-gas alloys, where similar large blue shifts are observed. The far-ultraviolet spectra of benzene trapped in krypton and argon matrices show a qualitatively different phenomenon. The Rydberg states of benzene are observed to interact with conduction-band continuum states to exhibit anomalous Fano-type line shapes. The Rydberg states repulse the neighboring continuum states to produce sharp decreases in the continuum absorption intensity. These results are discussed in connection with other systems which show Fano-type line shapes. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

THE ELECTRON-HELIUM ATOM PSEUDOPOTENTIAL, by J. Jortner, N. R. Kestner and others. [1965] [4]p. incl. diagr. refs. (AFOSR-66-1408) [AF AFOSR-65-781] AD 641211 Unclassified

Also published in Modern Quantum Chemistry, Part II: Interactions; Istanbul Lectures, Internat'l. Summer School of Quantum Chemistry, Istanbul (Turkey) (Aug. 16-Sept. 5, 1964), ed. by O. Sinanoğlu. New York, Academic Press, 1965, p. 129-132.

Calculation was made of the helium atom pseudopotential, based on data obtained by scattering very low energy electrons from He atoms.

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Chicago U. Inst. for the Study of Metals, Ill.

ELECTRONS IN LIQUIDS, by J. Jortner, S. A. Rice, and N. R. Kestner. [1965] [32]p. incl. tables, refs. (AFOSR-66-1450) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Public Health Service) AD 641207 Unclassified

Also published in Modern Quantum Chemistry, Part II: Interactions; Istanbul Lectures, Internat'l. Summer School of Quantum Chemistry, Istanbul (Turkey) (Aug. 16-Sept. 5, 1964), ed. by O. Sinanoğlu. New York, Academic Press, 1965, p. 133-164.

Some current theoretical studies of electron-solvent interactions in polar and nonpolar solvents are discussed. Topics include: Comments on the polaron model; continuum dielectric models; dielectric models for electrons in polar solvents, thermochemical data concerning charge distribution in metal-ammonia solutions; excitation states of electrons in polar solvents, application of theories of metals to concentrated metal-ammonia solutions; the free electron model, the bubble model.

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Chicago U. Inst. for the Study of Metals, Ill.

PHOTOCONDUCTIVITY IN CRYSTALS OF ORGANIC MOLECULES, by J. Jortner and S. A. Rice. [1965] [14]p. incl. refs. (AFOSR-66-1451) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], National Institutes of Health, and National Science Foundation) AD 641206 Unclassified

Also published in Modern Quantum Chemistry, Part III Action of Light and Organic Crystals; Istanbul Lectures, Internat'l. Summer School of Quantum Chemistry, Istanbul (Turkey) (Aug. 16-Sept. 5, 1964), ed. by O. Sinanoğlu. New York, Academic Press, 1965, p. 235-248.

A theoretical discussion is given of charge carrier generation in the bulk of molecular crystals of organic molecules, and of carrier mobility in aromatic crystals.

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Chicago U. Inst. for the Study of Metals, Ill.

CHEMICAL PREDICTIONS BY MO THEORY: THE RARE GAS HALIDES, by J. Jortner and S. A. Rice. [1965] [13]p incl. tables, refs. (AFOSR-66-1458) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and National Science Foundation) AD 641212 Unclassified

Also published in Modern Quantum Chemistry, Part I Orbitals, Istanbul Lectures, Internat'l. Summer School of Quantum Chemistry, Istanbul (Turkey) (Aug. 16-Sept. 5, 1964), ed by O Sinanoğlu. New York, Academic Press, 1965, p. 15-47

A semi-empirical analysis is made of the molecular structure of the xenon fluorides. Topics include. the electron-correlation method; the molecular orbital model, the valence bond model; interpretation of physical properties in terms of the models (molecular geometry, ESR, NMR, magnetic susceptibility. Mossbauer effect, heats of sublimation), excited electron states (allowed and forbidden transitions, Rydberg states).

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Chicago U. Inst. for the Study of Metals, Ill.

EXCITONS AND ENERGY TRANSFER IN MOLECULAR CRYSTALS, by J. Jortner, S. A. Rice, and R. Silbey. [1965] [22]p. incl. diagr. table, refs. (AFOSR-66-1506) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], National Science Foundation, and Public Health Service) AD 641209 Unclassified

Also published in Modern Quantum Chemistry, Part III Action of Light and Organic Crystals, Istanbul Lectures, Internat'l. Summer School of Quantum Chemistry, Istanbul (Turkey) (Aug. 16-Sept. 5, 1964), ed. by O. Sinanoğlu. New York, Academic Press, 1965, p 139-160.

A critical discussion is presented of some properties of exciton states in molecular crystals of aromatic molecules Emphasis is given to the problems related to the theoretical interpretation of singlet exciton states. Triplet and charge transfer exciton states are briefly considered.

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Chicago U. Inst. for the Study of Metals, Ill.

ANTIRESONANCES IN DOPED MOLECULAR SOLIDS—EXPERIMENTAL EVIDENCE FOR CONFIGURATION MIXING OF IMPURITY STATES AND CONDUCTION-BAND STATES, by E. S. Pysh, S. A. Rice, and J. Jortner. [1965] [3]p. incl. diagrs. refs. (Sponsored

jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Public Health Service)
Unclassified

Published in Phys. Rev., Ltrs., v. 15: 289-291, Aug. 16, 1965.

The absorption spectra arising from acetylene and benzene impurity states in solid Kr in the far uv region were described. Kr doped with acetylene (1%) shows 2 diffuse absorption bands at 8.67 and 8.90 ev. Benzene-doped Kr shows a series of negative peaks, which are evaluated in detail by using various possible theories.

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Chicago U. Inst. for the Study of Metals, Ill.

A BRIEF REVIEW OF SOME ASPECTS OF THE MOLECULAR THEORY OF LIQUIDS, by S. A. Rice. [1965] [91]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], Alfred P. Sloan Foundation, National Science Foundation, and Petroleum Research Fund)
Unclassified

Published in Liquids: Structure, Properties, Solid Interactions, Proc. of Symposium, General Motors Research Laboratories, Warren, Mich. (Sept. 5-6, 1963), ed. by T. J. Hughel. Amsterdam, Elsevier, 1965, p. 51-141.

This paper deals with the following topics: (1) An elementary survey of the macroscopic equilibrium properties of liquids, (2) Macroscopic and molecular interpretations of dissipative processes, (3) Transport properties in dense fluids, (4) A theory of the approach to equilibrium, (5) Derivation of kinetic equations, (6) The Rice-Allnatt theory of transport phenomena in monoatomic dense fluids, (7) Thermal conduction in fluids, (8) Computation of the shear viscosity in dense fluids, (9) Self-diffusion and molecular friction in dense fluids, and (10) The validity of the Rice-Allnatt theory and agreement with experiment. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

THE CHEMISTRY OF XENON, by J. G. Malm, H. Selig and others. [1965] [38]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and National Science Foundation)
Unclassified

Published in Chem. Rev., v. 65: 199-236, Apr. 1965.

All experimental and theoretical works on the chemistry of xenon published through June 1964 are reviewed. The study of xenon chemistry is limited to the stable fluorides and their complexes, two unstable oxides, and the aqueous species derived from the hydrolysis of the fluorides. The nature of the chemical bond in xenon fluorides is discussed. Interpretations of physical properties are considered, along with excited electronic states. Theoretical models are discussed.

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COMMENTS ON THE RICE-ALLNATT KINETIC EQUATIONS, by N. Hurt and S. A. Rice. [1965] [2]p. [AF AFOSR-65-781]
Unclassified

Published in Jour. Chem. Phys., v. 42: 4061-4062, June 15, 1965.

The equivalence of the 3 general methods (those of Bogoliubov, Kirkwood, and Prigogine) for the derivation of kinetic equations permit the demonstration of the validity of the Rice-Allnatt equation in the dilute-gas limit. The correlation between the strongly repulsive force and the weak long-range force can be neglected.

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Chicago U. Inst. for the Study of Metals, Ill.

COMMENTS ON THE USE OF CARBON SCF ATOMIC ORBITALS IN AROMATIC MOLECULES, by R. Silbey, N. R. Kestner and others. [1965] [2]p. incl. tables. [AF AFOSR-65-781]
Unclassified

Published in Jour. Chem. Phys., v. 42: 444-445, Jan. 1, 1965.

The effective "atomic" orbitals needed in molecules are somewhat less extended in space than the self-consistent field atomic orbitals due to shifts in electron density needed for binding. To determine the adequacy of this approximation the π-type orbitals of the C_2 molecule have been investigated.

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Chicago U. Inst. for the Study of Metals, Ill.

A CONJECTURE ON CONFORMATIONS LEADING TO ENERGY TRAPPING IN HELICAL POLYMERS, by I. H. Hillier and S. A. Rice. [1965] [7]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Public Health Service)
Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 53: 973-979, May 1965.

The conformations favorable to "excimer" formation in helical polymers are examined. It is concluded that in polystyrene nearest neighbors participate, while in the α-helix, with benzyl residues, excimer formation is between third or fourth nearest neighbors. This explanation is consistent with experimental observations that denaturation of the α-helix inhibits the anomalous emission associated with "excimer" formation, while it is present in both iso- and atactic polystyrene. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

CONJECTURE ON THE RATE OF VIBRATIONAL RELAXATION OF A DIATOMIC MOLECULE IN A MONATOMIC LATTICE, by H.-Y. Sun and S. A. Rice. [1965] [5]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Public Health Service) Unclassified

Published in Jour Chem. Phys., v. 42. 3820-3830, June 1, 1965.

In this paper we use a simple model—a substitutional diatomic molecule in a linear monatomic chain—to examine the problem of intermolecular vibrational relaxation in the solid phase. A binary collision theory of vibrational deactivation is proposed for the relaxation process, with the motion of the collision partners governed by the normal modes of the lattice. The collision frequency is calculated by using an analysis similar to that of the Slater theory of unimolecular reactions. The model calculations predict the relaxation time to be very long compared with the vibrational period of the diatomic molecule. We thus conclude that, in a molecular crystal composed of polyatomic molecules, the excitation energy will be removed by the surrounding medium, not by the transformation of internal energy into lattice modes, but rather by other processes such as the formation of vibration excitons, etc. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

DEEP IMPURITY STATES IN MOLECULAR CRYSTALS: THE OPTICAL EXCITATION OF A SUBSTITUTIONAL ARGON ATOM IN CRYSTALLINE NEON, by S. Webber, S. A. Rice, and J. Jortner. [1965] [13]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], National Science Foundation, and Public Health Service) Unclassified

Published in Jour. Chem. Phys., v. 42: 1907-1919, Mar. 15, 1965.

The calculation of the first electronic transition of an argon-atom impurity in a neon lattice is carried out in the Heitler-London scheme. The energy of this transition is taken to be the energy of the argon atomic transition, plus the correction to the SCF 4s orbital energy due to the presence of the crystal. The modification to the SCF 4s orbital is accomplished by the addition of charge-transfer functions on neighboring neon atoms. It is shown that the choice of the SCF atomic function is a very bad starting point for these systems. A general method for choosing basis functions for bound systems is presented. It is shown that for many cases a suitably chosen "model Hamiltonian" may be appropriate to a more complex system, and the case of a dielectrically screened hydrogenic "model Hamiltonian" is worked out for Ar-Ne.

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Chicago U. Inst. for the Study of Metals, Ill.

ELECTRON ENERGY GAPS IN A ONE-DIMENSIONAL LIQUID, by K. Hiroike. [1965] [7]p. incl. diagrs refs. [AF AFOSR-65-781] Unclassified

Published in Phys. Rev., v. 138: A422-A428, Apr. 19, 1965.

The method of Faulkner and Korringa is applied to a 1-dimensional liquid in which the atomic potentials are δ functions and the distances between neighboring atoms satisfy a Gaussian distribution. It is shown that an energy gap exists if σ, the standard deviation in the Gaussian distribution, is small enough The behavior of the energy gaps as σ is varied agrees very well with the numerical results of Makinson and Roberts. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

ELECTRON MOBILITIES IN LIQUID ARGON, by H. Schnyders, S. A. Rice, and L. Meyer. [1965] [4]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], National Science Foundation, Petroleum Research Fund, and Public Health Service) Unclassified

Published in Phys. Rev. Ltrs., v. 15: 187-190, Aug. 2, 1965.

The electron mobilities, μ, were measured both as a function of temperature, from 80 to 116 K, at 7 atm and electric fields E = -150 and -200 v/cm, and as a function of pressure from 10 to 90 atm at 100.3 K and E = -200 v/cm. The results agree with the theoretical μ values provided that a scaling factor of 1.8 is used in the calculations. In addition the electron drift velocities, ν_d, were measured as a function of E from 120 to 200 v/cm at 85.0 (6.0), 90.1 (7.0), and 105.5 K (8.3 atm). The ν_d vs E plots are straight lines passing through the origin.

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Chicago U. Inst. for the Study of Metals, Ill.

EXCHANGE EFFECTS ON THE ELECTRON AND HOLE MOBILITY IN CRYSTALLINE ANTHRACENE AND NAPHTHALENE, by R. Silbey, J. Jortner and others. [1965] [5]p. incl. diagrs tables. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-781, National Science Foundation, Petroleum Research Fund, and Public Health Service) Unclassified

Published in Jour. Chem. Phys, v. 42 733-737, Jan. 15, 1965.

Results are presented of calculations of the electron and hole band structure of crystalline anthracene and naphthalene in the right binding approximation, and of the

mobility tensor in the constant-free-time and constant-free-path approximations. This treatment differs from previous formulations by inclusion of the effects of intermolecular electron exchange and of vibronic coupling (in the weak coupling scheme). The bandwidths were found to be of the order of 0.02 ev and smaller, and the mobility data were found to be consistent with the band scheme. The predicted mobility in the c direction is found to be in good agreement with experiment, in contrast to previous treatments.

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Chicago U. Inst. for the Study of Metals, Ill.

LOCALIZED EXCITATIONS IN CONDENSED Ne, Ar, Kr, AND Xe, by J. Jortner, L. Meyer and others. [1965] [4]p. incl. diagr. table, refs. (Sponsored jointly by Advanced Research Projects Agency; [Air Force Office of Scientific Research under AF AFOSR-65-781], National Science Foundation, Petroleum Research Fund, and Public Health Service) Unclassified

Published in Jour. Chem. Phys., v. 42: 4250-4253, June 15, 1965.

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Phys., Columbus, Ohio, (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9 (Pt. A): 356-359, 1965.

Experiments are reported which lead to the conclusion that electronic excitation energy in solid and liquid Ne, Ar, Kr, and Xe can be trapped by the formation of excimers. The consistency of this conclusion with other electronic properties of these substances is briefly discussed.

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LOW-ENERGY ELASTIC SCATTERING OF ELECTRONS AND POSITRONS FROM HELIUM ATOMS, by N. R. Kestner, J. Jortner and others. [1965] [11]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Office of Naval Research) Unclassified

Published in Phys. Rev., v. 140: A56-A66, Oct. 4, 1965.

This paper calculates the electron-helium atom pseudopotential, and from that pseudopotential the cross section for low-energy elastic scattering of electrons from helium atoms. The agreement between experiment and theory is good. In addition, the scattering of low-energy positrons from helium atoms is considered. The case of electron-helium atom scattering is chosen only as an example of the use of the pseudopotential as a natural tool for the study of scattering problems. The numerical calculations demonstrate that the results obtained in this way are of comparable accuracy with the results of more tedious and less instructive approaches. In particular, the use of pseudopotential arguments leads to an easily understood physical description. Moreover, because the pseudopotential approach permits the use of variational procedures, even in the presence of bound (i.e., core) states, the necessary calculations are not difficult to carry through. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

ON THE ELECTRONIC STATES OF CRYSTALLINE NAPHTHALENE, by R. Silbey, J. Jortner and others. [1965] [12]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], National Science Foundation, Petroleum Research Fund, and Public Health Service) Unclassified

Published in Jour. Chem. Phys., v. 42: 2948-2959, Apr. 15, 1965.

An attempt is made to correlate the observed electronic spectrum of crystalline naphthalene with the observed spectrum of the free molecule. The normal Frenkel exciton theory is extended to include ion-pair states, and the effect of these on the spectrum is taken into account. The observed spectrum can be accounted for in the present analysis, if the ion-pair state is energetically close to the first excited singlet state of naphthalene.

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Chicago U. Inst. for the Study of Metals, Ill.

ON THE EQUATION OF STATE OF THE RIGID-SPHERE FLUID, by S. A. Rice and J. Lekner. [1965] [7]p. incl. diagrs. tables, refs. [AF AFOSR-65-781] Unclassified

Published in Jour. Chem. Phys., v. 42: 3559-3565, May 15, 1965.

A well-known integrodifferential equation due to Yvon, Born and Green, Kirkwood, and Bogoliubov (YBGKB) connects the pair and triplet distribution functions $g^{(2)}$ and $g^{(3)}$ of a classical fluid. An expression for $g^{(3)}$ is needed in order that the equation may be solved for $g^{(2)}$. An exact formal expression is known: $g^{(3)}(123) = g_s^{(3)}(123) \exp\left[\sum_{n+1}^{\infty} \rho^n \delta_{n+3}(123)\right]$, where $g_s^{(3)}$ is the superposition of the pair distribution functions, and the terms $\delta_{n+3}(123)$ in the exponent evaluate the correlations between particles fixed at 1, 2, and 3 and n other particles in the fluid. The first term δ_4 is known for hard spheres, and we have numerically evaluated δ_5 for three special configurations in order to approximate the entire series by the simplest Padé approximant, i.e., $\rho\delta_4/(1-\rho\delta_5/\delta_4)$. The YBGKB equation was solved using this approximation for $g^{(3)}$, and the pressure obtained from the contact value of $g^{(2)}$ is in almost perfect agreement with the molecular-dynamics data of Alder and Wainwright up to $p/\rho kT = 6.80$, which is the

Kirkwood upper limit for stability of a fluid of hard spheres. The results obtained with the use of only b_4 in the expression for the triplet distribution function are also presented. The Kirkwood theory of the fluid-solid transition is briefly discussed with reference to the hard-sphere system.

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Chicago U. Inst. for the Study of Metals, Ill.

ON THE KINETIC THEORY OF DENSE FLUIDS. XIX. COMMENTS ON AND A REDERIVATION OF THE KINETIC EQUATIONS, by K. Hiroike, P. Gray, and S. A. Rice. [1965] [10]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Petroleum Research Fund) Unclassified

Published in Jour. Chem. Phys., v. 42: 3134-3143, May 1, 1965.

This paper rederives the Rice-Allnatt kinetic equation and shows that, for the soft-force part of the interaction, the constant friction-coefficient Fokker-Planck operator is the first approximation to a more complex operator. This more complex operator is of the general Fokker-Planck form, but has momentum-dependent friction coefficients. The operator derived herein is identical with the operator obtained from the Prigogine theory in the weak coupling limit. The consistency between the Rice-Allnatt analysis of transport in liquids and the exact perturbation analysis of Prigogine is examined, as is the internal consistency of the Rice-Allnatt analysis. At present, there appears to be no inconsistencies between the two theories.

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Chicago U. Inst. for the Study of Metals, Ill.

ON THE QUANTUM-MECHANICAL FOKKER-PLANCK EQUATION, by H. T. Davis, K. Hiroike, and S. A. Rice. [1965] [10]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], Army Research Office (Durham), Petroleum Research Fund, and National Science Foundation) AD 635004 Unclassified

Published in Jour. Chem. Phys., v. 43: 2633-2642, Oct. 15, 1965.

Taking the Wigner function as the basic N-body distribution function, quantum-mechanical modifications to the Fokker-Planck equation are studied using the two different approaches introduced, respectively, by Kirkwood and Prigogine. The weak coupling limit is studied using the time smoothing technique first introduced by Kirkwood. The results can perhaps form the basis of an approximate treatment of the transport phenomena of pure liquids. The problem of the Brownian motion of a heavy particle is treated employing the perturbation techniques developed by Prigogine and co-workers. It is found that the form of the quantum-mechanical Fokker-Planck equation is identical to the classical equation, but that the friction coefficient contains quantum-mechanical corrections. Finally, it is noted that the weak coupling result obtained by the time-smoothing technique is identical to the approximation of small momentum transfer, if in the latter case the scattering cross section is represented in the Born approximation.

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Chicago U. Inst. for the Study of Metals, Ill.

ON THE SINGLET EXCITON STATES OF CRYSTALLINE ANTHRACENE, by R. Silbey, J. Jortner, and S. A. Rice. [1965] [20]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], National Science Foundation, Petroleum Research Foundation, and Public Health Service) Unclassified

Published in Jour. Chem. Phys., v. 42: 1515-1534, Mar. 1, 1965.

A detailed analysis of the lower excited states of crystalline anthracene is presented. Starting with zero-order product wavefunctions, the treatment differs from standard formulations in that interactions between molecules are computed directly by the use of π-electron theory, by the inclusion of the effects of extensive configuration mixing, and by the inclusion of long-range interactions out to the convergence limit. It is found that: (1) The computation of interaction energies cannot be reduced to dipole-dipole terms alone. By the use of π-electron theory it is shown that short-range high-order multipole (greater than dipole) interactions make important contributions to both the diagonal and off-diagonal elements of the energy matrix. (2) Long-range interactions of the dipole-dipole type are of importance for distances of the order of the wavelength of light. By application of momentum-conservation conditions, it is shown that the long-range dipole-dipole interactions, including the effects of retardation of the potential, are absolutely convergent. Major contributions to the Davydov splitting arise from molecular separations ranging from 50A to the convergence limit. (3) For the case of allowed singlet-singlet transitions, electron-exchange interactions are small relative to other contributions to the interaction energy. (4) Under the experimental conditions used to date, the Davydov splitting should be independent of crystal thickness. (5) In anthracene, crystal-field mixing of the p and s molecular states has a large effect on the Davydov splitting. Inclusion of mixing with higher excited π states has little effect on the Davydov splitting, but is required in the calculation of the polarization ratios in the vibronic components of the p band. (6) Charge-transfer exciton states play only a minor role in altering the properties of singlet exciton states arising from allowed transitions. (7) The detailed calculations reported herein yield good agreement with the observed Davydov splitting (ΔE) and polarization (P) ratios in anthracene.

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POSSIBLE USES OF HIGH PRESSURE TECHNIQUES FOR THE STUDY OF THE ELECTRONIC STATES OF

MOLECULAR CRYSTALS, by S. A. Rice and J. Jortner. [1965] [106]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Public Health Service) Unclassified

Published in Physics of Solids at High Pressures; Proc. First Internat'l. Conf., Tucson, Arizona (Apr. 20-23, 1965), ed. by C. T. Tomizuka and R. M. Emrick. New York, Academic Press, 1965, p. 63-168. (AFOSR-66-0131)

The paper surveys the current theory of the electronic states of molecular crystals of organic aromatic molecules, and examines how experimental studies at high pressures may be used to solve some of the problems arising in the interpretation of the observation. The survey is made under the following headings: singlet exciton states; charge-transfer excitons; triplet excitons; the excess electron band structure of crystals of aromatic compounds; pressure induced structural changes; pressure effects on radiationless transitions; a survey of the electrical properties of organic crystals at high pressure; the high pressure optical properties of organic compounds; pressure effects on intermolecular exchange interactions; pressure effects on the electron and hole mobility in organic crystals; and new experiments.

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THE STATISTICAL MECHANICS OF SIMPLE LIQUIDS; AN INTRODUCTION TO THE THEORY OF EQUILIBRIUM AND NON-EQUILIBRIUM PHENOMENA, by S. A. Rice and P. Gray. New York, Interscience Publishers, 1965, 582p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], Alfred P. Sloan Foundation, and Petroleum Research Fund) Unclassified

This book is primarily concerned with the theory of transport in simple liquids and the extensive development of the equilibrium theory. It attempts to attain 3 goals: (1) the provision of a systematic and coherent description of the theory of liquids, as it now stands, emphasizing the analysis and assessment of the approximations made and the relationship between theory and experiment; (2) the encouragement of further study, by exposing the theory in a manner which directs attention to the fundamental problems, and (3) the provision of an account of the theory suitable as an introduction to research.

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Chicago U. Inst. for the Study of Metals, Ill.

STUDY OF THE PROPERTIES OF AN EXCESS ELECTRON IN LIQUID HELIUM. I. THE NATURE OF THE ELECTRON-HELIUM INTERACTIONS, by J. Jortner, N. R. Kestner and others. [1965] [12]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Public Health Service) Unclassified

Published in Jour. Chem. Phys., v. 43: 2615-2625, Oct. 15, 1965.

A theoretical study is presented of the free and localized states of an excess electron in liquid helium. Electron-helium interactions are treated by the pseudopotential method, while multiple scattering effects on the properties of a quasifree electron in the dense fluid are treated using the Wigner-Seitz model. It is demonstrated that the plane-wave state is not the lowest energy state for an excess electron in liquid helium and that fluid deformation leads to a localized state of lower energy. The large, repulsive helium-atom pseudopotential coupled with the small helium polarization potential lead to electron localization which may be attributed entirely to short-range repulsions. The following experimental observations are adequately interpreted by these results: (a) The energy barrier of liquid helium for electrons, (b) The density-dependent transition from a delocalized state to a localized state of the excess electron, (c) The mobility of an excess electron in normal He^4 and in He^3. Pressure and temperature effects on the electron bubble are also discussed. It is concluded that a pressure-induced transition from the localized to the delocalized state of the excess electron will not occur in the fluid domain even at high pressures. Finally, some speculations concerning the optical properties of the excess-electron center are presented.

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Chicago U. Inst. for the Study of Metals, Ill.

STUDY OF THE PROPERTIES OF AN EXCESS ELECTRON IN LIQUID HELIUM. II. A REFINED DESCRIPTION OF CONFIGURATION CHANGES IN THE LIQUID, by K. Hiroike, N. R. Kestner and others. [1965] [8]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781] and Public Health Service) Unclassified

Published in Jour. Chem. Phys., v. 43: 2625-2632, Oct. 15, 1965.

A study of the structural changes in liquid helium in the vicinity of an excess electron is presented, using the formal similarity between the pair distribution function of an N-boson system with the wavefunction expressed as the product of pair wavefunctions, and the pair distribution function of a classical fluid. The present model leads to an interfacial surface energy term which is in good agreement with the observed surface tension of liquid helium at 0°K. An important contribution to the bubble energy arises from the volume kinetic energy arising from the excess kinetic energy of the fluid atoms removed from the boundary layer. The bubble radius of 12.4A calculated herein is found to be in excellent agreement with the available experimental data.

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Chicago U. Inst. for the Study of Metals, Ill.

THEORETICAL STUDIES OF SOLVATED ELECTRONS, by J. Jortner and S. A. Rice. [1965] [20]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific

Research under [AF AFOSR-65-781], Petroleum Research Fund and Public Health Service)
Unclassified

Presented at meeting of the Phys. Chem. Div. of the Amer. Chem. Soc., Atlantic City, N. J., Sept. 15-16, 1965.

Abstract published in 150th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1965.

Published in Advan. Chem. Ser., No. 50: 7-26, 1965.

Of the 3 models that have been proposed to explain the properties of excess electrons in liquid helium, 2 are considered in detail: (1) The electron is localized in a cavity in the liquid; (2) The electron is a quasi-free particle. The pseudopotential method is helpful in studying both of these models. The most useful treatment of electron binding in polar solvents is based on a model with the solution as a continuous dielectric medium in which the additional electron induces a polarization field. This model can be used for studies with the hydrated electron. (Contractor's abstract)

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Chicago U. [Inst. for the Study of Metals] Ill.

THE THEORY OF IONIC AND ELECTRONIC MOBILITY IN LIQUIDS, by S. A. Rice and J. Jortner. [1965] [127]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], National Science Foundation, Petroleum Research Fund, and Public Health Service)
Unclassified

Published in Prog. in Dielectrics, v. 6: 183-309, 1965.

This paper reviews the current status of the theory of ionic and electronic mobility in the liquid phase. Progress in the understanding of the behavior of charge carriers in liquids depends on both the theory of the equilibrium state and on certain aspects of the theories of irreversibility and transport phenomena in liquids. For this reason designed material is included to acquaint the reader with the major ideas of the theory of liquids. Emphasis throughout this paper is on the fundamental theory and on the underlying physical processes. Wherever possible the use of parameterized models is avoided as they frequently obscure important aspects of the physical situation by the introduction of ill-defined or ambiguous parameters.

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Chicago U. Inst. for the Study of Metals, Ill.

TRIPLET EXCITONS IN CRYSTALS OF AROMATIC MOLECULES, by J. Jortner, S. A. Rice and others. [1965] [15]p. incl. diagrs tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-781], National Science Foundation, and Public Health Service) Unclassified

Published in Jour. Chem. Phys., v. 42: 309-323, Jan. 1, 1965.

The band structure and the Davydov splitting of the first triplet exciton states in crystalline naphthalene, anthracene, and biphenyl are considered. It is found that: (a) An important contribution to the triplet exciton bandwidth arises from intermolecular exchange interaction. These interactions are calculated in the molecular orbital π-electron approximation. (b) Excitation exchange effects due to spin-orbit coupling are negligible. (c) Nonorthogonality corrections, considered within the framework of the symmetric orthogonalization procedure, have been found to be small. (d) Crystal-field mixing of triplet states arising from $\pi \rightarrow \pi^*$ excitations has no effect on the triplet bands. (e) An important contribution to the triplet exciton bandwidth may arise from configuration interaction with charge-transfer states. The dynamics of triplet excitons in aromatic crystals was studied in the two limiting cases of strong and weak scattering. The band model, with the constant mean-free-path approximation, leads to a mean free path of the order of one to two lattice distances and seems to be inappropriate. Trip-triplet annihilation leading to delayed blue fluorescence in crystalline anthracene can be adequately described in terms of a random-walk diffusion model when the effects of charge-transfer interactions are included.

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Chicago U. Inst. for the Study of Metals, Ill.

NEW THERMODYNAMIC POTENTIAL EFFECTS IN HELIUM II, by R. J. Donnelly. [1965] [2]p. incl. diagrs (AFOSR-65-2080) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-785 and National Science Foundation) AD 627496
Unclassified

Also published in Phys. Ltrs., v. 17: 109-110, July 1, 1965.

The purpose of this communication is to show that a number of thermodynamic potential effects may be observed between 2 baths of liquid helium II connected by a narrow channel, e.g., the saturated film, through which only the superfluid can pass. The effects discussed include pressure effects, centrifugal potential effects, and the effects of external fields other than gravity.

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Chicago U. Inst. for the Study of Metals, Ill.

PHASE COHERENCE AND STABILITY OF HELIUM II IN NARROW CHANNELS, by R. J. Donnelly. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-2081) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-785 and National Science Foundation) AD 627731 Unclassified

Also published in Phys. Rev. Ltrs., v. 14. 939-942, June 7, 1965.

A study is presented of the flow of superfluid helium through narrow channels which are narrow in the sense that the normal fluid is effectively clamped by its viscosity. Two situations are considered: (1) the flow of a saturated film without a potential difference and (2) a flow through a junction when the chemical potentials of the baths are different. Results are discussed in terms of the ac Josephson effect.

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Chicago U. Inst. for the Study of Metals, Ill.

CAPTURE CROSS SECTIONS FOR NEGATIVE IONS IN ROTATING HELIUM II, by B. E. Springett, D. J. Tanner, and R. J. Donnelly. [1965] [3]p. incl. diagrs. (AFOSR-65-2082) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-785 and National Science Foundation) AD 627730 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 585-587, Apr. 12, 1965.

This note presents experimental measurements of capture cross sections for negative ions in rotating helium II and compares them with calculated values. The measured cross section is given by $\sigma = \sigma(E_2) + (E_1)y_1/y_2$, where σ is the cross section, E_1 is the field in the region of length y_1 between the source and the grid, and E_2 is the field in the region of length y_2 between the grid, and the collector. The experimental apparatus is also described. The results are plotted as functions of temperature and applied voltage. The comparisons are in fairly good agreement. There is however a discrepancy in magnitude at low voltages which is throught to be due to the effects of space-charge limitation giving rise to a nonuniform field along the beam.

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Chicago U. Inst. for the Study of Metals, Ill.

THEORY OF THE INTERACTION OF IONS AND QUANTIZED VORTICES IN ROTATING HELIUM II, by R. J. Donnelly. [1965] [3]p. incl. diagrs. (AFOSR-65-2083) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-785 and National Science Foundation) AD 627725 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 39-41, Jan. 11, 1965.

The probability of capture and escape of ions by vortex lines are calculated for positive and negative ions having different radii but equal masses. The predictions are in qualitative agreement with observation.

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Chile U., Santiago.

AUDITORY AVOIDANCE BEHAVIOR AFTER EXTENSIVE AND RESTRICTED NEOCORTICAL LESIONS IN THE RAT, by M. A. Saavedra, T. Pinto-Hamuy, and C. Oberti. [1965] [5]p. incl. diagrs. table, refs. (AF AFOSR-61-84) Unclassified

Published in Jour. Compar. and Physiol. Psychol., v. 60: 41-45, Aug. 1965.

Twleve rats served as controls for 6 experimental groups (extensive lesion groups with and without damage of auditory cortex and 4 groups with restricted ablations centered on frontomotor, somatosensory, visual and auditory zones). The extensive lesion groups did not differ in auditory avoidance behavior; the 4 groups with restricted lesions did not differ among themselves but were significantly inferior to the normal rats and better than the extensive lesion groups. Frontomotor cortex seems to facilitate learning of a general motor response to a tone. The function of auditory and other sensory areas seem to be facilitatory; the effects could be exerted through the motor cortex. (Contractor's abstract)

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Chile U., Santiago.

OCULAR BEHAVIOR IN CHRONIC HIGH MESENCEPHALIC CATS (Abstract), by J. Villablanca. [1965] [1]p. (AFOSR-66-0844) [AF AFOSR-63-317] AD 641474 Unclassified

Also published in Abstracts of Papers presented at Twenty-third Internat'l. Cong. Physiological Sciences, Tokyo (Japan), Sept. 1-9, 1965.

Pupil behavior and ocular movements were studied in chronic cats with mesencephalic transection rostral to the oculomotor nuclei, these events were correlated to the behavioral arousal of the animal, the eeg recorded at mesencephalic and pontine reticular formation, EMG, EKG, and respiration. The findings are as follows: (1) Pupils are midriatic, nictitatings are retracted and slow movements of the eyes are present when the cat is awake. (2) A variable myosis ard closure of the nictitatings is observed, when the cat is lying down as if sleeping; pupils are extremely reactive to acoustical stimuli, and the EMG activity is diminished. (3) An extreme myosis, protruded nictitatings, downward rotation of the eyeballs and phasic movements of the eyes, are seen while the cat displays a deep sleep episode, EMG is silent. Conclusions are drawn from the data. (Contractor's abstract)

667

Chile U., Santiago.

THE ELECTROCORTICOGRAM IN THE CHRONIC CERVEAU ISOLÉ CAT, by J. Villablanca. [1965] [11]p. incl. illus. diagrs tables, refs. (AFOSR-66-0845) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-392 and AF AFOSR-63-317, and Rockefeller Foundation) AD 641472 Unclassified

Also published in Electroencephalog. and Clin. Neurophysiol. Jour., v. 19: 576-586, Dec. 1965.

The ECoG of cerveau isole preparation was studied in 16 high mesencephalic, chronic cats which survived for an average of 48 days. Relationships were sought between ECoG and the level of behavioral arousal and with the electrical activity at the brain-stem caudal to the transection. In the acute state, 2 ECoG patterns could be distinguished: spindle bursts or discontinuous slow waves; and continuous, high voltage slow activity. Periods of high voltage, continuous slow synchronized rhythms alternated with ECD in the chronic preparation. These cyclical lapses exhibited electrocortical synchronization which closely resembled the ECoG of slow sleep in the normal cat. Olfactory stimulation desynchronized the ECoG according to stage of the ECSP during which stimulation was presented. Maximal desynchronization was observed during the onset stage of the ECSP. The EEG patterns of the cerveau isole showed no systematic relationship with the level of arousal of the animal, nor with the electrical activity in the brain-stem. However the effect of nociceptive and proprioceptive stimulation revealed the possibility of an extraneural pathway which affected the ECoG of the isolated cerebrum. The possibility of the existence in the forebrain of the cat of an autochthonous tonic, mechanism capable of independently evoking a cyclic alternation between wakefulness and slow sleep is discussed.

668

Chile U., Santiago.

SYNAPTIC CONNECTIONS OF THE CENTRIFUGAL FIBERS IN THE PIGEON RETINA, by H. R. Maturana and S. Frenk. [1965] [3]p. incl. illus. diagrs. (AFOSR-66-1009) (AF AFOSR-64-628) AD 635457 Unclassified

Also published in Science, v. 150: 359-361, Oct. 15, 1965.

The centrifugal fibers in the pigeon retina end in the inner nuclear layer and form 2 kinds of terminals, convergent and divergent. In the inner nuclear layer the fibers synapse with amacrine and displaced ganglion cells. Because of their great number and their even distribution these fibers appear to constitute a system for the localized centrifugal control of the retinal functions.

669

Chile U., Santiago.

PHYSIOLOGICAL PROPERTIES OF THE GIANT AXON FROM DOSIDICUS GIGAS, by M. Luxoro, M. Cannessa, and F. Vargas. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-66-0987) [AF AFOSR-65-788] AD 635353 Unclassified

Also published in Proc Internat'l Union of Physiological Sciences, Twenty-third Internat'l. Cong., Tokyo (Japan) (Sept. 1-9, 1965), Amsterdam, Excerpta Medica Foundation, v. 4: 507-514, 1965.

Action potentials with overshoots between 30 to 55 mv were recorded from internally perfused axons. Concentrations of Na and K in the perfusing fluid and in the external medium were the same, only Ca and Mg were under chemical gradients. Simultaneous movements of Na-22 and Ca-45 were studied under internal perfusion. The ratios of permeability coefficients of the radioactive species at rest (2.2 to 3.9) and during stimulation at 50/sec (2.0 to 3.9) were the same. This finding and the fact that the increase in permeability of Rb-86 is of the same order of magnitude as that of Na-22, suggest that the permeability changes are less specific than previously thought. Na-K-Mg ATPase was isolated from this system. Activation of this enzyme by addition of Mg and a single monovalent cation was observed to a maximal rate at 300 M monovalent cation concentration Below this level, the effect of monovalent cations was additive and the enzyme discriminated between them in accordance with the lyotropic series. Divalent cations may alter the fixed charge of nerve proteins, in this connection, the effect of proteolytic enzymes was studied. Intracellular administration of proteases induced conduction block. Concerning the charge density of the membrane, water movement may provide information As a first step, the filtration coefficient was determined, the results differing from those in the literature Thus, these values are similar to those of other cells like muscle and erythrocytes.

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Cincinnati U., Ohio.

CILIA DEVELOPMENT AND ASSOCIATED PROTEIN SYNTHESIS IN THE SEA URCHIN EMBRYO (Abstract), by W. Auclair and D. M. Meisner. [1965] [1]p. (AFOSR-66-0289) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-964 and Public Health Service) AD 640938 Unclassified

Also published in Biol. Bull., v. 129 397, Oct 1965

The development of cilia during the blastula state of the sea urchin embryo is described. The synthesis of ciliary proteins is followed using C-^{14}-labeled glutamic acid and leucine, is found to be continuous throughout early development. The synthesis of these proteins is inhibited by actinomycin, an antibiotic that shuts off DNA-controlled RNA synthesis, although cilia still appear. It is concluded that normally there is continuous synthesis of ciliary proteins during early development for cilia formation, but it is not essential for the appearance of cilia. There is available in the cells of the embryo enough ciliary protein for the differentiation of cilia even if protein synthesis is stopped

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Cincinnati U. Dept. of Aerospace Engineering, Ohio.

STUDIES ON DISSOCIATING GASDYNAMICS. PART I ON THE LINEARIZED DISSOCIATING GASDYNAMICS, by T. Y. Li and S. J. Hsia July 1965 [53]p. incl diagrs refs. (Technical rept no AE 6501) (AFOSR-65-0849, pt 1) (AF AFOSR-64A-416) AD 620352 Unclassified

A small disturbance solution is obtained for a dissociated diatomic gas flowing around a straight 2-dimensional corner The analysis is based on a small disturbance

technique in which small departure from free stream conditions is assumed. An oxygen-like ideal dissociating gas is used as an example. (Contractor's abstract, modified)

672

Cincinnati U., Dept. of Aerospace Engineering, Ohio.

STUDIES ON DISSOCIATING GASDYNAMICS. PART II. HYPERSONIC SMALL PERTURBATION THEORY WITH EQUILIBRIUM DISSOCIATION AND IONIZATION OF AIR FOR BODIES ASSOCIATED WITH POWER LAW SHOCK WAVES, by T. Y. Li and K. W. Chang. July 1965 [37]p. incl. diagrs. refs. (Technical rept. no. AE 6502) (AFOSR-65-0849, pt. 2) (AF AFOSR-64A-416) AD 623777 Unclassified

The inviscid equilibrium hypersonic flow associated with a power-law shock is investigated. An analytical formulation is presented for a pure dissociating gas in thermal equilibrium. In order to obtain a method applicable to a mixture of gases and partly take into account the entropy layer effects, the locally similar solution approach is proposed. (Contractor's abstract, modified)

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Cincinnati U., Dept. of Aerospace Engineering, Ohio.

STUDIES ON DISSOCIATING GASDYNAMICS. PART III. ON THE DISSOCIATED HYPERSONIC LAMINAR BOUNDARY LAYERS, by S. J. Hsia and T. Y. Li. July 1965 [82]p. incl. diagrs. refs. (Technical rept. no. AE 6503) (AFOSR-65-0849, pt. 3) (AF AFOSR-64A-416) AD 621485 Unclassified

Some recent advances are reviewed and an effort is made to gather some useful information from the available literature on the study of laminar boundary layers problems including effects of chemical reactions. Particular attention is directed to the discussion of the effects resulting from the consideration of strong self-induced pressure field, of reacting external inviscid flow and of the thermodynamic properties of the reacting gas mixture. (Contractor's abstract, modified)

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City U. of New York. City Coll., N. Y.

INFRARED ABSORPTION OF STRAINED SILICON, Final rept. Dec. 16, 1965, 2p. (AFOSR-65-2703) (AF AFOSR-63-175) Unclassified

Work accomplished under this contract is reviewed. This includes the development of equipment and techniques necessary for measuring the stress dependence of the absorption coefficient of germanium and silicon at room temperature in the direct absorption edge region. In addition, work was begun on the development of equipment and techniques necessary to extend these measurements to lower temperatures and to the free carrier absorption region.

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City U. of New York. City Coll., N. Y.

INFRARED ABSORPTION OF UNIAXIALLY STRESSED GERMANIUM, by J. F. Aschner and E. Erlbach. [1965] [3]p. incl. diagrs (AFOSR-66-1523) (AF AFOSR-63-175) AD 641522 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 108, Jan. 27, 1965.

Also published in Jour. Phys. and Chem. Solids, v. 26: 2078-2080, Dec. 1965.

The changes in the absorption coefficient α of intrinsic germanium have been measured in the region of the indirect absorption edge as a function of uniaxial compressive stress. The stress was applied to the long axis of parallelopiped-shaped samples (2.5 x 0.1 x 0.1 cm), this axis being <111>. The infrared light was incident in a direction perpendicular to the stress, which ranged up to 7000 kg/cm^2. Using the most-recent values of the deformation potential constants, it is found that the energy gap for the conduction-band valley lying in the stress direction decreases with compressive stress while that of the other three valleys increases. Therefore, the changes in α from the unstressed condition should be positive at the lower energies and negative at the higher energies within the absorption-edge region, the changes increasing with stress in both cases. This has been confirmed both experimentally and by performing a calculation similar to that of McLean for the band structure of the deformed crystal. Quantitative comparison between experiment and theory is currently in progress.

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City U. of New York. City Coll., N. Y.

POLARIZATION DEPENDENCE OF INFRARED ABSORPTION IN GERMANIUM (Abstract), by J. F. Aschner and E. Erlbach. [1965] [1]p. [AF AFOSR-63-175] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 344, Mar. 24, 1965.

Previously reported measurements on the changes in the absorption constant α for unpolarized light, caused by uniaxially stressing germanium, have been extended to the case of polarized incident radiation. All the measurements were performed at room temperature in the region of the indirect absorption edge. Uniaxial stresses up to 7000 kg/cm^2 were applied in various crystallographic directions. Since germanium has cubic symmetry, no polarization dependence is permitted in the unstressed case and none was found. Uniaxial stress destroys this symmetry, however, thus allowing such a dependence to occur. A pronounced dependence on

polarization was found when uniaxial stress was applied in the <111> direction. Using the theoretical expression for α, it can be shown that this dependence arises from the destruction of the cubic symmetry of the valence and <000> conduction-band structure and/or the matrix element for the direct transition. The authors expect to obtain information on the angular dependence of the matrix elements from these measurements.

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City U. of New York. City Coll., N. Y.

THE LOGIC OF DECISION, by R. C. Jeffrey. New York, McGraw-Hill, 1965, 201p. incl. diagrs. tables, refs. (AFOSR-64-2465) (AF AFOSR-64-529) AD 633480 Unclassified

The Bayesian account of deliberation is viewed as providing, in a certain sense, a logic of decision. The text elucidates notions of subjective probability and subjective desirability or utility that form the core of Bayesian decision theory. A new theory of preference between propropositions (the events of mathematical probability theory) is proposed, within which a Bayesian agent's probability and utility functions are determined by features of his preference ranking. The elementary logical operations on propositions (denial, conjunction, disjunction) do the work that is done by the operation of forming gambles in the "classical" theory of Ramsey and Savage. In the new theory, the preference ranking of propositions determines the utility function only up to a fractional linear transformation with positive determinant, and determines the probability function only to within a certain quantization. The present theory is shown to be immune to the St. Petersburg paradox, so that one can reasonably be a Bayesian in the present sense and still have an unbounded utility function. Philosophical questions are considered that deal with uncertain evidence where an observation leads the agent to change his degrees of belief in one or more propositions to new values that fall short of 1. The final chapter suggests how notions of objective probability and desirability might fit into the subjectivistic framework.

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City U. of New York. City Coll., N. Y.

NEW FOUNDATIONS FOR BAYESIAN DECISION THEORY, by R. C. Jeffrey. [1965] [12]p. incl. diagr. (AFOSR-66-0417) (AF AFOSR-64-529) AD 632737 Unclassified

Also published in Logic, Methodology and Philosophy of Science; Proc. 1964 Internat'l. Cong., Hebrew U., Jerusalem (Israel) (Aug. 26-Sept. 2, 1964), ed. by Y. Bar-Hillel. Amsterdam, North-Holland Publishing Co., 1965, p. 289-300.

A theory of subjective probability and utility is outlined that is viewed as simpler and more satisfactory than Ramsey's ("Truth and Probability," in Foundations of Mathematics and Other Logical Essays, 1931). The theory is unified in the sense that probabilities and utilities are attributed to precisely the same objects, that is, to members of a class of propositions closed under the finite truth functional operations but from which the impossible proposition is deleted. The theory is noncausal in the sense that neither $[\ ,\ ]$ nor any other such causal notion is taken as primitive. The linear transformation in Ramsey's theory is a fractional linear transformation $U_2 = \frac{aU_1 + b}{cU_1 + d}$ in the present theory. This transformation may change probabilities. Boundedness above and boundedness below are not preferentially significant properties of utility functions in the present theory. The St. Petersburg paradox cannot occur in the agent's preference ranking.

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Clarkson Coll. of Tech. Dept. of Physics, Potsdam, N. Y.

BEHAVIOR OF YOUNG'S MODULUS OF A BETA BRASS SINGLE CRYSTAL FOR VARIOUS QUENCH TEMPERATURES, by M. C. Martin and H. E. Camp. [1965] [4]p incl. diagr. table, refs. (AFOSR-65-1926) (AF AFOSR-62-254) AD 626895 Unclassified

Also published in Jour. Appl. Phys., v. 36, 2154-2157, July 1965.

The standard direct strain method was used to determine the effect on Young's modulus of quenching - brass in a saturated salt solution. The measurements were made on one - brass single crystal with orientation function f(l, m, n) = 0.121. The measurements were performed at the temperatures of 25, -30, -90, and -196 C. From the measurements the reciprocal of Young's modulus was calculated and 2 anomalous points were determined. The increase in Young's modulus for the quench temperature of 275 C was attributed to isolated wrong pairs of atoms. The increase in Young's modulus at the quench temperature of 450 C was attributed to disorder being quenched in. (Contractor's abstract)

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Clarkson Coll. of Tech. Dept of Physics, Potsdam, N. Y.

ANISOTROPIC BEHAVIOR OF THE ELASTORESISTANCE EFFECT OF IRON SINGLE CRYSTALS, by M. C. Martin, E. A. Selleck, and G. D. Singer [1965] [2]p incl. diagr. table, refs. (AFOSR-66-1628) [AF AFOSR-65-794] AD 641241 Unclassified

Also published in Jour. Appl. Phys., v. 36 3950-3951, Dec. 1965.

The relationship between the elastoresistivity constants of single crystals of iron and the orientation function were examined. The deflection method was used employing a compensated potentiometer circuit and using static loads at room temperature. It was found that this relationship was linear as predicted by Bridgman's theory. The slopes for elastoresistance coefficient and elastoresistivity coefficient versus orientation function are given

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Clarkson Coll. of Tech. [Dept. of Physics] Potsdam, N. Y.

LOW-COST LIQUID NITROGEN CONTAINER, by M. C. Martin and K. F. Welton. [1965] [1]p. (AFOSR-66-1665) [AF AFOSR-65-794] AD 641244 Unclassified

Also published in Amer. Jour. Phys., v. 33. 1090, Dec. 1965.

A large bowl-shaped polyurethane container is described for use as low-cost liquid nitrogen container.

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Clemson U. [Dept. of Physics] S. C.

SIZE EFFECTS IN RESIDUAL RESISTANCE RATIOS FOR ZINC "WHISKERS", by M. J. Skove and E. P. Stillwell. [1965] [2]p. incl. diagr. refs. (AFOSR-66-0222) [AF AFOSR-63-180] AD 629701 Unclassified

Also published in Appl. Phys. Ltrs., v. 7· 241-242, Nov. 1, 1965.

The resistance ratios of 99.999% zinc whiskers have been found to depend strongly on diameter, whereas for thin ribbons the ratio varies little with the thickness. Marked increases in resistance on surface etching suggest some specular reflection of the electrons.

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Clemson U. [Dept. of Physics] S. C.

ELASTIC STRENGTH OF TIN WHISKERS IN TENSILE TESTS, by B. E. Powell and M. J. Skove. [1965] [2]p. incl. diagr. table. (AFOSR-65-2577) [AF AFOSR-65-180] AD 629850 Unclassified

Presented at meeting of the Amer. Phys. Soc., Chattanooga U., Tenn., Nov. 5-7, 1964.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 255, Feb. 25, 1965.

Also published in Jour. Appl. Phys., v. 36 1495-1496, Apr. 1965.

Tin whiskers were grown on tin-plated steel by the compression method; a period of 4 weeks was required to grow whiskers ranging in length from 1 to 1.5 mm The tensile tests were performed using a pulling apparatus capable of resolving the stress to 2×10^{-6} N and the elongation to 0.1 μ. The average yield strain of the ten strongest whiskers at room temperature was 1% The maximum yield strain was 2.9%, which is comparable to the results obtained in bending tests by other experimenters. Using the orientation obtained from Laue x-ray diffraction patterns, the strain cross section was determined.

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Clemson U. [Dept. of Physics] S. C.

SIZE EFFECT ON THE MAGNETORESISTANCE OF COPPER SINGLE CRYSTALS (Abstract), by E. P. Stillwell and M. J. Skove. [1965] [1]p. [AF AFOSR-65-180] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chattanooga U., Tenn., Nov. 5-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 255, Feb. 25, 1965.

The effect of sample dimensions on the transverse magnetoresistance of copper single-crystal whiskers has been observed. Previous observations of this effect have been limited to sodium polycrystalline wires due to the high-bulk magnetoresistance of other metals. In single-crystal samples, the magnetoresistance saturates for certain magnetic-field directions allowing the size effect to be seen. Such an effect was observed in a whisker with axis parallel to the [100] direction in a magnetic field parallel to the [010] direction. The sample cross section was $35.9 \pm 0.6\ \mu^2$ and the resistivity ratio $\rho 300^\circ K/\rho 4.2K$ was 139 ± 1. This gives the electron mean free path in the sample at 4.2°K to be approximately equal to the square root of the sample cross section. A maximum in the resistance at 4.2°K was observed at about 1.5 teslas.

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Cold Spring Harbor Lab of Quantitative Biology, New York.

COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY, VOL. XXX. SENSORY RECEPTORS, Cold Spring Harbor, N. Y. (June 4-11, 1965), ed. by L. Frisch Cold Spring Harbor Laboratory of Quantitative Biology, 1965 649p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-426, Atomic Energy Commission, National Institutes of Health, National Science Foundation, and Public Health Service) Unclassified

Papers presented at this symposia are classified under the following subject headings. General Physiology, Mechanoreceptors, Hearing, Olfactory Receptors, Electrical and Chemical Receptors, Photoreceptors, and Data Processing.

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Colorado School of Mines Research Foundation, Inc., Golden

PRODUCTION OF OXYGEN FROM SILICATES IN AN ULTRAHIGH VACUUM, by F. L. Smith [Final rept. June 21, 1962-Apr 7, 1965 Apr 12, 1965 [23]p incl illus diagrs (AFOSR-65-0739) (AF AFOSR-62-426) AD 615706 Unclassified

The object was to determine if an ultrahigh vacuum facilitated the decomposition of silicates into oxygen and silicon oxide (SiO) or silicon (Si) The practical object

was to initiate further research on the possibility of using this oxygen as a lunar resource. An ultrahigh vacuum chamber was constructed capable of obtaining pressures down into the 10^{-12} torr range, and simulating the lunar environment. In order to monitor the results of the experiments, a small mass spectrograph was installed on the ultrahigh vacuum test chamber. Tests were run on silicon dioxide, magnesium silicate, and a tektite (an amorphous silicate). All tests indicate that the ultrahigh vacuum significantly lowered the decomposition temperatures of the silicates. In all cases oxygen production was initiated at 1316°C. At 1472°C the production of oxygen was materially accelerated. The mass spectrograph studied indicates that Si was produced rather than SiO. In view of the very high pumping speed of the diffusion pump and cryopump on the chamber, it is believed that oxygen production is significant in the 1400 to 1650°C range.

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Colorado U. Dept. of Chemistry, Boulder.

BRIDGED POLYCYCLIC COMPOUNDS. XXVIII. THE PROTON MAGNETIC RESONANCE SPECTRA OF SOME DIBENZOBICYCLO[3.2.1]OCTADIENES, by S. J. Cristol, J. R. Mohrig, and D. E. Plorde. [1965] [3]p. incl. diagr. tables, refs. (AFOSR-65-1646) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-62-79] and National Science Foundation) AD 624373 Unclassified

Also published in Jour. Org. Chem., v. 30: 1956-1958, June 1965.

Proton magnetic resonance spectra for a number of 4- and 8-substituted dibenzobicyclo[3.2.1]octadienes are measured. Correlations of these data lead to generalizations which permit stereochemical assignments for substituents in these systems. It is possible to assign spectral frequencies to each of the four aliphatic protons in these octadienes because their chemical shifts are generally different enough to give separate peaks for each proton. Further evidence for proton assignments is found in observing the effects of substitution upon the position of spectral lines.

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Colorado U. Dept. of Chemistry, Boulder.

BRIDGED POLYCYCLIC COMPOUNDS. XXX. EQUILIBRATION STUDIES OF SOME SUBSTITUTED DIBENZOBICYCLO[3.2.1]OCTADIENES AND DIBENZOBICYCLO[2.2.2]OCTADIENES, by S. J. Cristol, F. P. Parungo and others. [1965] [8]p. incl diagrs. refs. (AFOSR-65-2375) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-62-79] and National Science Foundation) AD 629547 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 2879-2886, July 5, 1965

It was found that the endo-2 isomers of various substituted dibenzobicyclo[3.2.1]octadiene derivatives were more stable than the exo epimers and that acid-catalyzed epimerizations were readily carried out. In addition, more severe conditions led, in many cases, to rearrangements from dibenzobicyclo[3.2.1]octadienes to [2.2.2] isomers. These results are discussed in light of possible mechanisms and possible carbonium ion intermediates involved. (Contractor's abstract)

689

Colorado U. Dept. of Physics, Boulder.

PRODUCTION AMPLITUDES. II. PARTIAL-WAVE DECOMPOSITION AND ANALYTIC CONTINUATION IN TOTAL ANGULAR MOMENTUM, by A. O. Barut and Y. C. Leung. [1965] [8]p. incl. diagr. refs. (AFOSR-66-0457) [AF AFOSR-63-30] AD 630446 Unclassified

Also published in Phys. Rev., v. 138 B1128-B1135, June 7, 1965.

The problem of analytic continuation in total angular momentum j of a production amplitude is investigated on the basis of analyticity in one of the momentum-transfer variables z for definite combinations of helicity amplitudes which are free of certain kinematical singularities. On this basis also an upper bound for production amplitudes is obtained which has the same value for all z as the bound of a forward-scattering elastic-scattering amplitude. Furthermore the consistency of the analyticity in the whole cut z plane is investigated For this case the singularities in the j plane extend indefinitely to the right even if only N subtractions are made. These singularities are removed only if the spectral functions satisfy certain integral relations to the effect that they oscillate more rapidly for higher spin. When these conditions are satisfied the essential singularities of the Gribov-Pomeranchuk type need not be introduced The analysis further shows the dynamical role played by the spin variable in an analytic S-matrix theory. (Contractor's abstract)

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[Colorado U. Dept. of Physics, Boulder]

MASS SPECTRUM FROM NON-COMPACT GROUPS, by A. O. Barut [1965] [15]p incl. diagrs. table, refs (AFOSR-66-0792) [AF AFOSR-63-30] AD 641240 Unclassified

Also published in High Energy Physics and Elementary Particles. Lectures Presented at a Seminar, International Centre for Theoretical Physics, Trieste (Italy) (May 3-June 30, 1965). Vienna, International Atomic Energy Agency, 1965, p. 679-694

The mass differences of particles are considered from the beginning as part of the general symmetry considerations. The paper is mainly concerned with the symmetry properties of the particles at rest considered a bound states for composite particles

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[Colorado U. Dept. of Physics, Boulder]

INVARIANT AMPLITUDES AND THE INTERPRETATION OF SU(3)- AND SU(6)-TYPE SYMMETRIES, by A. O. Barut [1965] [15]p. incl. table, refs. (AFOSR-66-0820) [AF AFOSR-63-30] AD 641242 Unclassified

Also published in High Energy Physics and Elementary Particles, Lectures Presented at a Seminar, International Centre for Theoretical Physics, Trieste (Italy) (May 3-June 30, 1965). Vienna, International Atomic Energy Agency, 1965, p. 707-721.

Different types of representations of the poincare group, according to the choice of the diagonalized subgroup, and different realizations in each type are reviewed. The construction of invariant and covariant amplitudes are discussed on the basis of a global representation. The 2 ways in which the spin-orbit effects enter into the amplitude are discussed. Then starting with the amplitudes under the exact invariance group of the strong interactions, it is shown that one obtains automatically terms in the amplitude which are SU(3), SU(4) and SU(6) invariant with other terms having definite transformation properties. A criterion is given when these symmetries (especially those of the SU(4) and SU(6) type) are consistent approximate symmetries.

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[Colorado U., Dept. of Physics, Boulder]

SIMULTANEOUS ANALYTIC CONTINUATION TO THE SECOND SHEET IN TWO CROSSED CHANNELS AND THE DETERMINATION OF COUPLING CONSTANTS, by A. O. Barut and T. Sawada. [1965] [2]p. incl. diagr. (AFOSR-66-0829) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-30] and National Science Foundation) AD 641245 Unclassified

Also published in Phys. Ltrs., v. 14. 248-249, Feb. 1, 1965.

The purpose of this paper is to give a justification to the remarkable relation between the coupling constants and a particular second sheet singularity. It is shown that the postulate which allowed an exact determination of coupling constants within the context of strong interactions can be reduced to a generalized form of analyticity to the effect that the scattering amplitude is, in all its Riemann sheets, as analytic as possible consistent with unitarity.

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Colorado U. Dept. of Physics, Boulder.

PRODUCTION AMPLITUDES. I. CONSTRUCTION OF INVARIANT AMPLITUDES, by A. O. Barut and Y. C. Leung [1965] [9]p. incl. diagrs. refs. (AFOSR-66-0830) [AF AFOSR-63-30] AD 641243 Unclassified

Also published in Phys. Rev., v. 138 B1119-B1127, June 7, 1965.

Lorentz-covariant scattering amplitudes for production processes involving both massive and massless particles are systematically discussed. Explicit forms of both the spin and the isospin amplitudes for production processes involving pions, nucleons, photons, and neutrinos, as well as the crossing relations in both spin and isospin variables, are given. (Contractor's abstract)

694

Colorado U. Dept. of Physics, Boulder.

RENORMALIZED PERTURBATION SERIES OF ELECTRODYNAMICS FROM S-MATRIX THEORY, by A. O. Barut and R. A. Blade [1965] [13]p. incl. diagrs. (AFOSR-65-2791) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-30] and National Science Foundation) AD 628409 Unclassified

Also published in Nuovo Cimento, Series X, v. 39: 331-343, Sept. 1, 1965.

Electromagnetic processes are evaluated using extended unitarity and analyticity of the scattering amplitude. Assuming e^2 to be small, a successive pole approximation of the unitarity relation and appropriate approximative analyticity assumptions to every order in e^2 are shown to be equivalent to renormalized Feynman perturbation theory.

695

Colorado U. [Dept. of Physics] Boulder.

ANALYTIC PROPERTIES OF THE PARTIAL WAVE AMPLITUDES FOR PRODUCTION PROCESSES IN THE COMPLEX J-PLANE, by A. O. Barut and Y. C. Leung. [1965] [10]p. incl refs. (AFOSR-66-0456) [AF AFOSR-63-30] AD 630307 Unclassified

Presented at Lorentz Group Symposium, Institute for Theoretical Physics, Colorado U., Boulder, Summer 1964.

Also published in Lectures in Theoretical Physics, ed. by W. E. Brittin and A. O. Barut. Boulder, Colorado U. Press, v. 7A. 285-294, 1965.

The analytic properties of the partial-wave amplitudes for production processes in the complex angular momentum plane are investigated. Some general features are found.

696

Colorado U. [Dept. of Physics] Boulder

ANALYTICITY, COMPLEX AND QUATERNIONIC LORENTZ GROUPS AND INTERNAL QUANTUM NUMBERS, by A. O. Barut. [1965] [11]p. incl. refs (AFOSR-66-0458) [AF AFOSR-63-30] AD 630224 Unclassified

Presented at Lorentz Group Symposium, Institute for Theoretical Physics, Colorado U., Boulder, Summer 1964.

Also published in Lectures in Theoretical Physics, ed. by W. E. Brittin and A. O. Barut. Boulder, Colorado U. Press, v. 7A: 121-131, 1965.

The problem of the enlargement of the Poincare group is discussed. Examples of nontrivial enlargements and group theoretical models for broken symmetry are given. In particular, the inhomogeneous complex Lorentz group of the first kind is treated in detail whose representations give a correct description of spin and isospin and leads to a mass spectrum. Furthermore, the inhomogeneous quaternionic Lorentz group (both in complex and quaternionic Hilbert space) is discussed, whose 12-parameter little group is large enough to contain ordinary spin, and in the limiting case, an approximate symmetry such as U3.

697

Colorado U. [Dept. of Physics] Boulder.

REMARKS ON THE GROUP STRUCTURE OF CORBEN'S WAVE EQUATIONS, by A. O Barut. [1965] [3]p. (AFOSR-66-0469) [AF AFOSR-63-30] AD 630445 Unclassified

Presented at Elementary Particles Conference, Institute for Theoretical Physics, Colorado U., Boulder, Summer 1964.

Also published in Lectures in Theoretical Physics, ed. by W. E. Brittin and L. Marshall. Boulder, Colorado U. Press, v. 7B. 446-448, 1965.

The group-theoretical interpretation of the equations of Corben's relativistic quantum theory of rotational states is pointed out together with some difficulties associated with them.

698

[Colorado U. Dept. of Physics, Boulder]

DYNAMICS OF A BROKEN SU_N SYMMETRY FOR THE OSCILLATOR, by A. O. Barut. [1965] [4]p. incl refs. (AFOSR-66-0828) [AF AFOSR-63-30] AD 641237 Unclassified

Also published in Phys. Rev., v. 139: B1433-B1436, Sept. 6, 1965.

All states of a one-dimensional harmonic oscillator are represented by a special unitary representation of the noncompact 2+1 Lorentz group. The direct product of N such representations leads to a degeneracy which is represented by the Group SU_N whereas all states of the N-dimensional oscillator are represented by the noncompact unitary group NU_{N+1}^{N} whose Casimir operator determines the energy spectrum. The anharmonic oscillator is represented by a broken symmetry and mass-splitting formulas are obtained It is shown how new quantum numbers arise from the direct products of basic dynamical groups corresponding to composite structures.

699

Colorado U., Dept. of Physics, Boulder.

STATISTICAL MECHANICS OF IRREVERSIBLE PROCESSES AND THE PRINCIPLE OF MINIMUM ENTROPY PRODUCTION, by J. D. Currin. [1965] [3]p. [AF AFOSR-64-581] Unclassified

Published in Phys. Rev., v. 139: A1156-A1158, Aug. 16, 1965.

The transport properties of a system of N weakly interacting subsystems are derived using as the basic statistical assumption a principle of minimum entropy production. This replaces the assumption of "local equilibrium" where each subsystem is assumed to be described by a canonical distribution at the initial time. (Contractor's abstract)

700

[Colorado U. Dept. of Psychology, Boulder]

RATINGS OF FAVORABLENESS OF STATEMENTS ABOUT A SOCIAL GROUP AS AN INDICATOR OF ATTITUDE TOWARD THE GROUP, by C. Selltiz, H. Edrich, and S. W. Cook. [1965] [8]p. incl. tables, refs. (AFOSR-66-1159) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-62-176] and National Science Foundation) AD 640277 Unclassified

Also published in Jour. Personality and Social Psychol., v. 2: 408-415, Sept. 1965.

Earlier studies reporting effects of judges' attitudes on ratings of favorableness of statements have suggested the possible usefulness of such ratings as disguised attitude measures. Studies in which Negroes have been the attitudinal object have used a set of statements, a high proportion of which are unfavorable by current standards. In the hope of making the technique more sensitive as an indicator of attitude, a new set of statements about the position of Negroes was developed, representing a more symmetrical distribution of favorable and unfavorable items. These were administered in 3 different geographical regions to groups of Ss differing in attitude toward Negroes. Two criteria of judges' attitudes were used (a) membership in organizations such that it seemed reasonable to suppose that many of the members would hold specified attitudes about race relations; and (b) scores on a self-respect using these two criteria for classifying judges yielded similar results: scale values assigned to statements by judges with different attitudes differed significantly Difference in ratings of the unfavorable and intermediate statements were systematic, with the prointegration Ss rating them as more unfavorable

701

[Colorado U. Dept. of Psychology, Boulder]

INFLUENCE OF JUDGES' ATTITUDES ON RATINGS OF FAVORABLENESS OF STATEMENTS ABOUT A SOCIAL GROUP, by M. Zavalloni and S. W. Cook. [1965] [12]p. incl. tables, refs. (AFOSR-66-1160) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-62-176] and National Science Foundation) AD 640279 Unclassified

Also published in Jour. Personality and Social Psychol., v. 1: 43-54, Jan. 1965.

Replication of a study of Hovland and Sherif confirmed their central hypothesis, that scale values assigned to items are influenced by raters' attitudes. However, the present findings require modification of their more specific hypotheses in 3 respects: (a) ratings by 5 criterion groups spaced along an attitude continuum show a regular order, whereas Hovland and Sherif hypothesized that ratings are influenced by attitudes only in the case of raters with extreme attitudes and high involvement, (b) ratings of unfavorable as well as of neutral items are influenced by raters' attitudes; (c) the prediction that extreme judges make fine discriminations at their own end of the scale and lump together items at the other end is supported only with respect to unfavorable items. (Contractor's abstract)

702

[Colorado U. Dept. of Psychology, Boulder]

EFFECT OF ATTITUDE ON JUDGEMENTS OF PLAUSIBILITY, by P. Waly and S. W. Cook. [1965] [5]p. incl. tables. (AFOSR-66-1165) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-436] and National Science Foundation) AD 641558 Unclassified

Also published in Jour. Personality and Social Psychol., v. 2: 745-749, Nov. 1965.

Ss were asked to rate the plausibility of 40 statements about segregation. Ss' own attitudes were measured by a self-report inventory. Hypotheses: (a) A statement will be considered a more plausible or effective argument by Ss who agree with the position which the statement supports than by Ss who disagree with that position. (b) Despite the difference in absolute ratings of the arguments between judges with differing attitudes, they will agree on the relative plausibility of the various arguments supporting a given side of the issue. Both hypotheses were strongly supported. (Contractor's abstract)

703

Columbia U. Coll. of Physicians and Surgeons, New York.

CLASSICAL CONDITIONING OF ELECTRIC ORGAN DISCHARGE RATE IN MORMYRIDS, by F. J. Mandriota, R. L. Thompson, and M. V. L. Bennett. [1965] [3]p. incl. diagrs. refs. (AFOSR-66-0839) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-550 and Public Health Service) AD 641728 Unclassified

Also published in Science, v. 150: 1740-1742, Dec. 24, 1965.

Weakly electric fish of the African family Mormyridae emit pulses at variable intervals with a distribution skewed toward longer intervals. Fourteen specimens of the genera Mormyrops, Gnathonemus, and Marcusenius were classically conditioned to increase briefly their discharge frequency. The unconditioned stimulus was electric shock and the conditioned stimulus was light. These results are novel in that the overt conditioned response involves neither secretion nor movement. (Contractor's abstract)

704

Columbia U. Coll. of Physicians and Surgeons, New York.

ELECTRORECEPTORS IN MORMYRIDS, by M. V. L. Bennett. [1965] [18]p. incl. illus. diagrs. refs. (AFOSR-66-1007) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-550, Muscular Dystrophy Associations of America, National Institute of Neurological Diseases and Blindness, and National Science Foundation) AD 634553 Unclassified

Also published in Cold Spring Harbor Symposia on Quantitative Biology, Cold Spring Harbor, N. Y. (June 4-11, 1965), ed. by L. Frisch. Cold Spring Harbor Laboratory of Quantitative Biology, v. 30: 245-262, 1965.

The mormyromasts, large cutaneous organs that are readily visible on the surface of the skin, were studied by stimulating and recording at their external openings and in their innervating fibers. These organs were apparently electroreceptors. Three types were defined electrophysiologically and were termed large, medium and small pores. At the first two, electrical stimuli evoked potentials that apparently arose in receptor cells. At the third, the responses apparently were generated by the innervating fiber. Transmission from receptor to nerve cell appeared to be chemically mediated at medium and small pores and electrically mediated at large pores. All pores responded to voltage gradients across the skin and were independent of gradients along it. The skin was of high resistance compared to the interior of the body. When stimuli were applied between head and tail, most of the potential drop occurred across skin at the ends of the fish. Thus, although the thresholds of the pores did not vary consistently along the body, head-tail stimuli evoked responses which were of much lower threshold at the two ends than in the middle. Also, the polarity of the potential across the skin was opposite at the two ends and the responses differed accordingly. The anterior pores were somewhat more sensitive than the posterior to head-tail stimuli, and apparently the skin was of relatively higher resistance in this region. The relevance of the findings to electroreception and to receptor responses in general were discussed.

705

Columbia U. Coll. of Physicians and Surgeons, New York.

THE FINE STRUCTURE OF THE SUPREMEDULLARY NEURONS OF THE PUFFER WITH SPECIAL REFERENCE TO ENDOCELLULAR AND PERICELLULAR CAPILLARIES, by Y. Nakajima, G. D. Pappas and M. V. L. Bennett. [1965] [21]p. incl. illus. refs. (AFOSR-66-1137) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-550, Life Insurance Medical Fund, and National Institutes of Health) AD 641735 Unclassified

Also published in Amer. Jour. Anat., v. 116: 471-491, May 1965.

Many capillaries are embedded in the cytoplasm of large supramedullary neurons (about 200 to 300μ in diameter). Fewer such capillaries are seen in the smaller neurons (about 80 to 100μ in diameter). The neuron clusters remain unstained after vital staining with trypan blue indicating presence of the blood-brain barrier. Electron microscopic studies show that the capillary lumen is lined by nonfenestrated endothelial cells, pericytes, and a continuous basement membrane. Glial cell processes consisting mostly of astrocytes abut onto the capillary basement membrane separating the capillary from the neuron. The continuous glial investment around blood vessels may play a role in maintenance of the blood-brain barrier. The nucleus in supramedullary cells is roughly circular and contains one large and several small nucleoli. The perikaryon contains neurofilaments, diffusely distributed elements of endoplasmic bodies, and inclusion bodies; but is devoid of elementary neurosecretory granules. The cell body of the neuron is entirely covered by glial cells, often with processes which deeply indent the soma surface. Neither synapses nor arborizing dendrites are found on the cell body. (Contractor's abstract)

706

Columbia U. Columbia Radiation Lab., New York.

DEVIATION FROM THE $1/r^6$ POTENTIAL IN THE SCATTERING OF A POLAR MOLECULE BY NONPOLAR GASES, by M. M. Hessel and P. Kusch. [1965] [2]p. incl. table. (Rept. no. TR 20) (AFOSR-65-2864) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-330, [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research under DA 28-043-AMC-00099(E)) AD 620346 Unclassified

Also published in Jour. Chem. Phys., v. 43: 305-306, July 1, 1965.

The attenuation of a beam of velocity-selected KCl molecules of thermal energy as it trasverses a chamber containing either N or Ar was measured over ranges of beam velocity and temperature and pressure of the scattering gas. Data indicate the long range part of the interaction varies as approx. r^{-5}.

707

Columbia U. Columbia Radiation Lab., New York.

THE PHYSICS AND CHEMISTRY OF GASES AT HIGH TEMPERATURES, by P. Kusch. Final rept. Nov. 1, 1963-Oct. 31, 1965. Nov. 1965, 10p. (AFOSR-66-0166) (AF AFOSR-63-330) AD 628082 Unclassified

An extensive study has been made of the scattering of velocity-selected beams of atomic potassium and potassium chloride by argon and by molecular nitrogen. A detailed investigation of certain hyperfine structures in molecules of deuterated ammonia was made in a beam maser spectrometer. A conventional microwave spectrometer, capable of operation over a wide range of temperatures, was used to study the microwave spectrum of lithium chloride in detail and that of methyl vinyl ether. A reinvestigation of the spectrum of molecular cesium in the optical region was started. The technique of magnetic rotation spectra is being applied to a study of carbon disulfide.

708

Columbia U. Columbia Radiation Lab., New York.

THEORY OF ATOMIC BEAM OPTICAL DOUBLE RESONANCE SPECTROSCOPY, by R. Serber. Special technical rept., Apr. 15, 1965, 32p. incl. diagr. refs. (Rept. no. CU-4-65) (AFOSR-65-1325) (Sponsored jointly by Air Force Office of Scientific Research, Army Electronics Laboratories, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)) AD 464495 Unclassified

The theory of the atomic beam optical double resonance spectroscopy first introduced by I. I. Rabi is developed. An expression for the transition probability is derived which includes terms that may lead to line shifts and distortions. The approximations made in obtaining this result are given, and means for attaining a more precise line-shape formula are indicated.

709

Columbia U. Columbia Radiation Lab., New York.

RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM, by R. Novick. Quarterly progress rept. no. 10, Mar. 16-June 15, 1965, 63p. incl. diagrs. refs. (Rept. no. CU-6-65) (AFOSR-65-2273) (Sponsored jointly by Air Force Office of Scientific Research, Army Electronics Laboratories, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)) AD 467754 Unclassified

Observations have been made on the spectra of 6328A light scattered from carbon dioxide near the critical temperature and critical density. A technique has been developed for measuring the 2 relaxation times characterizing the disorientation of optically aligned atoms in a vapor. The method consists of alternately exciting pure dipole or pure quadrupole components of the density matrix

which give rise to $\Delta m = 1$ zero-field level-crossing signals. A discriminator against $\Delta m = 2$ signals simplifies analysis of the data. Measurements of these relaxation times will give considerable information on the coupling of an excited atom to its statistical environment. (Contractor's abstract, modified)

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Columbia U. Columbia Radiation Lab., New York.

RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM, by R. Novick. Quarterly progress rept. no. 11, June 16-Sept. 15, 1965, 69p. incl. diagrs. tables, refs. (Rept. no. CU-9-65) (AFOSR-65-2288) (Sponsored jointly by Air Force Office of Scientific Research, Army Electronics Laboratories, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)) AD 473833 Unclassified

Radiation due to the impact of very slow helium ions on the rare gases has been observed The dependence of the cross section on the kinetic energy of the He^+ beam shows unexpected and important features down to the lowest energies studied (5 ev). The absolute cross sections are typically of the order of 10^{-16} cm^2 and in some cases are almost an order of magnitude larger. In at least one case, the radiation has been shown to result from charge exchange with simultaneous excitation. Systematic observations have been made on the spectra of 6328A light scattered from carbon dioxide near the critical temperature T_c and the critical density ρ_c. These studies were made as a function of both scattering angle θ and temperature T using an f/7 collecting lens. A new optical system has been developed which uses a lensless geometry and is capable of defining scattering angles to an accuracy better than ± 10' of arc without any averaging effects of a collecting lens. (Contractor's abstract, modified)

711

Columbia U. Columbia Radiation Lab., New York.

RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM, by R. Novick. Quarterly progress rept. no. 12, Sept. 16-Dec. 15, 1965, 64p. incl. diagrs. tables, refs. (Rept. no. CU-12-65) (AFOSR-66-1339) (Sponsored jointly by Air Force Office of Scientific Research, Army Electronics Laboratories, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)) AD 628089 Unclassified

Specular reflection of x-rays by total reflection can be produced at grazing incidence from a uniform gold film evaporated onto annealed glass. Two designs for utilizing this effect to produce large-area x-ray gathering systems are presented. A magnetic resonance rf spectrometer is being constructed to study the hyperfine structure of the metastable states in potassium, rubidium, and lithium. With this spectrometer, magnetic quenching rather than inhomogeneous field deflection will be used for state selection. A second optical delay line was added to the existing photon-echo apparatus to provide a third excitation pulse. In addition to two-pulse echoes of the type previously studied, this arrangement produces a stimulated photon echo delayed from the third pulse by the time interval between the first two pulses. A precise measurement of the resonant self-broadening of the $(6s^2 6p7s)^3P_1^\circ$ state of lead has determined the collision-induced reaction rate to be $3.2(1) \times 10^{-8}$ $cm^3/sec \times N$. (Contractor's abstract, modified)

712

Columbia U. [Columbia Radiation Lab.] New York.

COHERENCE NARROWING AND COLLISION BROADENING IN THE $(6p7s)^3P_1^o - (6P^2)^3P_{0,1,2}$ TRANSITIONS IN LEAD (Abstract), by E. B. Saloman and W. Happer, Jr. [1965] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)] Unclassified

Presented at meeting of the Amer. Phys. Soc., Columbia U., New York, June 23-25, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 596, June 23, 1965.

The Hanle-effect linewidth in fluorescent radiation originating from the $(6p7s)^3P_1^o$ state of lead has been observed over a range of densities from 10^9 to 10^{15} atoms/cm^3 in a 50-cm^3 cell. The signal width was observed to be the same at a given density for the 3 decay branches to the $^3P_2$, $^3P_1$, and $^3P_0$, respectively, except for the $^3P_1^o - ^3P^o$ line at very high densities. As the density was increased from 10^9 atoms/cm^3, a steady narrowing of the signal width was observed up to a density of 4×10^{12} atoms/cm^3 when the linewidth was 81% of the low-density value. Thereafter, the linewidth remained constant up to a density of about 10^{14} atoms/cm^3. The observed data are in good agreement with Barrat's coherence-narrowing theory, suitably modified to take branching into account. At densities above 10^{14} atoms/cm^3, a broadening of the linewidths was observed, which we attribute to collisions. The collision-broadening cross section observed in the density range 2×10^{14} to 8×10^{14} atoms/cm^3 was $\sigma = 1.4(2) \times 10^{-12}$ cm^2.

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Columbia U. Columbia Radiation Lab., New York.

DIRECT DETECTION OF TWO-PHOTON EMISSION FROM THE METASTABLE STATE OF SINGLY IONIZED HELIUM, by M. Lipeles, R. Novick, and N. Tolk. [1965] [4]p. incl. diagrs. refs. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research

Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)], and National Aeronautics and Space Administration) Unclassified

Published in Phys. Rev. Ltrs., v. 15: 690-693, Oct. 25, 1965.

A description is given of an experiment designed to detect the decay in flight of a slow (12 ev) beam of metastable helium ions. The results give evidence of the direct detection by coincidence counting techniques of the 2-photon decay of the metastable $2^2S_{1/2}$ state of singly ionized helium.

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Columbia U. [Columbia Radiation Lab.] New York.

ELECTRIC-FIELD HANLE EFFECT IN MERCURY AND CADMIUM (Abstract), by W. Happer, Jr., A. Khadjavi, and A. Lurio. [1965] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Oct. 28-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 1096, Oct. 28, 1965.

We have measured the differential Stark shift between m = ± 1 and m = 0 sublevels of the $6s6p\,^3P_1$ state of mercury and the $5s5p\,^3P_1$ state of cadmium excited from the ground state by resonance radiation. In this work, we used level-crossing techniques with parallel electric and magnetic fields. Using both an electric and a magnetic field, one can eliminate any dependence on a knowledge of the effective lifetime of the excited state. The values obtained are $\alpha/h = 2360 \pm 70$ cps/[kV/cm]^2 for mercury and $\alpha/h = 2515 \pm 75$ cms/[kV/cm]^2 for cadmium. Both results are somewhat higher than those measured elsewhere by double resonance and by the method of beats.

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Columbia U. [Columbia Radiation Lab.] New York.

ELECTRIC-FIELD LEVEL CROSSING IN MERCURY (Abstract), by A. Khadjavi, A. Lurio, and W. Happer, Jr. [1965] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Columbia U., New York, June 23-25, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 596, June 23, 1965.

Pure electric and combined electric- and magnetic-field level crossings in the $^3P_1$ state of mercury were observed. From these measurements, one can obtain the differential Stark shift between the $\Delta m = \pm 1$ and the $\Delta m = 0$ Zeeman levels in the zero-spin isotopes. This shift is related to the atomic polarizability of the state. In the pure electric-field measurement, the differential Stark shifts are obtained from the linewidth of the crossing and a knowledge of the lifetime of the excited state. This method is subject to the usual coherence-narrowing problem. To avoid this difficulty, combined electric and magnetic fields were used since one need know only the g_J value for the state and the magnetic field at the cell in order to measure the differential shifts. Preliminary results are in agreement with those of Blamont.

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Columbia U. Columbia Radiation Lab., New York.

ELECTRON-NUCLEAR DOUBLE RESONANCE STUDY OF THE SELF-TRAPPED HOLE ASSOCIATED WITH LITHIUM IN NaF, by I. L. Bass and R. Mieher. [1965] [5]p. incl. diagrs. tables. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00099(E), and National Science Foundation) Unclassified

Published in Phys. Rev. Ltrs., v. 15 25-29, July 5, 1965.

Previous electron spin resonance and electron-nuclear double resonance studies have shown that self-trapped holes (V_k centers) in NaF doped with lithium associate with the Li ions. A study of the lithium V_{KA} center in NaF is presented. The V_{KA} designates the complex consisting of a V_K center associated with an alkali impurity.

717

Columbia U. [Columbia Radiation Lab.] New York.

ENDOR HYPERFINE CONSTANTS OF THE V_K CENTER IN LiF AND NaF (Abstract), by D. Daly and R. L. Mieher. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 28-043-AMC-00099(E)] and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., Columbia U., New York, June 23-25, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 615, June 23, 1965.

The ENDOR hyperfine constants of the V_K center have been reported previously for 6 shells of neighboring nuclei in LiF are given. The hyperfine constants of 4 shells in NaF. These hyperfine constants are composed of a Fermi contact term a and the dipole-dipole terms B_z, B_y, and B_z, where x, y, and z are the principal axes of the hyperfine tensor. Using the self-consistent-

field wavefunction for the F_2^- molecule-ion obtained by Wahl, a, B_x, B_y, B_z and the principal axis direction are calculated and compared with the experimental constants for both LiF and NaF. The effects of lattice relaxations, core polarization of the closed shell V_K orbitals, and overlap between the V_K orbital and the core orbitals of the neighboring nuclei are also shown.

718

Columbia U., [Columbia Radiation Lab.] New York.

ENDOR OF THE V_K CENTER IN CaF_2 (Abstract), by R. Marzke and R. L. Mieher. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 28-043-AMC-00099(E)] and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., Columbia U., New York, June 23-25, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10· 615, June 23, 1965

The V_K center has been observed by Hayes and Twidell in CaF_2, which has an F-F spacing nearly the same as LiF but along (100) instead of (110). The authors studied the ENDOR of the V_K center in CaF_2 and have identified neighboring nuclei from the angular dependence of the lines. The observed hyperfine constants give additional information on the F_2^- molecule that was studied in LiF by Gazzinelli and Mieher

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Columbia U. [Columbia Radiation Lab.] New York

ENDOR STUDY OF THE H CENTER IN LiF (Abstract), by M. L. Dakss and R. L. Mieher. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 28-043-AMC-00099(E)] and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., Columbia U., New York, June 23-25, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10· 615, June 23, 1965.

A detailed ENDOR study was carried out on the H center in LiF. Hyperfine constants for 5 sets of nonequivalent neighboring nuclei have been determined. The results give good support to the model of Känzig and Woodruff.

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Columbia U. [Columbia Radiation Lab.] New York.

EVIDENCE FOR A METASTABLE SEXTET STATE IN NITROGEN (Abstract), by P. Feldman and R. Novick. [1965] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)] and National Aeronautics and Space Administration) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys Soc., Series II, v. 10· 455, Apr. 26, 1965.

The lowest-lying metastable $^6S^0$ state of the nitrogen atom, arising from a $(2s2p^33s)$ configuration, has been postulated as the energy-storage mechanism responsible for the pink region associated with the nitrogen afterglow. The estimated excitation energy of this state is 17.2 ev above the atomic ground state. A search for this state was made using the same experimental arrangement as used in the study of long-lived autoionizing states in the alkali atoms. Molecular nitrogen was admitted into the system through a variable leak and excited by electron bombardment An excitation threshold was observed at about 30 ev. Assuming that an atomic state is formed and allowing 9.8 ev for dissociation, then this corresponds to an energy of 20 ev in the c.m. Quenching of the signal was obtained with both external and magnetic fields.

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Columbia U. [Columbia Radiation Lab.] New York.

FINE AND HYPERFINE STRUCTURE OF THE 4P STATE OF Li^7 (Abstract), by R. C. Isler, S. Marcus, and R. Novick. [1965] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)] and National Aeronautics and Space Administration) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Oct. 28-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10· 1096, Oct 28, 1965.

The average value of the four $\Delta m = 2$ level-crossing signals has been used to obtain the fine-structure interval in the 4P state of Li^7. This interval is 1199.72 ± 0.19 Mc sec. 11% smaller than the corresponding interval in hydrogen. The spacing between the hyperfine crossings is 4.044 ± 0.023 kc sec in terms of the resonance frequency of the proton probe used for measuring the magnetic-field strength. This spacing, which is related to linear combinations of dipole-dipole and core-polarization interactions, scales closely as $1/n^3$ between the 4P and 3P states, just as it does between the 3P and 2P states, thus indicating that the core-polarization interaction itself scales closely as $1/n^3$ in the P states of Li^7.

722

Columbia U. Columbia Radiation Lab., New York.

LEVEL-CROSSING SPECTROSCOPY WITH AN ELECTRIC FIELD: STARK SHIFT OF THE 3^2P TERM IN LITHIUM, by B. Budick, S. Marcus, and R. Novick. [1965] [3]p. incl. diagrs. table, refs. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00099(E), and National Aeronautics and Space Administration) Unclassified

Published in Phys. Rev., v. 140: A1041-A1043, Nov. 15, 1965.

The method of level-crossing spectroscopy has been extended to a study of the Stark effect on the 3P term of lithium. Lithium atoms in a broad atomic beam are subjected to collinear electric and magnetic fields. The field values required to produce a level crossing or degeneracy are determined by observing the change in the angular distribution of the fluorescence resulting from the optical excitation of the 3P term. The magnetic field required to produce the crossing is found to shift to higher values as the electric field is applied. The shift increases as the square of the electric field and is given by $\Delta H = +0.056\,(11)E^2$, where ΔH is in gauss and E is in kv per cm. The coefficient is in good agreement with the value 0.048 obtained from second-order perturbation theory and the Bates and Damgaard approximation. (Contractor's abstract)

723

Columbia U. [Columbia Radiation Lab.] New York.

LIFETIME OF THE $(6p8s)^3P_1^0$ STATE IN LEAD (Abstract), by E. B. Saloman. [1965] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Oct. 28-30, 1965

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 1096, Oct. 28, 1965.

Hanle-effect studies have been made in the $(6s^26p8s)$ $^3P_1^0$ state of lead. Pb^{208} atoms were excited to this state by 2053A lead resonance light, and the 5201A cross fluorescent line from this state was detected. The width of the level-crossing signal corresponds to a lifetime for this state of $1.29\,(14) \times 10^{-8}$ sec, where the quoted uncertainty is 3 times the standard deviation. This result is a factor of 4 longer than the result calculated from the oscillator strengths of Corliss and Bozman.

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Columbia U. Columbia Radiation Lab., New York.

OBSERVATION OF DIFFERENT LIFETIMES FOR ATOMIC STATES EXCITED WITH LINEARLY AND CIRCULARLY POLARIZED LIGHT, by W. Happer and E. B. Saloman. [1965] [3]p. incl. diagrs. table, refs (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham and Office of Naval Research] under DA 28-043-AMC-00099(E), and National Aeronautics and Space Administration) Unclassified

Published in Phys. Rev. Ltrs., v. 15: 441-443, Sept. 6, 1965.

The lifetimes of the magnetic moment and the alignment of the first $3P_1^0$ state of lead were measured for different values of the density of the lead vapor.

725

Columbia U. Columbia Radiation Lab., New York.

OBSERVATION OF TIME-DEPENDENT CONCENTRATION FLUCTUATIONS IN A BINARY MIXTURE NEAR THE CRITICAL TEMPERATURE USING A He-Ne LASER, by S. S. Alpert, Y. Yeh, and E. Lipworth. [1965] [3]p. incl. diagrs. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00099(E), and National Science Foundation) AD 617493 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 486-488, Mar. 29, 1965.

By means of a He-Ne laser hemodyne spectrometer, the frequency spectrum of the time-dependent concentration fluctuations has been observed in a cyclohexane-amiline mixture just above the critical temperature.

726

Columbia U. [Columbia Radiation Lab.] New York.

OBSERVATION OF TIME-DEPENDENT DENSITY FLUCTUATIONS IN A BINARY MIXTURE NEAR THE CRITICAL TEMPERATURE, USING A He-Ne LASER (Abstract), by Y. Yeh, S. S. Alpert and others. [1965] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00099(E)], Army Research Office (Durham), and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Nov. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 310, Mar. 24, 1965

A He-Ne laser homodyne spectrometer has been used to observe the line spectrum of 6328A light scattered off a

binary mixture of cyclohexane and aniline near the critical point. The Rayleigh-scattered light, which is broadened by the density fluctuations, was observed at an angle of 22 from the unscattered light. The frequency distribution of the scattered-light approximated a Lorentzian lineshape. The linewidth of the scattered radiation depends linearly on the temperature from 30.32 to the critical temperature of 29.69 C. The line narrows as the critical temperature is approached from above and the rate of narrowing is 230 ± 20 cps/°C. At 29.72 C, the linewidth was observed to be 18 cps. No correction to the linewidth from possible multiple scattering effects have been made as yet.

727

Columbia U. Columbia Radiation Lab., New York.

OPTICAL EXCITATION WITH VERY LOW ENERGY IONS, by M. Lipeles, R. Novick, and N. Tolk. [1965] [5]p. incl. diagrs. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00099(E), and National Aeronautics and Space Administration) Unclassified

Published in Phys. Rev. Ltrs., v. 15: 815-819, Nov. 22, 1965

Radiation due to the impact of very slow helium ions was observed on the rare gases and on some molecular gases. The dependence of the cross section for this process on the kinetic energy of the He^+ beam shows unexpected features down to the lowest energies studied (5 ev). For example, there is a sharp peak at 10 ev for the production of uv photons in Xe. The absolute cross sections are typically of the order of 10^{-16} cm^2 and in some cases are almost an order of magnitude larger. In at least one case the radiation was shown to result from charge exchange with similar excitation. Energy balance considerations show that the reactions studied involve the transfer of a large fraction of the kinetic energy into internal electronic energy. The excitation clearly involves nonadiabatic nonradiative transitions between the levels of the molecular-ion complex formed during the collision. The low-energy peaks in the cross section imply that the molecular energy levels are shifted in energy during the collision until they nearly cross. The experimental apparatus and data obtained are discussed. Curves are given showing the kinetic-energy dependence of the cross sections for the production of photons by He^+ impact on the rare gases.

728

Columbia U. Columbia Radiation Lab., New York.

ELECTRON SPIN RELAXATION IN COPPER TUTTON SALTS AT LOW TEMPERATURES, by F. R. Nash. [1965] [10]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-sc-90789) Unclassified

Published in Phys. Rev., v. 138 A1500-A1509, May 31, 1965.

By means of a pulse saturation technique applied at X-band frequencies, electron-spin relaxation times have been observed as a function of crystal size in the liquid-helium temperature range for the $CuNH_4$ Tutton salt throughout the concentration range 0.02-100%. The concentration range 12-100% exhibits what is thought to be a phonon bottleneck. This is manifest in a marked size dependence of the observed decay constants. Alternative explanations are considered. For the concentration range 0.05 to 5%, size-dependent decay times have also been recorded. There appears to be a correlation between this kind of size effect and contamination by the paramagnetic impurity of iron. Rapid crystal growth is found to alleviate the size effects throughout the range of concentrations studied. The effects of deuteration have been examined in crystals of 1% concentration and it was found that there was an order-of-magnitude difference in the relaxation times of the hydrated and deuterated salts, size for size, below the helium λ point. The hydrated and deuterated CuK Tutton salts at the same concentration showed no such difference. The supposed spin-lattice coupling is concentration-dependent, and its nature has not yet been established theoretically. (Contractor's abstract)

729

Columbia U. Columbia Radiation Lab., New York.

LIGHT SOURCES FOR DOUBLE RESONANCE AND LEVEL CROSSING SPECTROSCOPY, by B. Budick, R. Novick, and A. Lurio. [1965] [9]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under [DA 36-039-sc-90789] and National Aeronautics and Space Administration) Unclassified

Published in Appl. Opt., v. 4: 229-235, Feb. 1965.

The requirements on light sources for double resonance and level crossing spectroscopy are reviewed. A modern version of the Carlo-Löchte-Holtgreven flow lamp is described and its performance for a number of elements is compared with that of sealed-off electrodeless discharge lamps and Schüller-type hollow cathode sources. The electrodeless lamp is particularly effective in the case of the group IIb intercombination lines. The high atomic density available in the flow lamp makes it useful for partially forbidden resonance lines for a number of chemical species including highly reactive metals, such as Ca. The hollow cathode lamp is well suited to the fully allowed resonance lines of a wide range of elements including highly refractory metals.

730

[Columbia U.] Columbia Radiation Lab., New York.

METASTABLE AUTOIONIZING ATOMIC-ENERGY LEVELS IN CESIUM (Abstract), by R. Novick and G. Sprott. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office

(Durham)], and Office of Naval Research under [DA 36-039-sc-90789] and National Aeronautics and Space Administration) Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10. 184-185, Feb. 25, 1965.

Two metastable autoionizing atomic-energy levels have been observed in a beam of cesium atoms excited by electron bombardment. The excitation energies are 8.5 (± 1.5) and 11 (± 1.5) ev, the latter corresponding to the $(p^5sd)^4F_{9/2}$ state previously observed in K and Rb. The cross section and lifetime for this state are also in agreement with our previous data on these alkali elements. On the other hand, a second long-lived autoionizing state (albeit with a production cross section a factor of 10 smaller) had not been observed in either K or Rb and its excitation energy does not fit into the ^1D level scheme of Beutler and Guggenheimer. A possible configuration for this state may arise from the excitation of a 5p electron from the $(5p^66s)^2S_{\frac{1}{2}}$ ground state to a low-lying f level.

731

Columbia U. Columbia Radiation Lab., New York.

ORDERING IN SOLID HYDROGEN, by A. Danielian. [1965] [6]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham], and Office of Naval Research under [DA 36-039-sc-90789]) Unclassified

Published in Phys. Rev., v. 138: A282-A287, Apr. 5, 1965.

It is shown that in the case of the model for solid orthohydrogen considered, the ground-state superlattice structure, produced by the electrostatic quadrupole interactions, may be derived exactly. It consists essentially of 2 unequal sublattices: one consisting of molecules A in the state M = 0 and the other consisting of molecules B in either of the states M = ± 1, the latter being twice as many as the former. The configuration on each triangular plane, normal to the axis of symmetry of the lattice, is such that each A molecule is surrounded by 6 B molecules, and each B molecule is surrounded by 3 A molecules and 3 B molecules. The transition temperature of the system is found to be 5.8° K in the zeroth approximation and 3° K in a tetrahedral approximation, the latter being in agreement with the experimental estimate. (Contractor's abstract)

732

Columbia U. Columbia Radiation Lab., New York.

SCATTERING FROM FLUIDS OF NONSPHERICAL MOLECULES. I. X-RAYS AND NEUTRONS, by W. A. Steele and R. Pecora. [1965] [9]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under [DA 36-039-sc-90789], and National Science Foundation) AD 616189 Unclassified

Also published in Jour. Chem. Phys., v. 42: 1863-1871, Mar. 15, 1965.

The general theory of the statistical mechanics of nonspherical molecules is applied to the problem of the scattering of x-rays and slow neutrons from a fluid composed of nonspherical molecules. Expressions for the differential scattering cross sections are derived for the cases of both elastic and inelastic scattering. General properties of the time-dependent correlation functions are discussed, and a short-time approximation is given and applied to the calculation of the inelastic neutron scattering cross section. (Contractor's abstract)

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Columbia U. Columbia Radiation Lab., New York.

SCATTERING FROM FLUIDS OF NONSPHERICAL MOLECULES. II. LIGHT, by R. Pecora and W. A. Steele. [1965] [8]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under [DA 36-039-sc-90789], and National Science Foundation) AD 616190 Unclassified

Also published in Jour. Chem. Phys., v. 42: 1872-1879, Mar. 15, 1965.

The statistical mechanical theory of nonspherical molecules is applied to the problem of the scattering of light from fluids composed of optically nonspherical molecules. Expressions for the scattered light intensity in the elastic and inelastic scattering cases are expressed in terms of angular moments of the generalized pair distribution function of the fluid. The special case of axial symmetry is considered, and comparison with previous theoretical and experimental work is briefly made. (Contractor's abstract)

734

Columbia U. Columbia Radiation Lab., New York.

STABILITY CONSIDERATIONS FOR A Rb^{87} MASER OSCILLATOR, by P. Davidovits and R. Novick. [1965] [5]p. incl. diagrs. refs. (Technical rept. no. 2) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36 039-sc-90789) AD 617219 Unclassified

Also published in IEEE Internat'l. Conv. Rec., Pt. 5: 2-6, 1965.

Self-sustained oscillation was obtained in an optically pumped rubidium maser operating at the Rb^{87} hyperfine transition frequency of 6835 mc/sec. The entire apparatus can be mounted within the volume of one cubic foot. The operating temperature is 60 C, and the overall power consumption is only a few watts. The

anticipated long-term stability is one part in 10^{12}. Preliminary estimates also indicate that the device has far better short-term stability than any other existing frequency standard. The present paper explains the basic principles of the rubidium maser and examines the factors affecting the stability of oscillation. (Contractor's abstract)

735

Columbia U. [Dept. of Astronomy] New York.

A MODEL FOR A HOMOGENEOUS STAR OF MODERATE MASS, by A. H. Bennick and L. Motz. [1965] [6]p. incl. tables, refs. (AFOSR-65-1081) (AF 49(638)1335) AD 619632 Unclassified

Also published in Astrophys. Jour., v. 141: 195-200, Jan. 1, 1965.

A new method for obtaining a set of integration variables which are consistent on both sides of the interface between the central convective core and radiative envelope of a stellar model is derived. It is shown that, once the core size and the composition are chosen, the set of variables is a function of a single free parameter, the ratio of the energy generated by the carbon cycle in the convective core to the energy generated by the proton-proton chain in the core. This set of variables is then used to construct a stellar model that has a convective central core, a radiative zone, and an outer convective layer.

736

Columbia U. [Dept. of Astronomy] New York.

EFFECTS OF A LARGE MAGNETIC FIELD ON ENERGY TRANSFER IN WHITE SWARF STARS, by J. D. Lindstreet. Doctoral thesis [1965] [143]p. incl. diagrs. tables, refs. (AFOSR-66-2779) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)1358 and National Science Foundation) AD 643427 Unclassified

The thesis is concerned with possible effects of a large magnetic field (in the range of ~10^5 to 10^{13} gauss) on the transfer of thermal energy out of a white dwarf star. It is shown that a field at the surface of a white dwarf ~2 x 10^5 gauss is sufficient to produce observable Zeeman splitting of spectral lines, but that when the surface field exceeds about 10^7 gauss, the sigma components of the Zeeman triplet are no longer visible and the line is simply weakened by the field. The possibility that a large surface field would result in significantly increased opacity through absorption by the inverse of the cyclotron radiation process is investigated, and it is shown that this 'cyclotron opacity' would be unobservable except under special conditions. In a white dwarf, heat flow in the interior is carried almost entirely by degenerate electron conduction. It is shown that fields of the order 10^9 or 10^{10} gauss result in substantial magnetoresistivity normal to the direction of the field, and some consequences of this effect for the surface radiation of a white dwarf are discussed. (Contractor's abstract)

737

Columbia U. Dept. of Astronomy, New York.

GALACTIC MAGNETIC FIELDS, by L. Woltjer. [1965] [12]p. (AFOSR-67-0088) (AF 49(638)1358) AD 645704 Unclassified

Also published in The Structure and Evolution of Galaxies; Proc. Thirteenth Conf. on Physics, Instituts Solvay, Brussels (Belgium) (Sept. 1964), London, Interscience, 1965, p. 30-41.

Several propositions are given for the galactic magnetic field: (1) In our galaxy regions occur with a magnetic flux of 10^{36} gauss cm^2 or more; this flux must be primeval; (2) Frequently extensive magnetic fields—observable in radio galaxies—are dynamically associated with galaxies; (3) In the Galactic Disk the field strength exceeds 10^{-5} gauss, in the Galactic Halo it is somewhat less than 10^{-5} gauss, and (4) The role of magnetic forces in interstellar gas dynamics and in particular in the phenomenon of spiral structure remains very uncertain.

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Columbia U. [Dept. of Chemistry] New York.

ELECTRON SPIN RESONANCE OF SEMIQUINONES: SPIN-DENSITY DISTRIBUTION AND CARBONYL SIGMA-PI PARAMETERS, by M. R. Das and G. K. Fraenkel. [1965] [11]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-285 and National Science Foundation) Unclassified

Published in Jour. Chem. Phys., v. 42: 1350-1360, Feb. 15, 1965.

The spin-density distributions in the 1,4-benzosemiquinone and 2,5-dioxy-1,4-benzosemiquinone ions have been estimated by measuring the proton and C^{13} splittings and using reasonable choices for the values of the sigma-pi parameters which relate the splittings to the spin densities for C C and C-H bonds. The determination of the signs as well as the magnitudes of the C^{13} splittings was required to obtain the spin densities. With Q_{CH}^{H} = -27.0 G in the relation $a_i^H = Q_{CH}^H \rho_i^\pi$ between proton splitting a_i^H and carbon-atom-pi electron spin density ρ_i^π, the sigma-pi parameters for the C^{13} splitting at a carbonyl position were found to be Q_{CO}^{C} = 17.7 G and Q_{OC}^{C} = -27.1 G. The values of Q_{CO}^{C} and Q_{OC}^{C} depend on the value assumed for Q_{CH}^{H}. Contrary to earlier predictions made on the basis of molecular orbital calculations, the sign of the C^{13} splitting from the 2 position of the p-benzosemiquinone ion was found to be negative. Carbon-13 splittings were also observed in the anthrasemiquinone ion both ethanol and 1,2-dimethoxyethane (DME) solutions. The sign of the 9-position C^{13} splitting changes from +0.70 G in ethanol to -0.47 G in DME solution. By using the sigma-pi parameters for the carbonyl group carbon atom,

the spin densities were determined for this radical and MO calculations performed to reproduce the spin-density distributions. The variation of the splittings in the p-benzosemiquinone ion with solvent composition could be accounted for quantitatively by using the newly determined sigma-pi parameters.

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Columbia U. Dept. of Chemistry, New York.

ELECTRON SPIN RESONANCE STUDIES OF DEUTERIUM ISOTOPE EFFECTS. A NOVEL RESONANCE-INTEGRAL PERTURBATION, by M. Karplus, R. G. Lawler, and G. K. Fraenkel. [1965] [2]p. incl. refs. (AF AFOSR-63-285 and AF AFOSR-65-285) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 5260-5261, Nov. 20, 1965.

Electron spin resonance (ESR) studies of aromatic radicals previously demonstrated that the replacement of a hydrogen atom by deuterium can produce significant modifications in the proton hyperfine splitting constants (a^H) for ring positions other than the one of substitution. It is proposed that a consistent explanation of these data is provided by a vibrational perturbation of the Hückel resonance-integral parameter B. If the carbon-atom 2pπ orbitals follow the out-of-plane bending motion of the C–H or C–D bonds, the integral B depends on the deuterium or hydrogen position. An equation is given for the energy shift of the Hückel molecular orbital for a deuterated species. Application of the equation to benzene-1-d and cyclooctatetraene-d is discussed. It was found that for both compounds the antisymmetric orbital is unaffected while the symmetric orbital is destabilized, and the magnitude of the effect for $C_6H_5D^-$ indicated that there would be an observable perturbation for $C_8H_7D^-$, in disagreement with experiment. The resonance-integral perturbation model can be applied to other radicals.

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Columbia U. Dept. of Chemistry, New York.

MEASUREMENT OF g VALUES IN THE ELECTRON SPIN RESONANCE SPECTRA OF FREE RADICALS, by B. G. Segal, M. Kaplan, and G. K. Fraenkel. [1965] [10]p. incl. diagr. tables, refs. (AF AFOSR-63-285) Unclassified

Published in Jour. Chem. Phys., v. 43: 4191-4200, Dec. 15, 1965.

Measurements have been made of the g values in the electron spin resonance spectra of 20 aromatic free radicals with an accuracy which has not previously been attainable. The largest source of error for both absolute and relative measurements resulted from variations in the difference between the magnetic field at the ESR sample and at the proton NMR probe, located just outside the center of the microwave cavity, which was used to measure the field. Except for the p-benzosemiquinone radical, g values were not found to depend on temperature over the range from room temperature to -100 C. The depencence of the g value on solvent and counterion was also investigated to some extent, and the g value of the perinaphthenyl radical was found to vary markedly with solvent. Agreement with Stone's theory of the g values of aromatic radicals is excellent, except for those radicals in which molecular distortions are expected according to the Jahn-Teller theorem and for radicals in which the unpaired electron is in a nonbonding molecular orbital. (Contractor's abstract)

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Columbia U. Dept. of Chemistry, New York.

THE SYM-DIBENZCYCLOOCTATETRAENE ANION RADICAL AND DIANION, by T. J. Katz, M. Yoshida, and L. C. Siew. [1965] [5]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-285, National Institutes of Health, and National Science Foundation) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 4516-4520, Oct. 20, 1965.

sym-Dibenzcyclooctatetraene is easily reduced in tetrahydrofuran solution to the corresponding anion radical and dianion by lithium, sodium, or potassium metal. Polarographic reduction in 96% dioxane-water proceeds at low potentials suggesting that the interaction of unsaturated centers in the anions is considerable. The esr spectrum of the anion radical and the nmr spectrum of the dianion are given and analyzed. (Contractor's abstract)

742

Columbia U. [Dept. of Chemistry] New York.

TEMPERATURE DEPENDENCE OF THE HYPERFINE SPLITTING OF THE METHYL RADICAL, by I. A. Zlochower, W. R. Miller, Jr., and G. K. Fraenkel [1965] [2]p. (AF AFOSR-63-285) Unclassified

Published in Jour. Chem. Phys., v. 42. 3339-3340, May 1, 1965.

Measurements were made of the Me-radical proton splitting in a 50 C range above and below room temperature. From a plot of hyperfine splitting vs temperature, the temperature dependence was analyzed as $|a^H| = [22.674 \pm 0.003 - (2.1 \pm 0.2) \times 10^{-3} (t - 25)]$.

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[Columbia U. Dept. of Electrical Engineering, New York]

ON THE FORMULATION OF ADAPTIVE OPTIMAL CONTROL PROBLEMS, by A. E. Pearson and P. E. Sarachik. [1964] [10]p incl. diagrs. refs.

(AFOSR-64-2420) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-284 and National Science Foundation) AD 453611 Unclassified

Presented at Joint Automatic Control Conf., Stanford, Calif., June 24-26, 1964.

Also published in Jour. Basic Eng., v. 87: 125-134, Mar. 1965. (AFOSR-65-2430; AD 629691)

This paper relates to an approach introduced by Kulikowski for adaptive optimal control of nonlinear systems. In this approach the plant dynamics are represented symbolically by an operator which transforms or maps input time functions into corresponding output time functions. The contributions of the paper arise mainly from the physical considerations associated with such an operator representation, specifically the memory of the plant, and the influence of these considerations upon the formulation. It is shown that the optimal control problem may be formulated in various ways for a given plant and given performance criteria depending upon how the memory of the plant is taken into account. (Contractor's abstract)

744

Columbia U. Dept. of Mechanical Engineering, New York.

INTERACTION STRESSES OF EDGE DISLOCATIONS WITH OBSTACLES IN A DISCRETE CRYSTAL MODEL, by H. Southworth, Jr. [1965] [23]p. incl. diagrs. refs. (AFOSR-65-2556) (AF AFOSR-63-228) AD 628404 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1649-1671, Nov. 1965.

The purpose of this work is to determine the effect of the assumption of a discrete as opposed to a continuum structure. New types of behavior found in the discrete analysis which have no continuum counterparts include the following: (1) The discrete dislocation has a non-zero width which changes with interaction geometry. The dislocation widens when the rate of change of interaction stress with decreasing slip plane obstacle distance is negative. When the rate of change is positive the dislocation is found to narrow. (2) The discrete theory allows interaction stress calculation which include the Peierls stress. (3) A critical separation distance between two dislocations of opposite sign on the same slip plane exists where only the critical shear stress for the perfect lattice would prevent their mutual annihilation. This differs little from the dislocation vs free surface interaction. (4) For a dislocation versus a similar dislocation on the same slip plane a certain separation distance is found that cannot be minimized by a uniform shear stress less than the critical shear stress for the perfect lattice. (Contractor's abstract, modified)

745

Columbia U. Dept. of Mechanical Engineering, New York.

THERMAL EFFECTS OF DISLOCATION VELOCITIES IN A LINEAR CHAIN, by J. H. Weiner. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-2576) (AF AFOSR-63-228) AD 629668 Unclassified

Also published in Phys. Rev., v. 139: A442-A449, July 9, 1965.

The effects of the thermal motion of atoms upon a dislocation in steady motion in a modified Frenkel-Kontorova model are examined. The energy associated with the localized mode due to the dislocation and the energy associated with the nonlocalized modes are considered separately and referred to as the energy of the dislocation system and of the surrounding heat bath, respectively. Several distinct components of the net energy exchange between dislocation system and heat bath are isolated. In particular, one component is found which may be described as a coordinating effect between the thermal motion of the atoms and the dislocation motion, which results in a transfer of energy from the heat bath to the moving dislocation. When model parameter values are chosen so that this component of energy transfer is dominant, the drag on a moving dislocation in the model studied decreases with increase in temperature. Computer simulation of the model lends support to the principal features of the theory. (Contractor's abstract)

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Columbia U. Dept. of Mechanical Engineering, New York.

DISLOCATION KINK IN A CRYSTAL MODEL, by W. T. Sanders. [1965] [8]p. incl. diagrs. refs. (AFOSR-66-1298) (AF AFOSR-63-228) AD 641383 Unclassified

Also published in Jour. Appl. Phys., v. 36: 2822-2829, Sept. 1965.

A modified Frenkel-Kontorova dislocation model, with a piecewise linear substrate potential is extended to 2 dimensions to describe the entire slip plane of the dislocation with one kink. Accurate solutions are found, with the aid of several analytic techniques and a digital computer, for the static configuration under applied stress. The kink Peierls stress σ_{kp}, the kink width w, and the kink energy F, are determined for a range of values of γ, the perfect crystal shear strength. σ_{kp} is found to be very sensitive to γ, and to have maxima of the order of 10^{-6} to 10^{-5}, in units of the shear modulus. w and E are less sensitive to γ; w ranges from 4 to 30 lattice parameters, while E varies from several hundred to several thousand degrees Kelvin for typical crystal parameters.

747

Columbia U. [Dept. of Physics] New York.

WAVE PROPAGATION ALONG WARM-PLASMA (Abstract), by P. Diament, V. L. Granatstein, and S. P. Schlesinger. [1965] [1]p. [AF 49(638)631] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 8, Jan. 27, 1965.

To determine the dispersion relations for waves propagating along homogeneous isotropic, warm-plasma columns surrounded by a dielectric medium, a steady-state, linearized model with temperature introduced through a scalar pressure is adopted. An approximate solution is obtained from a quasistatic analysis and, for comparison, a more rigorous dispersion relation is derived from Maxwell's equations. The quasistatic analysis yields propagating waves with cutoff frequencies corresponding to the Dattner scattering resonances. The rigorous analysis, as exact as the model, yields no resonant frequencies for zero axial wavenumber, but provides dispersion relations for the surface modes, with temperature effects, and for the Dattner modes as well. The quasistatic and exact predictions are compared with each other, with the cold case, and with published theoretical and experimental results on dipole scattering by warm-plasma columns.

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Columbia U. Electronics Research Labs., New York.

A REPRESENTATION OF GAUSSIAN PROCESSES, by K. S. Miller and L. R. Abramson. [1965] [9]p. incl. refs. (AF 49(638)1113) Unclassified

Published in Internat'l. Jour. Eng. Sci., v. 2: 431-439, Jan. 1965.

A problem of great interest which has been treated by many authors is that of determining the properties of the envelope of noise with or without carriers. One theory is that a Gaussian noise current is decomposed into 2 independent orthogonal Gaussian processes with the same variance. This decomposition and the numerous corollaries derived from it are open to criticism on 2 counts. First, they are based on heuristic, nonrigorous, arguments. Second, they are based on a special formulation for stationary Gaussian noise. The authors show that the decomposition together with the associated properties can be deduced in a mathematically sound fashion for any stationary Gaussian process. (Contractor's abstract)

749

Columbia U. Electronics Research Labs., New York.

DETERMINATION OF DIRECT CURRENT ARC PLASMA CURRENT DENSITY BY HALL-EFFECT MAGNETIC PROBE, by P.-S. Tschang. [1965] [4]p. incl. illus. diagrs. refs. (AFOSR-65-1745) (Sponsored jointly by Aerospace Research Laboratories, and Air Force Office of Scientific Research under AF 49(638)1395) AD 625977 Unclassified

Also published in AIAA Jour., v. 3, 849-852, May 1965.

A method of determining the current density of the cylindrical plasma column of an electric arc is presented based on the measurement of the self-magnetic field due to the arc drift current. This is accomplished by means of a miniature Hall-effect magnetic probe traversing the column diametrally at approximately 120 cm/sec. The theory of the Hall probe is briefly sketched and the method of data reduction given. The probing unit was tested on the plasma column of the fluid-transpiration arc. Results of several representative probings are presented showing general conformity to theory of the arc self-magnetic field radial profile. The results indicate the fluid-transpiration arc current density to be uniform over a large cross section of the column. The perturbative effects of the probe insertion on the plasma are analyzed. The advantages of using Hall probes as against coil-type magnetic probes are examined. (Contractor's abstract, modified)

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Columbia U., Electronics Research Labs., New York.

EFFECTS OF MECHANICAL AND THERMAL ELECTRODE PROPERTIES ON THE BEHAVIOR OF THE FLUID TRANSPIRATION ARC, by C. Sheer, P. S Tschang, and C. G. Stojanoff. Aug. 1965, 132p. incl. illus. diagrs tables, refs. (ARL-65-163) (AFOSR-66-1452) (Sponsored jointly by Aerospace Research Laboratories, and Air Force Office of Scientific Research under AF 49(638)1395) AD 635872 Unclassified

A triple cathode, single anode arc assembly, designed to produce a symmetrical free-burning plasma jet, was completed and placed into operation. A second arc assembly with a single gas-injection cathode, was also constructed for the double purpose of testing porous anodes and accelerating the acquisition of diagnostic data. Diagnostic instrumentation was developed, based on high speed transient probing with miniature sensing elements. Work was carried forward on the development of porous anodes. Diagnostic experiments include measurements of arc terminal characteristics, current density distribution, temperature variations, potential distribution, plasma luminosity distribution and calorimetry experiments. The influence of forced convection into the negative column near the cathode was separately investigated. A 2-dimensional computer analysis of transpiration cooling of the porous anode was worked out

751

Columbia U. School of Engineering and Applied Science, New York.

A KINETIC-THEORETIC DESCRIPTION OF SHOCK WAVE FORMATION, II, by C. K. Chu. Feb. 1965 [10]p. incl. diagrs. (Rept. no. 16) (AFOSR-65-1265) (AF 49(638)1254) AD 621200 Unclassified

Also published in Phys. Fluids, v. 8: 1450-1455, Aug. 1965.

This paper extends the method and results previously obtained for shock waves in 1-dimensional gas to a monatomic 3-dimensional gas. The classical Riemann problem—the flow of a gas in a shock tube—is treated as an initial value problem for the Krook equation, after the Krook equation is first reduced to 2 simultaneous

Krook equations each for a 1-dimensional gas. Results are obtained on the formation of shocks corresponding to Mach numbers of 1.27, 1.5, and 1.75. It is seen that the stronger the shock, the shorter the formation time. The short time behavior of the flow agrees with free flow, while the long time behavior agrees with fluid dynamics. (Contractor's abstract)

752

Columbia U. School of Engineering and Applied Science, New York.

AN ELEMENTARY NUMERICAL TREATMENT OF THE BOLTZMANN EQUATION FOR A SIMPLE GAS WITH PARTICULAR ATTENTION TO WALL INTERACTION, by H. G. Elrod. May 1965, 45p. incl. diagrs. (AFOSR-65-1616) (AF 49(638)1254) AD 618043 Unclassified

Solutions are developed for the Boltzmann equation for a simple gas. Work is especially directed towards providing a better understanding of kinetic-theory predictions for flow phenomena near a wall. The analysis is applied to the elementary subdivision of phase space into 4 quarter spheres. As an example, the 4-group model is then applied to a study of transient couette flow.

753

Columbia U. [School of Engineering and Applied Science] New York.

TRANSPORT PROPERTIES OF HYDROGEN, by D. Brezing. [1965] [6]p. incl. diagrs tables, refs. (AFOSR-65-2494) (AF 49(638)1254) AD 628015 Unclassified

Also published in AIAA Jour., v. 3. 1422-1427, Aug. 1965.

The transport properties of hydrogen are calculated for a pressure range from 10^{-6} to 10^{2} atm and at temperatures up to 10^{6} K. The lower temperature limit is taken where the equilibrium gas mixture contains less than 1% molecular hydrogen. The Boltzmann formalism, which assumes binary collisions in the expressions for the transport properties of gas mixtures, is applied. Theoretical values, supported by experimental data whenever possible, are used for the atom-atom, atom-ion, and atom-electron collision cross sections. For Coulomb force interactions between charged particles, the Debye length is used as cutoff distance. The collision integrals for all interactions are computed. Values of viscosity, thermal, and electrical transport coefficients, as well as the thermoelectric coefficients, are presented.

754

Columbia U. School of Engineering and Applied Science, New York.

IONIZING SHOCK STUDIES IN AN ELECTROMAGNETICALLY DRIVEN SHOCK TUBE, by B. Miller. June 1965, 133p. incl. illus. diagrs. tables, refs. (AFOSR-66-0300) (AF 49(638)1254) AD 621990 Unclassified

A coaxial electromagnetic shock tube was used to study ionizing shocks propagating through hydrogen. An experiment is described which produced plane switch-on ionizing shocks. Studies were conducted covering the sub-Alfvenic, trans-Alfvenic and super-Alfvenic regimes. Data is presented that verifies the existence of switch-on fronts in all these regimes, and demonstrates the significant effect of the initial electric field on the shock jump conditions. The results substantiate the theory of normal ionizing shocks developed by Taussig. A simple physical criterion is employed to choose from among the several theoretically predicted ionizing waves propagating at a given speed. This criterion has strong intuitive support and results in a consistent picture of ionizing shock propagation that is in general agreement without experimental observations. The existence of a small homogeneous plasma sample, behind the ionizing shock wave and before the expansion fan, is demonstrated. Previous failures to find large homogeneous plasma samples are shown to be consistent with the theory of ionizing shock waves. (Contractor's abstract, modified)

755

Columbia U. [School of Engineering and Applied Science] New York.

STRONG IONIZING SHOCK WAVES, by R. A. Gross. [1965] [20]p. incl. diagrs. refs. (AFOSR-66-0358) (AF 49(638)1254) AD 631379 Unclassified

Presented at meeting of the Amer. Phys. Soc., Calif. Inst. of Tech., Pasadena, Nov. 23-25, 1964.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 273, Feb. 25, 1965.

Also published in Rev. Modern Phys., v. 37: 724-743, Oct. 1965.

The physical effects created by strong shock waves propagating in hydrogen are reviewed and theoretically studied for speeds up to relativistic conditions. In the progression from weak to relativistic shock speeds, various physical phenomena affect the shock wave. Dissociation, ionization, and the presence of an upstream electric field cause several important effects for slow (sub-Alfvenic speed) normal ionizing shock waves. Switch-on shock behavior is extended to slow ionizing waves. The effect of radiation is investigated for both the optically thick and thin cases. Relativistic shock jump equations are solved for wave speeds approaching the speed of light. Thermonuclear shock solutions are examined. The theory of the electromagnetically driven shock tube is reviewed and the corresponding shock tube problem is explored. Wave stability is reviewed. Experimental results on strong ionizing shock waves are reviewed. (Contractor's abstract)

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Columbia U. [School of Engineering and Applied Science] New York.

NORMAL IONIZING SHOCK WAVES, by R. T. Taussig. [1965] [12]p. incl. diagrs. refs. (AFOSR-66-0359) (AF 49(638)1254) AD 632228 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 217, Feb. 25, 1965.

Also published in Phys. Fluids, v. 8: 1616-1627, Aug. 1965.

Solutions to the steady-state jump equations are obtained for a normal ionizing shock wave propagating into a nonconducting, quiescent gas in an electromagnetic field. Comparison of these solutions to pure magnetohydrodynamic shocks and ordinary gas shocks indicates that ionizing shocks are hybrids having some properties common to both magnetohydrodynamic and gas shocks. Some completely novel effects are produced by the upstream electromagnetic field. The shock velocities are bounded for a given upstream electric field strength where the electric field is assumed parallel to the shock plane. For electric fields larger than a critical value, no steady compressive shocks exist, and for nonzero electric fields 'switch-on' behavior is extended to slow shocks. Solutions analogous to detonation-deflagration waves have been found, and the Chapman-Jouguet condition is applied to them. The complete boundary value problem is solved in the context of an electromagnetic annular shock tube to place the analytic results in the framework of experimentally observable phenomena. (Contractor's abstract)

757

Columbia U. School of Engineering and Applied Science, New York.

U-235 RESONANCE CROSS SECTIONS AND GASEOUS CORE REACTOR CALCULATIONS, by G. W. Tumm. Aug. 1965, 100p. incl. diagrs. tables, refs. (AFOSR-66-0951) (AF 49(638)1254) AD 626757 Unclassified

This report contains (1) Calculation of U-235 resonance cross sections to 40,000°K for conditions applicable to gaseous core nuclear reactors; (2) Comparison between measured cross sections and calculated resonance integrals for U-235; (3) Calculation of the critical mass for configurations representing approximately the so-called "coaxial flow" - and "vortex flow" gaseous core nuclear reactors. The theoretical cross sections calculations compare well with measured quantities, e.g. U-235 resonance integral (300°K): 271.0 barns (measured and 271.7 barns (calculated) k_{eff} for measured critical masses; 1.0065 (for fuel compressed towards cavity center) and 1.0019 (for fuel compressed towards cavity walls). The critical mass calculations for various gaseous core reactor configurations (spherical) show that the fuel requirements of a "vortex flow" reactor is approximately one-half of that needed for a "coaxial flow" - reactor.

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Columbia U. [School of Engineering and Applied Science] New York.

IONIZING SHOCK STUDIES IN AN ELECTROMAGNETICALLY DRIVEN SHOCK TUBE, by B. Miller, L. Levine, and R. A. Gross. [1965] [16]p. incl. illus. diagrs. (AFOSR-67-1818) (AF 49(638)1254) AD 656716 Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Oct. 28-30, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 1145, Oct. 28, 1965.

Also published in Proc. Fifth Internat'l. Shock Tube Symposium, Naval Ordnance Laboratory, White Oak, Silver Spring, Md., Apr. 28-30, 1965, p. 221-236.

A 1-m-long, 7-cm-mean-radius, coaxial electromagnetic shock tube with a 1-cm annulus has been used to study strong ionizing shock waves propagating through hydrogen. The shock tube, shaped-pulse capacitor bank, and associated circuitry are described. Experimental techniques used to successfully obtain uniform breakdown and the launching of plane ionizing shock waves are presented. Diagnostic studies with photomultipliers and magnetic- and electric-field probes are discussed. Constant-speed normal-ionizing shock waves propagating at 2-8 x 10^6 cm/sec have been studied. Variation of the longitudinal magnetic field between 800 and 12,000 (g) produced sub-Alfvénic, switch-on, and super-Alfvénic shock waves. We discuss the influence of the initial gas state, including the electric field, on the shock-jump conditions. The effect of initial conditions on shock-formation time has been observed. Analysis of magnetic-field profiles has led to quantitative shock-width data and to the identification of a switch-on-like shock with an identifiable uniform gas sample and expansion fan. A comparison between theoretical and measured wavespeed and magnetic field as a function of drive current is presented.

759

Columbia U. [School of Engineering and Applied Science] New York.

HYDROMAGNETIC PLASMA RESEARCH (Abstract), by R. A. Gross and C. K. Chu. [1965] [2]p. (Bound with its AFOSR-65-1266; AD 622527) (AF 49(638)1254) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif. Apr. 29-30, 1965.

Constant speed normal ionizing shock waves propagating in hydrogen at 2 to 8 x 10^6 cm/sec have been studied in detail. Variation of the longitudinal magnetic field

between 800 and 12,000 gauss produced sub-Alfvenic, switch-on, and super-Alfvenic shock waves. Detailed analysis of magnetic field profiles has produced quantitative shock width data, and profiles strongly suggestive of a switch-on shock, an identifiable uniform gas sample and an expansion fan. The influence of the cold gas electric field and the upstream signal speed are evident in the shock speed, the wave profiles, and the shock formation time. The physical effects created by strong shock waves propagating in hydrogen have been studied up to relativistic conditions. The effect of radiation on shock structure has been investigated for both optically thick and thin cases. The relativistic shock jump equations have been numerically solved for wave speeds approaching the speed of light. Work is in progress on the structure of a thermonuclear shock wave. Extensive digital computations have been completed which determine the chemical equilibrium shock jump conditions for an ionizing shock in hydrogen. The formation of a shock wave has been successfully computed from the viewpoint of kinetic theory. Stability and formation of hydromagnetic waves have also been studied numerically.

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Columbia U. [School of Engineering and Applied Science] New York.

KINETIC THEORETIC DESCRIPTION OF SHOCK-WAVE FORMATION (Abstract), by C. K. Chu. [1965] [1]p. [AF 49(638)1254] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 24, Jan. 27, 1965.

Numerical results are obtained on the unsteady 1-dimensional flow of a gas in a shock tube from the viewpoint of kinetic theory. The gas is assumed to be governed by the Krook-model equation and the flow is treated as a pure initial value problem of the Krook equation. In a previous paper, the problem was solved by finite differences for a 1-dimensional gas (corresponding to $\gamma = 3$). The present results are calculated for a monatomic 3-dimensional gas ($\gamma=5/3$). An exact reduction procedure is used to replace the Krook equation for the 3-dimensional gas by a pair of simultaneous Krook equations, each for a 1-dimensional gas; this greatly reduces the computation required. The results agree with free flow at small times and with fluid dynamics at large times. The shock-formation time is found. The developed shock profiles are in agreement with steady profiles computed by Liepmann et. al. Rarefaction-wave dispersion and contact-layer diffusion are automatically incorporated in the results.

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Columbia U. School of Engineering and Applied Science, New York.

A KINETIC-THEORETIC DESCRIPTION OF THE FORMATION OF A SHOCK WAVE, by C. K. Chu. June 1964 [45]p. incl. diagrs. tables. (Rept. no. 11) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1254 and National Science Foundation) AD 606511 Unclassified

Also published in Phys. Fluids, v. 8: 12-22, Jan. 1965.

The classical Riemann problem--the flow of a gas in a shock tube--is treated in the context of kinetic theory as an initial value problem for the one-dimensional Krook equation. The only simplifying assumption made is that the gas is one-dimensional: its particles all move in one direction. This corresponds to a gas with an adiabatic constant $\gamma = 3$. A finite difference method is proposed, utilizing the fact that for sufficiently small time intervals, the gas experiences essentially free molecular flow, so that the collision effects can be treated as a first order correction. The conservation laws are not used. The computed results generalize the classical solution: the computed solution agrees excellently with the classical solution, but in addition, has shock structure, diffusion of the contact discontinuity, and dispersion of the expansion wave, all incorporated. The same procedure is used to calculate steady state shock structure, to which the shock developed in the shock tube is compared. It is seen that for the strength of the shock calculated (pressure ratio of tube 10:1, shock Mach number 1.43, $\gamma = 3$), the shock is essentially "fully-developed" after about 20 mean collision times of the low pressure gas.

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Columbia U. [School of Engineering and Applied Science] New York.

NORMAL IONIZING SHOCK WAVES, by R. T. Taussig. 1965, 184p. incl. diagrs. refs. (Rept. no. 23) (AF 49-(638)1254) AD 631372 Unclassified

Solutions to the steady state jump equations are obtained for a normal ionizing shock wave moving into a nonconducting, stationary gas in an electromagnetic field. The properties of ionizing shock waves common to pure MHD and to ordinary gas shocks are discussed. Coupling between electromagnetic and dissociation-ionization effects across the shock is analyzed. Numerical solutions are presented for several electric field strengths in molecular hydrogen using accurate thermodynamic properties and assuming that the gas upstream and downstream from the shock is in chemical equilibrium. The steady state problem of a current-driven shock wave is solved in the context of an electromagnetic annular shock tube. The results agree well with experimental evidence. Evolutionary normal ionizing shock wave solutions are selected and their stability determined in perfect fluid. A theory of shock wave stability in a fully dissipative fluid, based on recent work in magnetohydrodynamics, is outlined.

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Columbia U. [School of Engineering and Applied Science] New York.

STRONG SHOCK WAVES, by R. A. Gross. [1965]

[5]p. incl. illus. diagrs. (AFOSR-66-0060) [AF 49-(638)1634] AD 632257 Unclassified

Also published in Phys. Today, v. 18: 20-24, Oct. 1965.

The questions discussed in this paper include: Can strong shock waves create very hot plasma? What temperatures can shock waves produce: What physical phenomena become important with increasing shock speed? What is the present state of our understanding of shock waves, where do they occur in nature, and how strong a shock wave can now be produced in laboratory devices?

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Columbia U. [School of Engineering and Applied Science] New York.

DEACTIVATION OF NEON METASTABLES BY HYDROGENIC IMPURITIES, by T. Marshall. [1965] [6]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-48, and Office of Naval Research) Unclassified

Published in Jour. Appl. Phys., v. 36: 712-717, Mar. 1965.

Measurements are reported of the total cross section for deactivation of neon $^3P_2$ and $^3P_0(2p^53s)$ metastables by inelastic collisions with H_2, D_2, CH_4, and NH_3. Observations were conducted by applying the methods of resonance radiation absorption and microwave diagnostics to the afterglow plasma following a weak pulsed discharge in a neon-hydrogenic impurity mixture. The cross section for $^3P_2$ deactivation by H_2 was found to increase from 0.7×10^{-15} cm^2 at 300 K to 2.5×10^{-15} cm^2 at 650°K. The cross section for ionization of H_2 by $Ne^*{}^3P_2$ collision was found to represent only a fraction of the above. The reaction which dissociates H_2 and partly converts the metastable energy into Hα(6563A) light has been observed in H_2, D_2, CH_4, and NH_3 and may represent a significant contribution to the total deactivation in each case. No Hα light was produced as a result of the destruction of a helium $^3S_1$ metastable by collision with H_2. (Contractor's abstract)

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Columbia U. Lamont Geological Observatory, Palisades, N. Y.

CONDITIONS FOR A DENSITY MINIMUM IN THE UPPER MANTEL, by O. L. Anderson. [1965] [5]p. incl. tables, refs. (AFOSR-65-2924) (AF 49(638)1355) AD 616168 Unclassified

Also published in Jour. Geophys. Research, v. 70: 1457-1461, Mar. 15, 1965.

A number of recent articles have indicated that there is a density minimum in the upper mantle. An example is the article by Clark and Ringwood, where the density minimum is based upon petrology. In this paper the conditions for a density minimum are established using the Mie-Gruneisen equation of state. It is shown that for a homogeneous mantle with a positive value of thermal expansivity, the sign of the density gradient is the same as the sign of the s velocity gradient. The conditions for a density minimum in a nonhomogeneous upper mantle are also discussed. (Contractor's abstract)

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Columbia U. Lamont Geological Observatory, Palisades, N. Y.

THE RELATION BETWEEN REFRACTIVE INDEX AND DENSITY OF MINERALS RELATED TO THE EARTH'S MANTLE, by O. L. Anderson and E. Schreiber. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-2925) (AF 49(638)1355) AD 616166 Unclassified

Also published in Jour. Geophys. Research, v. 70: 1463-1471, Mar. 15, 1965.

It is known that the density of many minerals is related to the average index of refraction by a linear law called the Gladstone-Dale law. It is shown that this law is generally applicable only to minerals whose anion is oxygen and whose mean molecular weight is close to 21. Another relationship, called Drude's law, which is deduced from classical dielectric theory, fits the data just as well as the empirical linear law. The correlation between density and index includes the minerals arising from various combinations of SiO_2, MgO, Al_2O_3, Na_2O, and K_2O. An implication is that density controls certain physical properties of oxides, independently of composition or crystal class. This is analogous to the rule found by Birch which relates sound velocity to density and holds for the same groups of minerals. (Contractor's abstract)

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Columbia U. Lamont Geological Observatory, Palisades, N. Y.

LATTICE DYNAMICS IN GEOPHYSICS, by O. L. Anderson. [1965] [11]p. incl. diagrs. tables, refs. (AFOSR-65-2926) (AF 49(638)1355) AD 616167 Unclassified

Also published in Trans. New York Acad. Sci., Series II, v. 27: 298-308, Jan. 1965.

An arbitrary but useful way to classify solid physical properties is into the classes of lattice properties or defect properties. In lattice dynamics the word lattice indicates lattice properties and the word dynamics indicates the importance of thermal vibrations of atoms to those properties. These properties are defined in terms of the set of normal vibrational modes, calculated from a model composed of discrete masses connected by springs in a large array. This information is contained in a fundamental diagram, associated with the particular

model, called the frequency vs wave number diagram. A few conclusions emerge from this method which are independent of the numerical values of the density and velocity distribution used. It is clear that the region of the largest uncertainty in physical properties is 400-1000 km. It is shown that the Debye temperature is insensitive to the density distribution, and can be regarded as known to within 5%, subject only to drastic revisions in the present estimates of the mean molecular weight of the mantle.

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Columbia U. Lamont Geological Observatory, Palisades, N. Y.

AN APPROXIMATE METHOD OF ESTIMATING SHEAR VELOCITY FROM SPECIFIC HEAT, by O. L. Anderson. [1965] [3]p. incl. diagr. table, refs. (AFOSR-65-2927) (AF 49(638)1355) AD 624493 Unclassified

Also published in Jour. Geophys. Research, v. 70: 4726-4728, Sept. 15, 1965.

It is pointed out that the isotropic shear velocity v of inorganic materials such as of minerals and rocks can be estimated from low temperature specific heat measurements.

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Columbia U. Lamont Geological Observatory, Palisades, N. Y.

MEASUREMENT OF P AND S SOUND VELOCITIES UNDER PRESSURE ON LABORATORY MODELS OF THE EARTH'S MANTLE, by O. L. Anderson and E. Schreiber. Final rept. Dec. 16, 1963-Dec. 15, 1965, Dec. 16, 1965 [74]p. incl. diagrs. tables, refs. (AFOSR-66-0576) (AF 49(638)1355) AD 478109 Unclassified

The techniques of ultrasonic interferometry were used to measure the isotropic sound velocities and their derivatives for polycrystalline specimens of aluminum oxide and magnesium oxide. The pressure derivatives were determined to 4 kbars at room temperature and at -78.5 C. The temperature derivatives were measured at 1 atm. The isothermal pressure derivatives of the bulk modulus and the isothermal temperature derivatives of the bulk modulus were determined. From these data, the critical temperature gradient for velocities, $(dT\ dP)_v$, were evaluated, and the velocity behavior of these materials as a function of temperature and depth in the mantle, are discussed. It was found that, because $(dT/dP)_{v_p} > (dT/dP)_{v_s}$, they exhibit a shear velocity minimum and a less pronounced longitudinal velocity minimum under conditions likely to exist in the upper mantle. An expression was derived, employing the measured values of the bulk modulus B_0 and its pressure derivative B_0', which predicts compression at extremely high pressures. Using the derived expression $\ln(V_0/V) = [1/B_0' \ln(P/B_0) + 1]$ and the values of B_0 and B_0' for MgO and Al_2O_3 reported here, the agreement between the calculated compression and measured compression reported in the literature was within 0.5% to 350 kbars. (Contractor's abstract)

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Columbia U. Lamont Geological Observatory, Palisades, N. Y.

THE BULK MODULUS-VOLUME RELATIONSHIP FOR OXIDE COMPOUNDS AND RELATED GEOPHYSICAL PROBLEMS, by O. L. Anderson and J. E. Nafe. [1965] [13]p. incl. diagrs. tables, refs. (AF 49(638)1355) Unclassified

Published in Jour. Geophys. Research, v. 70: 3951-3963, Aug. 15, 1965.

The relationship between the sound velocity and density in various oxide compounds at atmospheric pressure is relevant to problems of the earth's interior. Here data on elastic constants of various compounds are collected and analyzed. It is shown that the bulk modulus-volume per ion pair relationship for oxide compounds differ in a remarkable degree from that found for alkali halides, fluorides, selenides, sulfides, and covalent compounds. It is shown that a change of volume has the same effect on the bulk modulus of oxide compounds, whether the volume change is produced by pressure, compositional variation, phase changes, temperature, or porosity. It thus appears that volume is the primary variable affecting the elastic moduli of oxide compounds, and all other variables affect the moduli only insofar as they affect the volume itself. (Contractor's abstract)

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Columbia U. Lamont Geological Observatory, Palisades, N. Y.

THE PRESSURE DERIVATIVES OF THE SOUND VELOCITIES OF POLYCRYSTALLINE MAGNESIA, by O. L. Anderson and E. Schreiber. [1965] [8]p. incl. diagr. tables, refs. (AF 49(638)1355) AD 615623 Unclassified

Also published in Jour. Geophys. Research, v. 70: 5241-5248, Oct. 15, 1965.

The sound velocities and the pressure derivatives of the sound velocities of a gem-quality sample of polycrystalline MgO were measured by the 'phase comparison' technique. The pressure derivatives found from experiments at pressures up to 4 kb are $dv_s/dp = 4.351 \times 10^{-3}$ km sec/kb and $dv_p/dp = 7.711 \times 10^{-3}$ km/sec/kb. Arguments are presented which indicate that these pressure derivatives hold up to at least 100 kb. These values yield a vanishingly small value of the pressure derivative of Poisson's ratio. The Grüneisen constants of the shear and longitudinal modes are calculated, from which the acoustic Grüneisen

constant is estimated to be 1.60. This agrees very well, with the Grüneisen constant obtained from thermal properties. (Contractor's abstract)

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Columbia U. Lamont Geological Observatory, Palisades, N. Y.

TWO METHODS FOR ESTIMATING COMPRESSION AND SOUND VELOCITY AT VERY HIGH PRESSURES, by D. L. Anderson. [1965] [7]p. incl. diagrs. table, refs. (AF 49(638)1355) AD 623759 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 54: 667-673, Sept. 1965.

Precision sound velocity measurements made at relatively low pressure (less than 10 kilobars) can be used to estimate sound velocity and volume compression at very high pressures. If the parameters of a continuous analytic function are sufficiently accurately determined at low values of the independent variable, the function may be evaluated at high values of the independent variable, the function may be evaluated at high values of the independent variable. Consequently, only materials undergoing compression without phase change are treated. What is new is the presentation of 2 functions suitable for representing volume dependence upon pressure (compression curves) and the evaluation of the parameters in these functions from acoustic data taken at low pressures but with high precision. The parameters are the bulk modulus and its higher derivatives.

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Columbia U. Lamont Geological Observatory [Palisades, N. Y.]

THEORETICAL SEISMOGRAMS OF SPHEROIDAL TYPE ON THE SURFACE OF A HETEROGENEOUS SPHERICAL EARTH, by T. Usami, Y. Sato, and M. Landisman. [1965] [20]p. incl. diagrs. tables. (AFOSR-66-1281) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-303 and National Aeronautics and Space Administration) AD 634557 Unclassified

Also published in Bull. Earthquake Research Inst., v. 43: 641-660, 1965.

Theoretical seismograms for motion of spheroidal type on a Gutenberg-Bullen A' earth model have been computed by superposition of normal modes. Contributions from free oscillations having periods between one minute and one hour and from the fundamental to the tenth radial mode have been included. Surface waves attributed to the first three radial modes appear clearly on the theoretical seismograms. Those of the first mode are common on observational seismograms. Waves reflected from, transmitted through and diffracted around the core, are also evident on the theoretical seismogram. The arrival time of these and other body wave phases agrees well with theoretical arrival times computed by the ray method for the same earth model.

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Columbia U. Lamont Geological Observatory, Palisades, N. Y.

SUPPORT OF VISITING SEISMOLOGISTS, by J. T. Kuo. Final rept. Mar. 1, 1962-Aug. 31, 1965 Sept 1, 1965, 8p. incl. diagr. (AF AFOSR-62-303) AD 624453 Unclassified

During the past three years, nine years, nine visiting seismologists from Japan, England and Denmark have been working either jointly with the Lamont seismology staff or individually on many important problems. As a result of their research progress was made in the following areas. (1) earthquake prediction--considering earthquakes as statistical events in a stochastic process, (2) a more detailed understanding of the travel times of body waves through North America for both nuclear explosions and earthquakes, (3) extending the theoretical investigation of wave propagation through complicated structures, such as a corrugated interface and a medium with a hyperbolic type of interface, and (4) a detailed understanding of the dissipation factor 1 Q both in the upper and the lower mantle and in the core. These findings are closely related to the problems of location of seismic events and of differentiation of explosions from earthquakes.

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Commonwealth Scientific and Industrial Research Organization. Div. of Physics, Sydney (Australia).

THERMAL EXPANSION AT LOW TEMPERATURES OF HEXAGONAL METALS. Mg, Zn AND Cd, by R. D. McCammon and G. K. White. [1965] [10]p. incl. diagrs. table, refs. (AFOSR-65-1927) [AF AFOSR-62-391] AD 626891 Unclassified

Also published in Philos. Mag., v. 11: 1125-1134, June 1965.

Measurements were made between 2 and 30 K of the linear thermal expansion of single crystals of Mg, Zn and Cd, both parallel ($\parallel$) and normal ($\perp$) to the hexad axis. Values were obtained at liquid oxygen temperatures and at room temperature which agree with previous data. For Mg, the linear coefficient $\alpha_\perp$ is larger than $\alpha_\parallel$ below 30 K, and at the lowest temperatures (< 10 K) $\alpha_\parallel = (0.9_5 T + 0.021 T^3) \times 10^{-9}$ K^{-1} and $\alpha_\perp = (1.2_5 T + 0.036 T^3) \times 10^{-9}$ K^{-1}, the Grüneisen parameter, γ, remains between 1.4 and 1.5. In Zn, $\alpha_\perp$ is negative between 8 and 70 K; $\alpha_\parallel$ is always positive and increases very rapidly between 10 and 40 K. Gamma has a value of 2.0 at room temperature and below 10 K but has a maximum of about 2.8 at $\theta \sim 15$. For Cd, $\alpha_\perp$ is negative from 5 to 40 K, but below this a positive term, assumed to be due to the electron [illegible] predominates, $\alpha_\parallel$ varies with temperature much [illegible] zinc. Gamma is about 2.3 at high and low temperatures and reaches a maximum of 3.4 at $\theta \sim 15$. (Contractor's abstract)

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Commonwealth Scientific and Industrial Research Organization, Div. of Physics, Sydney (Australia).

THE THERMAL EXPANSION OF ALKALI HALIDES AT LOW TEMPERATURES, by G. K. White. [1965] [14]p. incl. diagrs. tables, refs. (AFOSR-65-2549) [AF AFOSR-62-391] AD 627622 Unclassified

Also published in Proc. Roy. Soc. (London), v. 286A: 204-217, June 22, 1965.

Linear thermal expansions of 8 alkali halides have been determined at liquid oxygen temperatures and at temperatures from 30 down to 2 K. For temperatures T θ 20, where θ is the Debye temperature, the expansion coefficients are well represented by $\alpha = AT^3 + BT^5$. Values are reported for the Grüneisen parameter $\gamma = 3\alpha V C\chi$, where C/V is the heat capacity per unit volume and χ is the compressibility. For CsBr (b. c. c. structure) γ appears to be nearly independent of temperature, with a value of 2·0 but for the other crystals, which have the rock-salt structure, the parameter γ varies with temperature, chiefly between θ/10 and θ/5. At room temperature, γ lies between 1·45 and 1·7 but at low temperature this generally decreases to a value γ_0 which is ~ -0.1 for RbI, + 0.3 for KCl, KBr and KI and 1.0 for NaCl and NaI. LiF does not show this decrease, γ_0 being 1.7. The values observed for γ_0 are compared with those calculated from elastic constants and their pressure derivatives and the general behavior of γ(T) is observed to conform qualitatively to the predictions of simple theoretical models of Born, Blackman and Barron. (Contractor's abstract)

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Commonwealth Scientific and Industrial Research Organization, Div of Physics, Sydney (Australia).

THERMAL EXPANSION OF GERMANIUM AND SILICON AT LOW TEMPERATURES, by R. H. Carr, R. D. McCammon, and G. K. White [1965] [7]p. incl diagrs. table, refs. (AFOSR-65-2557) [AF AFOSR-62-391] AD 628423 Unclassified

Also published in Philos. Mag., v. 12: 157-163, July 1965.

The linear expansion coefficients (α) of silicon and germanium are reported at temperatures down to θ 50. At temperatures below 16 K, the expansion coefficients are very small but are positive and hence the Grüneisen parameter γ 3αVK C (K is the bulk modulus and C V is heat capacity per unit volume) is positive. At T θ 15, γ has a minimum value of ~0.1 for germanium and ~0.42 for silicon. At higher temperatures α and γ become positive and agree with data of Gibbons. Individual γ-values for the transverse acoustic modes must be reduced considerably by dispersion to account for the deep minimum in γ(T). (Contractor's abstract)

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Commonwealth Scientific and Industrial Research Organization. Div. of Physics, Sydney (Australia).

THERMAL PROPERTIES OF SILICA AT LOW TEMPERATURES, by G. K. White and J. A. Birch. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-2558) [AF AFOSR-62-391] AD 628424 Unclassified

Also published in Phys. and Chem. Glasses, v. 6: 85-89, June 1965.

At temperatures below 20° K, the magnitude of the negative thermal expansion of vitreous silica is reduced by about 10% with increase in fictive temperature from 1000 to 1400° C. A much greater reduction of 2 to 4 times is produced by fast neutron irradiation (5 x 10^{19} nvt). Corresponding changes in density and the heat capacity (observed at low temperatures) also occur. The negative expansion and other 'anomalous' properties appear to have a common origin in view of the parallel changes in these properties which occur with heat treatment, irradiation, and network-filling additives. Low-frequency transverse optical modes of vibration seem to be responsible but it is puzzling that the anomalous behavior persists at such low temperatures (~ 2°K). (Contractor's abstract)

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Commonwealth Scientific and Industrial Research Organization. Div. of Physics, Sydney (Australia).

THERMAL EXPANSION OF MAGNETIC METALS AT LOW TEMPERATURES, by G. K. White. [1965] [11]p. incl. diagrs. tables, refs. (AFOSR-65-2590) [AF AFOSR-62-391] AD 629558 Unclassified

Also published in Proc. Phys. Soc. (London), v. 86: 159-169, July 1965.

Measurements have been made from 2° to 30°K and 60° to 90 K of the thermal expansion of iron, cobalt and nickel, which show that the Grüneisen parameter γ_l for the lattice decreases slightly at low temperatures and that the electronic parameter γ_e (calculated from the ratio of the electronic contributions to expansion and heat capacity) is about 2. 2. Similar measurements below 30 K on α-manganese, chromium, face-centered cubic iron-nickel (35-50% Ni) alloys and $Fe_{0.5}Mn_{0.5}$ indicate a negative term, proportional to T, in the expansion coefficient. This is particularly large in Invar and in α-manganese. For γ-manganese (+ 15% Cu), no negative term is observed in the expansion. Results are discussed in terms of electronic and magnetic contributions (Contractor's abstract)

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Communication Research Inst., Miami, Fla.

VOCAL MIMICRY IN TURSIOPS: ABILITY TO MATCH NUMBERS AND DURATIONS OF HUMAN VOCAL

BURSTS, by J. C. Lilly. [1965] [2]p. incl. diagrs. (AFOSR-65-1513) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-415] and National Institutes of Health) AD 623492
Unclassified

Also published in Science, v. 147: 300-301, Jan. 15, 1965.

In addition to its normal underwater sonic communication path, the dolphin, Tursiops truncatus, can be trained to emit sounds from the blow-hole opened in air. By proper rewarding and evocative techniques, such vocal emissions can be changed from the natural patterns. One such group of new sounds is said to resemble the human voice. Aspects of these sounds which are physically determinable, specifiable, and demonstrable are the similarities in numbers of bursts of sound emitted by man and dolphin and in durations of successive emissions. In 92% of the exchanges the number of bursts emitted by Tursiops equalled, ± 1, the number just previously emitted by a man in sequences of 1 - 10 bursts.

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Computer Usage Co., Inc., Palo Alto, Calif.

STRATEGIES OF FUNCTION DECOMPOSITION FOR ARTIFICIAL INTELLIGENCE, VOL. II, by D. G. Willis. [Final rept.] Sept. 1964-June 1965. July 1, 1965, 152p. incl. diagrs. tables. (AFOSR-65-1612) (AF 49(638)-1454) AD 620186 Unclassified

Preliminary results are reported in 13 research notes on strategies of function decomposition solely from observations of inputs (variable configurations) and outputs (function values). The classes of functions to which the results apply include discrete, finite, deterministic functions as well as arbitrary close discrete approximations to continuous functions of continuous variables. Non-deterministic (i.e., probabilistic) and sequential (i.e., finite automata) functions are not included. The research notes consider (a) decomposition costs and the equivalence of all measures of cost or complexity, (b) the detection of economical decompositions; and (c) generalizing properties of economical decompositions. Efficient procedures are suggested for detecting economical non-composite decompositions of any given partial or total discrete function solely from input and output observations. Composite decompositions become tractable when enough is known or properly conjectured about their sub-functions.

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Connecticut U. Dept. of Physics, Storrs.

CHARGE-STATE CORRELATIONS IN Ar^+-Ar COLLISIONS, by E. Everhart and Q. C. Kessel. [1965] [3]p. incl. diagrs. (AFOSR-65-2811) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-805] and Army Research Office (Durham)) AD 614545 Unclassified

Also published in Phys. Rev. Ltrs., v. 14, 247-249, Feb 22, 1965.

Single collisions of Ar^+ on Ar at 25 to 150 kev were studied using a coincidence scattering device. For the reaction $Ar^+ + Ar \rightarrow Ar^{m+} + (m+n-1)e$, the charge states m and n of both particles from the same large-angle collision were determined. The probabilities of observing m and n in coincidence were found, and the inelastic energy loss for the (m, n) reaction was determined. No correlation between m and n was found, and an interpretation of the observations was developed.

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Connecticut U. Dept. of Physics, Storrs.

THREE DISCRETE Q VALUES IN Ar^+-Ar COLLISION (Abstract), by Q. C. Kessel, A. Russek, and E. Everhart [1965] [3]p. incl. diagrs. refs. (AFOSR-65-2829) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-805] and Army Research Office (Durham)) AD 617801
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Also published in Phys. Rev. Ltrs., v. 14, 484-486, Mar. 29, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 459, Apr. 26, 1965.

In certain Ar^+ on Ar collisions, in particular for 25-kev scattering at 16° and other collisions having the same distance of closest approach, 3 discrete values exist for the inelastic energy loss Q, roughly 90, 380, and 610 ev, all ± 20 ev. Using coincidence methods, it was shown that the 1st and 3rd Q values correspond to events where the distribution after collision among the charge states of one particle is uncorrelated with the charge state of the other particle. However, for the 2nd Q value, the charge-state distributions are found to be correlated. The data are consistent with a model wherein there are only 2 intermediate atomic (perhaps autoionization) levels, A ~ 50 and B ~ 310 ev appearing in each atom after collision. The three Q values correspond to 2A, A + B, and 2B, respectively. Apparently level B begins to appear when the L shells of the 2 argons interpenetrate during the collision.

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Connecticut U. Dept. of Physics, Storrs.

WIDTHS OF Q-DISTRIBUTIONS IN Ar^+ ON Ar COLLISIONS (Abstract), by E. Everhart and Q. Kessel [1965] [1]p. [AF AFOSR-65-805] Unclassified

Published in Fourth Internat'l. Conf. on Physics of Electronic and Atomic Collisions, Abstracts of Papers, Laval U., Quebec (Canada) (Aug. 2-6, 1965), New York, Science Bookcrafters, Inc., [1965] p. 287.

Large-angle single collisions of Ar^+ ions on Ar targets have been studied at 25 kev using a coincidence scattering apparatus. In these violent collisions there is

considerable interpenetration of the 2 atoms such that the L-shells overlap in some cases. Recent theories have described conflicting models of the mechanism of the interaction. With the data obtained using a coincidence scattering apparatus and the recent measurements designed to measure this distribution more accurately, it should be possible to resolve some of the differences between these models. (Contractor's abstract, modified)

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Cork U. Coll. (Ireland)]

THE ν-METHOD FOR AEOLOTROPIC RECTANGULAR AND SKEW PLATES, by P. M. Quinlan. [1965] [36]p incl diagrs. table. (AFOSR-65-2437) (AF EOAR-61-4) AD 632221 Unclassified

Also published in Proc. Roy. Irish Acad., v 64A: 49-84, Mar. 1965.

For abstract see item no. 716, Vol 6.

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Cork U. Coll. (Ireland).

THIN ELASTIC PLATES AND SHELLS, PILE GROUPS, MAGNETIC FILMS AND NON-LINEAR BENDING, by P. M. Quinlan. Final rept. Mar. 15, 1965, 8p. (AFOSR-65-0738) (AF EOAR-63-21) AD 615440 Unclassified

This research is a continuation of the study of thin elastic shells through the use of double Fourier series, using Dirac delta functions summed to a single series. It extends earlier work on rectangular plates, taking examples from aeroelasticity, and investigates general equations or equilibrium of a thin plate. Included are considerations of non-constant curvature in the case of the bending and buckling of shallow shells of revolution.

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Cork U. Coll. (Ireland).

THE ν-METHOD FOR RECTANGULAR PLATES, by P. M. Quinlan. [1965] [25]p. incl. diagrs. tables. (AFOSR-66-0211) (AF EOAR-63-21) AD 630448 Unclassified

Also published in Proc. Roy. Soc. (London), v. 288A: 371-395, Nov. 1965.

A comprehensive method is presented for the numerical solution of the rectangular plate problem under a wide range of loadings and boundary conditions. A particular integral is obtained as a double Fourier sine series, which is the complete solution when the plate is simply supported with all edges in the same horizontal plane. This is summed to a highly convergent single series of negative exponentials in the plate variables. The necessary calculus for differentiation and integration is established, from which the particular slopes, moments and shears follow whether for concentrated or line loads or loads distributed uniformly over polygonal regions. By treating a concentrated moment as a force-pair, this case is deduced from that for a concentrated load. The necessary complementary functions and the ensuing simultaneous equations are formulated in a manner suited to programming for an electronic computer. A master program for rectangular plates has been developed in mercury autocode at the university of Sheffield. An illustrative example is included of a concentrated moment acting on a fully fixed rectangular plate. (Contractor's abstract)

788

Cork U. Coll. [Dept. of Electrical Engineering] (Ireland).

A TRANSISTORIZED RATIO AMPLIFIER EMPLOYING THE PRINCIPLE OF ELAPSED TIME COMPUTATION, by A. A. Cremin and M. C. Sexton. [1965] [2]p. incl. illus. diagrs. (AFOSR-66-0377) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-46 and English Electric Valve Company, Ltd.) AD 630223 Unclassified

Also published in Electron. Eng., v. 37: 747-748, Nov. 1965.

A description is given of an analogue circuit suitable for obtaining the ratio of 2 time-varying input signals. The method involves the use of elapsed time (time-base) circuits to generate sampling frequencies considerably higher than the input signal frequencies thereby producing an essentially continuous output signal proportional to the input ratio. (Contractor's abstract)

789

Cork U. Coll. Dept. of Electrical Engineering (Ireland).

FREQUENCY-MODULATED TECHNIQUE FOR THE STUDY OF THE TONKS-DATTNER RESONANCES, by A. A. Cremin and M. C. Sexton. [1965] [2]p. incl. diagrs. (AFOSR-66-1547) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-46 and English Electric Valve Company, Ltd.) AD 639831 Unclassified

Also published in Electron. Ltrs., v. 1: 297-298, Dec. 1965.

A new method of observing the resonance spectrum of a plasma column irradiated by microwave energy is described. Using a frequency-swept backward-wave oscillator, the resonances are observed as a function of frequency under constant plasma conditions. (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N Y

CATALYTIC RECOMBINATION IN STEP-FUNCTION FLOWS OF ATOMIC OXYGEN, by A. L. Myerson.

Final rept. Jan. 1965 [25]p. incl. illus. diagrs. tables, refs. (AFOSR-65-0125) (AF 49(638)782)
Unclassified

The research provided a new understanding of the time-dependent thermal behavior of various metallic surfaces to recombination heating caused by step function or pulsed flows of atomic oxygen. Solutions for the absolute value of surface recombination efficiency and the diffusion layer mass transfer of a cylindrical probe in Oseen flow were obtained. A purely mathematical solution to this flow is also underway. A theoretical analysis was made of the effect of pressure gradient on a chemically frozen boundary layer. Relationships were obtained between surface recombination heating and pressure gradients in the boundary layer for both relatively noncatalytic and highly catalytic surfaces.

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

MECHANISMS OF SURFACE RECOMBINATION FROM STEP-FUNCTION FLOWS OF ATOMIC OXYGEN OVER NOBLE METALS, by A. L. Myerson. [1965] [7]p. incl. illus. diagrs. table, refs. (AFOSR-65-1711) (AF 49-(638)782) AD 627487 Unclassified

Also published in Jour. Chem. Phys., v. 42 3270-3276, May 1, 1965.

Surface recombination on 4 noble metals and titanium dioxide has been studied in flows containing a step-function increase in oxygen atom concentration. This has been accomplished by means of thin film heat-transfer techniques using catalytic and noncatalytic films. It is shown that silver, gold, platinum, palladium, and titanium dioxide all have the same small, but significant, catalytic efficiency during the first 50 or so msec of their initial exposure to atomic oxygen but that oxides are quickly formed on the metal surfaces which determine the catalytic ability during succeeding exposure. In some cases, these oxides are unstable and quickly converted to other oxides of different catalytic efficiency which determine the final catalytic properties of the metal. It is also shown that the better recombination catalysts are those for which the average metal-oxygen bond energies of the oxides are weaker. (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

MOLECULAR INTERACTIONS AT HIGH TEMPERATURES, by G. T. Skinner. Final rept. Jan. 1965, 41p. incl. illus. diagrs. refs. (AFOSR-65-0127) (AF 49-(638)793) Unclassified

The objectives of this research were to measure collision cross sections, for application to calculations of transport properties, and to measure surface accommodation coefficients. An apparatus was developed which is capable of producing a beam at the theoretically-predicted limiting intensity. It was found, by means of repeated experimentation, that there can be a utilization of the shock-tube-driven beam for both collision cross-section measurements and surface-interaction studies

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

EXPERIMENTAL STUDY OF THE COLLIMATION PROBLEM IN A HIGH-INTENSITY MOLECULAR BEAM, by G. T. Skinner and J. Moyzis. [1965] [7]p incl diagrs. refs. (AF 49(638)793) Unclassified

Published in Phys. Fluids, v. 8 452-458, Mar. 1965

The discrepancy between the experimentally observed beam intensities obtained with nozzle sources, and the intensities predicted by the inviscid theory is generally attributed to viscous effects upstream of the "skimmer." Experiments are described which show the scattering of a 1.2-ev nitrogen beam downstream of a "skimmer" or collimator. Such scattering can only result from collisions with slow molecules, traveling with the beam, coming from the viscous region upstream. Elimination of this scattering was accomplished by limiting the radial extent of the flow field approaching the "skimmer," and beams were obtained having the theoretically available intensity.

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

HIGH TEMPERATURE PHENOMENA IN HYPERSONIC FLOWS, by A. Hertzberg. Final rept Jan. 1965, 18p. incl. illus. diagrs. refs. (AFOSR-65-0212) (AF 49(638)952) Unclassified

The objective of this study was to investigate aerodynamic problems encountered in the hypersonic flight regime. By means of experimental research in a hypersonic shock tunnel, some definitive experimental data on the thermochemical nonequilibrium occurring in nozzle expansion of high temperature air was calculated. Several findings on the effects of low density on pressure are given.

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

EXPERIMENTAL STUDIES OF LOW-DENSITY EFFECTS IN HYPERSONIC WEDGE FLOWS, by R. J. Vidal and J. A. Bartz. Dec 1965, 29p. incl. illus. diagrs. table, refs. (Technical rept no. AF 1500-A-2) (AFOSR-65-0335) (AF 49(638)952) AD 616898
Unclassified

Also published in Rarefied Gas Dynamics, Proc. of the Fourth Internat'l. Symposium, Toronto U. (Canada) (July 14-17, 1964), ed. by J. H. de Leeuw. New York Academic Press, v. 1: 467-486, 1965

Experimental heat transfer and pressure data are presented which extend from the classical thin boundary

layer regime to near-free-molecule flow with Knudsen numbers based on ambient stream conditions as large as 5. These data are compared with viscous shock layer theory for heat transfer and with theory for the combined effects of wedge angle and boundary layer displacement to define the theoretical range of validity and to identify the low density departures from boundary layer theory. It is noted that low density effects are first evident in the pressure data. It is concluded that the cause of these departures cannot be identified within existing solutions based on the Navier-Stokes relations. It is hypothesized that the departures might stem from second-order Burnett molecular effects. (Contractor's abstract)

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Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

PLANETARY RADAR ASTRONOMY, by G. Pettengill. [1965] [11]p. incl. diagrs. table, refs. (AFOSR-65-1765) (AF 49(638)1156) AD 625980 Unclassified

Presented at NATO Advanced Study Inst., Nat'l. Observatory of Athens, Cape Sounion (Greece) Aug. 2-15, 1964.

Also published in Solar System Radio Astronomy, ed. by J. Aarons, New York, Plenum Press, 1965, p. 401-411.

A review is presented of the development of radar astronomy and its application to the study of planetary orbits, surfaces, and rotations. Its most important result is an improved value for the astronomical unit of 149,598,000 ± 500 km. From the strength of the returned echoes, it is possible to exclude the presence of substantial amounts of liquid water on Mercury, Venus, and Mars. Venus appears to have the densest surface, approximately the same as for solid terrestrial rocks. Mercury appears to reflect in most respects like the moon, but Mars has a surface reflectivity which is highly variable and appears to be correlated with surface position. The surface slopes of Venus appear to be less steep than in the case of the moon, while for Mars they are smoother yet. In the case of Venus, rotation has very reliably been established to be 247 ± 5 days retrograde sidereal with an axis oriented very nearly perpendicular to the orbital plane of the planet.

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Cornell U. Center for Radiophysics and Space Research, Ithaca, N. Y.

INCOHERENT SCATTER FROM PLASMA OSCILLATIONS IN THE IONOSPHERE, by F. W. Perkins, E. E. Salpeter, and K. O. Yngvesson. [1965] 3p. incl. diagr. (AFOSR-65-2267) [AF 49(638)1156] AD 629337 Unclassified

Also published in Phys Rev. Ltrs., v. 14: 579-581, Apr. 12, 1965.

The incoherent backscattering of radar pulses (430 mc sec) from the ionosphere between 150 and 600 km was observed. Scattering from weakly damped longitudinal electrostatic plasma oscillations was detected. The observations were compared with the predictions of a non-equilibrium theory which allows for the presence of photoelectrons.

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Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

OCCULTATION OF TAURUS-A BY THE SOLAR CORONA AT 430 MC/S IN JUNE 1964, by M. R. Kundu. [1965] 2p. incl. diagrs. (AFOSR-65-2268) (AF 49(638)-1156) AD 629338 Unclassified

Also published in Nature v. 205· 683-684, Feb. 1965.

The radiation from Taurus-A was observed at 430 mc/sec during the occulation of Taurus-A by the solar corona in June 1964. A slight increase in the angular size of the source was noted, together with a decrease in its intensity. These effects were attributed to multiple scattering of the radiation at electron density irregularities in the corona.

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Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

LUNAR RADAR REFLECTIONS, by G. Pettengill. [1965] 15p. incl. diagrs. tables, refs. (AFOSR-65-2269) (AF 49(638)1156) AD 628197 Unclassified

Presented at NATO Advanced Study Inst., Nat'l. Observatory of Athens, Cape Sounion (Greece), Aug. 2-15, 1964.

Also published in Solar System Radio Astronomy, ed. by J. Aarons, New York, Plenum Press, 1965, p. 355-369.

The radar cross section of the moon has been measured over a frequency range of about 10 octaves, stretching from 7.84 m to 8.6 mm. Within the accuracy of measurement, which in only a few cases exceeds a factor of 2, there is no significant frequency dependence. The mean of all measurements yields a value of 0.07 of the geometrical (disk) cross section. The angular scattering law has also been determined over a wide range of frequencies, although the best measurements appear to lie in the region from 70 to 8.6 cm. There is a marked frequency dependence both in the mean surface slopes and in the fraction of surface which appears to scatter roughly. At the longer wavelengths the mean surface slope is about 1 in 7, while in the millimeter region the corresponding value approaches 1 in 2. The division of power between the quasi-specular peak corresponding to normal reflection from large smooth areas and the largely nondirectional scattering from rough areas varies from 4 to 1 (favoring quasi-specular) at 68 cm to 1 to 6 (favoring rough) at 0.86 cm. The measurements described above may be used to deduce a surface dielectric constant of about 3. For most likely surface materials this requires a bulk density of about one-half that of siliceous rocks typical of the earth's

surface. This value is larger than that deduced for the visible lunar surface and undoubtedly corresponds to conditions a few meters below.

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Cornell U. Center for Radiophysics and Space Research, Ithaca, N. Y.

RADIOMETRIC OBSERVATIONS OF JUPITER AT 430 MC/S, by H. E. Hardebeck. [1965] [1]p. (AFOSR-65-2812) (AF 49(638)1156) AD 629335 Unclassified

Also published in Astrophys. Jour., v. 141: 837, Feb. 15, 1965.

During January and February of 1964, 17 drift-curves of the planet Jupiter were made. The average black-body disk temperature for the observations was 26,700 K ± 1300°K (standard error), which produces a flux density of $5.80 \pm 0.28 \times 10^{-26}$ watts/m^2/(c/s) at a distance corresponding to a polar semidiameter of 22.75" (4.04 A.U., the mean least Earth-Jupiter distance). This value falls in the range reported by Drake and Hvatum (1960) for 3 sets of measurements at 68 cm during 1959. The present observations represent too few Jovian longitudes for any intensity-longitude dependence to be observed.

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Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

A RADAR DETERMINATION OF THE ROTATION OF THE PLANET MERCURY, by G. H. Pettengill and R. B. Dyce. [1965] 2p. incl. diagrs. (AFOSR-65-2868) (AF 49(638)1156) AD 629334 Unclassified

Also published in Nature, v. 206: 1240, June 19, 1965.

Radar observations at 430 mc/s with an aerial gain of 56 dB and a transmitted power of 2 mw resulted in sufficient sensitivity to obtain echoes not only from the nearest part of the planetary disc, but also from more distant regions. By using short pulses of 500 μsec duration it was possible to isolate the echo power from these more distant regions, and to carry out a Fourier analysis of their spectral composition. Since the source of the delayed echoes can quite reliably be associated with a known area of the planetary surface, the magnitude of the apparent planetary rotation can be inferred from the measured spectral dispersion. The rotation was found to be direct with a sidereal period of 59 ± 5 days. The findings of a value which differs from the orbital period indicates that either the planet has not been in its present orbit for the full period of geological time or that the tidal forces acting to slow the initial rotation have not been correctly treated previously.

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Cornell U. Center for Radiophysics and Space Research, Ithaca, N. Y.

ENHANCEMENT OF PLASMA DENSITY FLUCTUATIONS BY NONTHERMAL ELECTRONS, by F. Perkins and E. E. Salpeter. [1965] [8]p. incl. refs. (AFOSR-65-2876) (AF 49(638)1156) AD 629336 Unclassified

Also published in Phys. Rev., v. 139: A55-A62, July 5, 1965.

In a plasma in thermal equilibrium, the spectrum of electron density fluctuations that have a wavelength longer than the Debye length has a sharp maximum near the electron plasma frequency. In this paper, the effect of a non-Maxwellian electron velocity distribution on the spectrum of electron density fluctuations is computed for frequencies near the electron plasma frequency. The electron velocity distribution is assumed to be isotropic but not necessarily Maxwellian and the effects of electron-ion collisions are included. The results show how the presence of a small number of energetic electrons can enhance the intensity of the fluctuations near the plasma frequency, provided the Landau damping resulting from these energetic electrons is greater than both the collision damping and the Landau damping caused by the ambient electrons. The results are applied to the ionosphere radar-backscatter experiments, where the energetic electrons are photoelectrons produced by solar uv radiation. In the case of the Arecibo radar experiments, the intensity of the fluctuations near the electron plasma frequency is estimated to be enhanced at plasma frequencies greater than about 4 or 5 mc sec (Contractor's abstract)

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Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

INDEX OF REFRACTION SURFACES FOR PLASMA WAVES, by T. Yeh and M. H. Cohen. [1965] 19p incl. diagrs. table. (AFOSR-65-2878) (AF 49(638)1156) AD 628273 Unclassified

Also published in Radio Science, v. 69D: 539-557, Apr. 1965.

Surfaces of index of refraction have been calculated for the 4 modes which exist in a warm plasma, ignoring all damping mechanisms. The surfaces are displayed as contour diagrams. Dispersion curves are obtained as profile cuts through the surfaces. (Contractor's abstract)

804

Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

ARECIBO RADAR-RADIO TELESCOPE-DESIGN AND CONSTRUCTION, by T. C. Kavanagh and D. H. H. Tung. [1965] 30p. incl. illus. diagrs (AFOSR-66-0399) (AF 49(638)1156) AD 629468 Unclassified

Also published in Jour. Construction Div., ASCE, v 91: 69-98, May 1965.

The design and construction of the radar-radio telescope at the Arecibo, Puerto Rico Ionospheric Observatory

was described. The fixed-dish spherical reflector has an 870-ft radius and a 1,000-ft diameter. The movable feed, capable of scanning the sky to 20 from the zenith, is independently suspended from three reinforced concrete towers using steel cables. Rigid specifications and a low budget required the application of many advanced structural, mechanical, and electronic concepts. The site selection, construction of the towers using slip frames, and erection and suspension of the movable feed are described in detail. (Contractor's abstract, modified)

805

Cornell U. Center for Radiophysics and Space Research, Ithaca, N. Y.

MOTION OF A TEST PARTICLE IN A PLASMA, by F. Perkins. [1965] [7]p. incl. refs. (AFOSR-66-1443) (AF 49(638)1156) AD 639876 Unclassified

Also published in Phys. Fluids, v. 8: 1361-1367, July 1965.

The motion of a charged test particle in a completely ionized gas without a magnetic field is investigated. The possible trajectories of this test particle are described by a distribution function that spreads out in phase space as time increases. A convergent kinetic equation which accounts for long-range collective effects and short-range collisions in a consistent manner is derived to describe the time evolution of the distribution function. Expressions for the energy loss rate and dynamical friction are calculated from appropriate moments of the kinetic equation, and they show how the Coulomb logarithm, $\ln\Lambda$, varies with the velocity of the test particle. The errors introduced by the use of a convergent kinetic equation are estimated and these indicate that the kinetic equation method gives the test particle's diffusion in phase space only on coarse grained time and spatial scales. For the case of a fast electron, the time scale must be larger than the electron plasma period and the spatial scale larger than e^2/KT. (Contractor's abstract)

806

Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

A REVIEW OF RADAR STUDIES OF PLANETARY SURFACES, by G. H. Pettengill. [1965] 6p incl. diagrs. refs. (AFOSR-66-1455) (AF 49(638)1156) AD 638242 Unclassified

Also published in Radio Science, v. 69D. 1617-1623, Dec. 1965.

In recent years, radar has been used to study the surfaces of the planets Mercury, Venus, Mars, and Jupiter. In the case of Venus, attenuation in the planetary atmosphere at short wavelengths has also been reported. For Mercury and Venus, where the diurnal rotation is difficult to establish by other means radar has provided a clear-cut determination of the sidereal periods as 59 and 247 days, respectively. Mercury is found to possess surface conditions not unlike those on the Moon. Venus appears to have a surface considerably denser and smoother than the Moon, but displaying several localized regions of scattering enhancement. Mars appears smoother than the other planets, with a marked degree of surface differentiation. Except for one brief period of observation in 1963, Jupiter appears exceedingly inefficient as a reflector of decimetric radio energy. (Contractor's abstract)

807

Cornell U. Center for Radiophysics and Space Research, Ithaca, N. Y.

RADIOMETRIC OBSERVATIONS OF VENUS AND MARS AT 430 MC/S, by H. E. Hardebeck. [1965] [3]p. incl. diagr. (AFOSR-66-1526) [AF 49(638)1156] Unclassified

Also published in Astrophys. Jour., v. 142: 1696-1698, Nov. 15, 1965.

Observations of Venus near the inferior conjunction in 1964 and of Mars near the opposition of 1965 were made at the Arecibo Ionospheric Observatory at 430 mc/sec. The average black-body temperature of Venus was found to be 518 ± 40 K. No radiation from Mars was detected in these observations. A recomputation of results previously reported for Jupiter indicate that its black-body disk temperature is 28900° K ± 2700° K.

808

Cornell U. Center for Radiophysics and Space Research, Ithaca, N. Y.

SCINTILLATIONS ON THE SMALL DIAMETER RADIO SOURCES, by M. H. Cohen. [1965] 3p. incl. diagrs. (AFOSR-66-1527) (AF 49(638)1156) AD 638229 Unclassified

Also published in Nature, v. 208: 277, Oct. 1965.

Observations at the Arecibo Ionospheric Observatory indicate that irregularities in the solar wind appear to be responsible for the rapid scintillations on the radiation from small diameter radio sources. Power spectra of radiometer output signals of several small diameter radio sources are discussed.

809

Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

RADAR ASTRONOMY, by G. H. Pettengill. [1965] 34p. incl. diagrs. illus. tables, refs. (AFOSR-66-1678) (AF 49(638)1156) AD 638231 Unclassified

Also published in Ann. Rev. Astron. and Astrophys., v. 3: 377-410, 1965.

A general review of radar astronomy is given. Typical radar systems are described and results cited. Methods

of determining elements of orbits and rotation rates of planets are discussed. A proposed test of the Einstein theory of general relativity is described. Recent results of radar observations on the moon are summarized.

810

Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

RECENT ARECIBO OBSERVATIONS OF MERCURY, by G. H. Pettengill. [1965] [1]p. incl. diagr. (AFOSR-66-1702) (AF 49(638)1156) AD 638230 Unclassified

Also published in Radio Science, v. 69D: 1627-1628, Dec. 1965.

The rotation rate of mercury is derived from recent radar measurements made at the Arecibo Ionospheric Observatory. The best estimate appears to be a sidereal rotation period of 59 ± 5 days in the direct sense. By making use of short pulses, enough echo strength was available from the planetary surface to measure the doppler frequency spectrum at known relative delays.

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Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

RECENT ARECIBO OBSERVATIONS OF MARS AND JUPITER, by R. B. Dyce. [1965] [1]p. incl. diagr. (AFOSR-66-1709) (AF 49(638)1156) AD 639268 Unclassified

Also published in Radio Science, v. 69D: 1628-1629, Dec. 1965.

Radar range and Doppler spectrum measurements of Mars and Jupiter in 1964 and 1965 are reported. It was found that the radar reflectivity of Mars is a function of longitude. Another finding of the work was the tendency for the strongest echo strength to be associated with dark regions passing near the subradar point. No significant echoes were reported for Jupiter.

812

Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

APPLICATION OF PLANETARY MEASUREMENTS TO PLANETARY RADIUS AND ROTATION RATE DETERMINATIONS, by I. I. Shapiro. [1965] 2p. incl. diagr. (AFOSR-66-1707) (AF 49(638)1156) AD 638225 Unclassified

Also published in Radio Science, v. 69D: 1632-1633, Dec. 1965.

Measurements of radius and rotation rates from radar observation are discussed. The rotation rate of Venus was found to be 247 ± 5 days retrograde with a rotation axis inclined at about 85 ± 2° to the ecliptic, and the rotation rate of Mercury was found to be about 59 days direct.

813

Cornell U. [Center for Radiophysics and Space Research] Ithaca, N. Y.

RESULTS OF RECENT INVESTIGATIONS OF JUPITER'S DECAMETRIC RADIATION, by T. D. Carr, S. Gulkis and others. [1965] 8p. incl. diagrs. refs. (AFOSR-66-2683) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1156, Army Research Office (Durham), National Aeronautics and Space Administration, National Science Foundation and Office of Naval Research) AD 643582 Unclassified

Also published in Radio Science, v. 69D: 1530-1536, Dec. 1965.

The activity of Jupiter's decametric radiation appears to be greatest between 5 and 10 mc/sec, but measurements made below 10 mc/sec are subject to large ionospheric errors. No significant change in rotation period has appeared since 1960. The effect of the satellite Io as reported by Biggs has been corroborated. Marked variations in axial ratio with System III longitude were observed, from which estimates were made of the meridians of the poles. A ray-tracing study was made of the focusing of radiation escaping from possible Jovian field-alined ducts. The effect of asymmetrical stop zones is discussed. A possible explanation of the influence of Io is offered. (Contractor's abstract)

814

[Cornell U. Center for Radiophysics and Space Research, Ithaca, N. Y.]

THE GRAVITATIONAL COMPASS, by P. Szekeres. [1965] [5]p. incl. diagrs. refs. (AFOSR-66-0382) (AF AFOSR-63-321) AD 630231 Unclassified

Also published in Jour. Math. Phys., v. 6: 1387-1391, Sept. 1965.

A purely covariant approach to general relativity, using the equation of geodesic deviation, is adopted. The physical interpretation is essentially that due to Pirani, but instead of using clouds of particles to analyze the gravitational field, a 'gravitational compass' is proposed which fulfills the same purpose. Particular attention is focussed on the different roles played by the matter and the free gravitational field. The latter splits up conveniently into a super-position of a tranverse wave component, a longitudinal component, and a 'Coulomb' field, all of which introduce 'shearing' forces on the gravitational compass, while the matter contributes a general contraction. Applications to the Friedmann cosmological models and the problem of interacting gravitational waves are discussed. (Contractor's abstract)

815

Cornell U. Center for Radiophysics and Space Research, Ithaca, N. Y.

STELLAR EVOLUTION, by E. E. Salpeter. [1965]

[12]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-321 and National Science Foundation)
Unclassified

Published in The Structure and Evolution of Galaxies; Proc. Thirteenth Conf. on Physics, Instituts Solvay, Brussels (Belgium), (Sept., 1964), London, Interscience, 1965, p. 71-82.

The material comprising this paper is divided into 3 sections as follows (1) survey of theoretical calculations on the structure and evolution of individual stars, (2) summary of work on the statistics of stellar evolution and the luminosity functions as observed in our Galaxy, and (3) bulk properties which can also be observed for distant galaxies, such as the evolution of integrated colors and light-to-mass-ratios.

816

Cornell U. [Dept. of Chemistry] Ithaca, N. Y.

SOLID STATE STUDIES OF TUNGSTEN TRIOXIDE SINGLE CRYSTALS BELOW ROOM TEMPERATURE, by B. L. Crowder and M. J. Sienko. [1965] 5p. incl. diagrs. refs. (AFOSR-65-0801) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF AFOSR-62-218)
AD 616209 Unclassified

Also published in Inorg. Chem., v. 4: 73-77, 1965.

The Hall voltage, electrical resistivity, and thermoelectric power have been measured as a function of temperature on single crystals of WO_3 in the range 140 - 300 K. Discontinuities appear on cooling at approx +10 and -40 , corresponding, respectively, to a monoclinic-to-triclinic, γ-to--, and a piezoelectric-to-ferroelectric, --to-α, transition. The γ-to-- transition is strongly dependent on the domain characteristics and the impurity concentrations of the individual crystals. Introduction of oxygen vacancies leads to disappearance of the discontinuities at +10 and -40 . (Contractor's abstract)

817

Cornell U. [Dept. of Chemistry] Ithaca, N. Y.

ELECTRON PARAMAGNETIC RESONANCE OF Mn^{2+} IN SINGLE CRYSTALS OF α-Zn_2SiO_4 (Abstract), by H. K. Perkins and M. J. Sienko. [1965] [1]p. (Sponsored jointly by Advanced Research Projects Agency, and Air Force Office of Scientific Research under [AF AFOSR-62-218])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10. 488, Apr. 26, 1965.

Single crystals of α-Zn_2SiO_4 containing 0.03 mol% Mn^{2+} were grown from the melt. The electron-paramagnetic-resonance spectra were studied at X-band and K-band frequencies at room temperature for various crystallographic orientations. The spectra are complicated because of 6 nonequivalent Mn^{2+} sites per unit cell, each giving the usual 30 allowed lines centered about a magnetic field corresponding to a g value of 2.00. The crystallographic symmetry has a 3-fold rotation axis that groups the 6 sites into 2 sets. The axial field parameter D for one set of sites is 0.07 cm^{-1}. This relatively large D value accounts for intense forbidden lines ($\Delta m_I = \pm 1$) that were observed. The number of sites is consistent with substitutional replacement of Zn^{2+} by Mn^{2+}.

818

Cornell U. [Dept. of Chemistry] Ithaca, N. Y.

[THE MECHANISM OF THE DIELS-ALDER REACTION]. by M. J. Goldstein, G. L. Thayer, Jr., and M. Yoshida. Final rept. Aug. 1965, 24p. incl. diagrs. tables, refs. (AFOSR-65-1800) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-142, and National Science Foundation) AD 621526
Unclassified

The principal findings of this work on Diels-Alder type reactions included: (1) the determination of both carbon and oxygen kinetic isotope effects in a decarboxylation reaction, (2) the establishment of the magnitude of an oxygen kinetic isotope effect in any organic reaction; and (3) the exploitation of the exact force field calculations of realistically formulated transition state structures for a detailed mechanistic interpretation of kinetic isotope effects.

819

Cornell U. [Dept. of Chemistry] Ithaca, N. Y.

THE MECHANISM OF A DIELS-ALDER REACTION. II. THE STRUCTURE OF THE TRANSITION STATE, by M. J. Goldstein and G. L. Thayer, Jr. [1965] 9p. incl. diagrs. tables, refs. (AFOSR-65-2195) (AF 49-(638)942 and AF AFOSR-63-142) AD 626514
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 1933-1941, May 5, 1965.

Carbon and oxygen kinetic isotope effect (k_{12}/k_{13} = 1.030 and k_{16}/k_{18} = 1.014) have been determined for decarboxylation of the maleic anhydride adduct of α-pyrone. Subjected to both approximate and exact theoretical analysis, they require a one-center transition state. the C-C bond connecting the labile lactone to the remainder of the molecule is effectively broken in the transition state whereas the C-O connecting bond remains virtually intact. Exact analysis provides a more quantitative description and relates structural to experimental uncertainties. The reliability of these conclusions is shown to depend critically on the use of heavy atom kinetic isotope effects measured at multiple, ad-

adjacent sites. Some more general aspects of the one-center and two-stage descriptions of Diels-Alder addition are discussed. (Contractor's abstract)

820

Cornell U. [Dept. of Chemistry] Ithaca, N. Y.

THE MECHANISM OF A DIELS-ALDER REACTION. I. A RETRODIENE DECARBOXYLATION, by M. J. Goldstein and G. L. Thayer, Jr. [1965] 9p. incl. diagrs. tables, refs. (AFOSR-65-2196) (AF 49(638)942 and AF AFOSR-63-142) AD 626511 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 1925-1933, May 5, 1965.

The mechanistic problem of Diels-Alder addition is reconsidered and the advantages to be gained from heavy atom kinetic isotope effect studies are indicated. Decarboxylation of the maleic anhydride adduct of α-pyrone is the shown to satisfy applicable criteria for Diels-Alder retrogression: (a) production of cis-1,2-dihydrophthalic anhydride as the kinetically controlled product, (b) adequately first-order kinetics with $\Delta H^* = 33.2$ kcal/mole and $\Delta S^* = 2.69$ e.u.; and (c) identification of the lactonic function as the source of 99.3% of the carbon dioxide liberated. The accepted structures of both reactant and product are confirmed but not that of an isomer of the product, the purported 4,5-dihydrophthalic anhydride, here identified as 1,4-dihydrophthalic anhydride. The dipole moment of the reactant (1.34 D.) is consistent with expectation for the endo isomer.

821

Cornell U. [Dept. of Chemistry] Ithaca, N. Y.

A KINETIC DESCRIPTION OF THE VAN HOVE CORRELATION FUNCTIONS, by M. Nelkin, J. M. J. Van Leeuwen, and S. Yip. [1965] 24p. incl. diagrs. refs. (AFOSR-65-1961) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-324 and Atomic Energy Commission) AD 626515 Unclassified

Also published in Inelastic Scattering of Neutrons, Vienna, International Atomic Energy Agency, v. 2: 35-58, 1965.

The Van Hove density correlation function $G(r,t)$ for a classical fluid is written as the integral over momenta of an appropriate one-particle distribution function $F(r,\vec{p},t)$. A similar procedure gives the self-correlation function $G_s(r,t)$ in terms of a different distribution function $F_s(r,\vec{p},t)$. It is shown that for moderately dense gases these distribution functions can be calculated from kinetic equations. The kinetic equations are derived from density series expansions of $F(r,\vec{p},t)$ and $F_S(r,\vec{p},t)$. For times short compared to the time between collisions the density series can be used directly. For longer times it is necessary to sum an infinite series of terms in order to properly account for the effects of multiple collisions. The summation of the most dominant terms can be carried out in terms of the solution to an integral equation. If the effects of incomplete collisions can be ignored, the appropriate equation for $F(r,\vec{p},t)$ becomes the linearized Boltzmann equation as used in the theory of sound propagation in gases. The appropriate equation for $F_s(r,\vec{p},t)$ becomes the neutron transport equation. The kinetic equations are directly applicable only to dilute systems; however, they are suitable for a systematic study of dynamical correlations. The essential difference between the 2 equations is the collisional invariants.

822

Cornell U., Dept. of Chemistry, Ithaca, N. Y.

DEPENDENCE OF THE PROBABILITIES OF VIBRATIONAL DE-EXCITATION ON INTERACTION POTENTIALS, by H. K. Shin. [1965] 4p. (AFOSR-65-2955) [AF AFOSR-63-324] AD 628395 Unclassified

Also published in Jour. Chem. Phys., v. 42: 59-62, Jan. 1, 1965.

Using the WKB semiclassical approximation, the dependence of the probability of vibrational de-excitation on the assumed form of the interaction potential is discussed. The asymptotic results show that the Morse and Lennard-Jones potentials have, respectively, 2 and 3 correction terms in the exponential part. The magnitudes of the correction terms are important compared to the leading term. The exact form of the leading term is also dependent upon the interaction potential. (Contractor's abstract)

823

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

DERIVATION OF KINETIC EQUATIONS FOR SLOW-NEUTRON SCATTERING, by J. M. J. Van Leeuwen and S. Yip. [1965] [14]p. incl. diagrs. refs. (AFOSR-65-2956) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-324 and Atomic Energy Commission) AD 627982 Unclassified

Also published in Phys. Rev., v. 139: A1138-A1151, Aug. 16, 1965.

It is shown that for moderately dense classical gases Van Hove's correlation functions $G(r,t)$ and $G_s(r,t)$ can be calculated from kinetic equations. The kinetic equations are derived from the cluster expansion of a one-particle distribution function which describes the propagation of a density-momentum impulse. For times short compared with the time between collisions, the density series can be used directly. But for longer times a different treatment is necessary because of the increasing importance of multiple collisions. Considering only the dominant terms, the series is shown to be the iterated solution of an integral equation. In lowest order, this equation has the form of a linearized Boltzmann equation in which the collision kernel is nonlocal because of the finite extent of the particles, and is

non-Markoffian if the duration of a collision is finite. The present approach permits a systematic treatment of coherent as well as incoherent scattering. In particular, we demonstrate an earlier assertion that the appropriate equations for studying the 2 kinds of scattering are, respectively, the linearized Boltzmann equation and the neutron transport equation. The effects of statistical correlation are introduced approximately in the kinetic equations in lowest order. (Contractor's abstract)

824

Cornell U. Dept. of Chemistry, Ithaca, N. Y.

SPECTRAL WIDTH OF THE CRITICAL OPALESCENCE DUE TO CONCENTRATION, by P. Debye, Jr. [1965] 2p. (AFOSR-65-1676) (AF AFOSR-65-750) AD 617017 Unclassified

Also published in Phys. Rev. Ltrs., v. 14. 738-784, May 10, 1965.

It has been found that the spectral line characterizing the light scattered by a binary mixture in the vicinity of its critical point sharpens up extraordinarily with decreasing scattering angle and with decreasing temperature distance. In this case the linewidth is theoretically determined mainly by the diffusion coefficient of the 2 liquids in each other, and the effect indicates that this coefficient tends to zero at the critical point. An attempt is made to explain the effect. Two rules are formulated: (a) For the angle I of scattering characterized by the function $s = 2 \sin 1/2 I$, the scattering line broadens proportional to s^2 with increasing I, (b) The scattering line should broaden proportional to the temperature distance $T-T_c$, where T is the temperature at which the experiment is performed and T_c is the critical temperature.

825

Cornell U. Dept. of Engineering Physics, Ithaca, N. Y.

OBSERVATIONS ON THE MORPHOLOGICAL CHANGES IN THIN COPPER DEPOSITS DURING ANNEALING AND OXIDATION, by L. Bachmann, D. L. Sawyer, and B. M. Siegel. [1965] [5]p. incl. illus. table. (AFOSR-66-0052) [AF AFOSR-65-770] AD 629839 Unclassified

Also published in Jour. Appl. Phys., v. 36: 304-308, Jan. 1965.

Thin copper films were deposited in an ultrahigh vacuum on carbon and silicon monoxide substrates at room temperature. Their morphological changes after annealing and oxidation were investigated by electron microscopy and and electron diffraction. The changes during annealing of very thin deposits (< 50 A mean thickness) are strongly influenced by the substrate. The copper on carbon substrates grows into large crystallites during heat treatment at 500 C whereas on silicon monoxide substrates very little recrystallization occurs. During the annealing of thicker deposits of copper self-diffusion of the metal can take place and the change in structure of the heat-treated film is independent of the substrate. The structures of the cuprous oxide particles formed during exposure to different pressures of oxygen at 150 to 200 C indicate that different transport mechanisms are involved in the oxidation process at very low oxygen pressures from those at pressures above 10^{-2} Torr. (Contractor's abstract)

826

Cornell U. Dept. of Physics, Ithaca, N. Y.

MEASUREMENT OF THE L ABSORPTION SPECTRA OF XENON, by T. Watanabe. [1965] [3]p. incl. diagrs. tables, refs. (AFOSR-65-1178) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF 49(638)402, and National Science Foundation) AD 621661 Unclassified

Also published in Phys. Rev., v. 137: A1380-A1382, Mar. 1, 1965.

The x-ray L_I, L_{II}, and L_{III} absorption spectra of gaseous xenon were measured with a two-crystal x-ray spectrometer. Absolute values of the absorption coefficients were determined on both sides of each edge. It was found that the L_{II} and L_{III} spectra have similar structural characteristics at the edge, each having a resonance absorption peak, while the absorption coefficient at the L_I edge increases smoothly and does note exhibit the absorption peak. The jump ratios were found to be 1.12, 1.38, and 2.60 for the L_I, and L_{III} edges, respectively An estimate was made of the oscillator strengths for the bound-bound transitions. (Contractor's abstract)

827

Cornell U. [Dept. of Physics] Ithaca, N. Y.

LOW TEMPERATURE ELECTRONIC SPECIFIC HEAT OF SIMPLE METALS, by N. W. Ashcroft and J. W. Wilkins. [1965] [3]p. incl. table, refs. (AFOSR-65-1983) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)402, National Academy of Sciences, and Office of Naval Research) AD 627196 Unclassified

Also published in Phys. Ltrs., v. 14: 285-287, Feb. 15, 1965.

For the metals Na, Al, and Pb, the contributions to the low temperature electronic specific heat from band structure, electron-electron interactions, and electron-phonon interactions are calculated. The contributions due to band structure and electron-electron interactions are shown to be quite small. The contribution of electron-phonon interactions is shown to have a dominant effect on the low temperature electronic specific heat

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Cornell U. Dept. of Physics, Ithaca, N. Y.

SPECTRAL MEASUREMENTS WITH ALIGNED AND MISALIGNED TWO-CRYSTAL SPECTROMETERS. II. ALIGNMENT, by H. W. Schnopper. [1965] [8]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1986) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under AF 49-(638)402, and National Science Foundation) AD 626870 Unclassified

Also published in Jour. Appl. Phys., v. 36: 1423-1430, Apr. 1965.

Conditions for and methods of aligning a 2-crystal spectrometer are discussed. These include the alignment of rotation axes, crystals, and x-ray beam. The results of a new nondispersive crystal alignment procedure are compared in detail with theory for a typical case of CuKα radiation and calcite crystals. This method is contrasted with other procedures which lead only to pseudo-alignments. It is shown that x-ray methods which are sensitive to vertical divergence do not lead to crystal alignment unless the beam is already perfectly aligned. It is concluded that the x-ray beam can be aligned only after the crystals have been aligned. (Contractor's abstract)

829

Cornell U. Dept. of Physics, Ithaca, N. Y.

SPECTRAL MEASUREMENTS WITH ALIGNED AND MISALIGNED TWO-CRYSTAL SPECTROMETERS. I. THEORY OF THE GEOMETRICAL WINDOW, by H. W. Schnopper. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-1987) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under AF 49(638)402, and National Science Foundation) AD 627462 Unclassified

Also published in Jour. Appl. Phys., v. 36: 1415-1423, Apr. 1965.

It is shown in this paper that (1) the geometrical window of the instrument is a function of the alignment of the crystals, the beam, and the rotation axes as well as the vertical divergence; (2) even for the case of perfect spectrometer alignment, errors are introduced into the measurement of the spectral parameters because of the presence of a finite vertical divergence in the x-ray beam; and (3) improper beam and crystal alignment cause inaccuracies in the measurement of spectral parameters. Calculations which predict the effects of vertical divergence and of beam and crystal misalignment on the geometrical window and also on the wavelength position, line shape, linewidth, and line asymmetry of the (1, +1) and (1, -1) curves are made for the case of CuKα radiation reflected from calcite crystals. In particular, it is shown that the error in the measurement of the Bragg angle is 6 1/2 times more sensitive to misalignment of the central ray of the x-ray beam than it is to total vertical divergence.

830

Cornell U. Dept. of Physics, Ithaca, N. Y.

ORIGIN OF ANOMALOUS SURFACE REFLECTION OF X-RAYS, by A. N. Nigam. [1965] [3]p. incl. illus. diagr. (AFOSR-65-2569) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under AF 49(638)402, and National Science Foundation) AD 629257 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 549, Apr. 26, 1965.

Also published in Phys. Rev., v. 138: A1189-A1191, May 17, 1965.

The anomalous surface reflection of x-rays from 'clean' mirrors, reported by Yoneda is shown to be primarily due to the horizontal angular divergence of the incident beam itself. (Contractor's abstract)

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Cornell U. Dept. of Physics, Ithaca, N. Y.

THEORETICAL FITTING OF THE ARGON K ABSORPTION SPECTRUM ON A ONE-ELECTRON MODEL, by T. Watanabe. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-66-1486) (Sponsored jointly by Advanced Research Projects Agency, Air Force Office of Scientific Research under [AF 49(638)402], and National Science Foundation) AD 636706 Unclassified

Also published in Phys. Rev., v. 139: A1747-A1751, Sept. 13, 1965.

The one-electron model was used to analyze the argon K absorption spectrum near the K edge. It was assumed that the absorption spectrum consists of (1) two Lorentzians due to $1s \rightarrow 4p$ and $1s \rightarrow 5p$ resonant transitions, (2) a modified arctangent to account for the $1s \rightarrow np (n \geq 6)$ and the $1s \rightarrow$ continuum transitions, and (3) a constant background due to the L, M ionizations. The transmission spectrum containing adjustable parameters was constructed on the one-electron model and was then smeared by the experimental window function. The values of these parameters were selected to minimize the x^2 value between the observed transmission curve and the smeared-model transmission curve. The criterion showed that the present model fits the observed curve. Pertinent parameters were interpreted in terms of oscillator strengths and the K-state width. The oscillator strengths (0.00217 and 0.00066) of the $1s \rightarrow 4p$ and $1s \rightarrow 5p$ transitions show fair agreement with the theoretical values (0.00166 and 0.00053). The K-state width parameter is 0.68 ev, which compared well with the value obtained by several different spectral methods as well as the value obtained from the K fluorescence yield. (Contractor's abstract)

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Cornell U. [Dept. of Physics] Ithaca, N. Y.

K X-RAY EMISSION SPECTRA FROM THE METAL-ATOMS IN MnO_4^-, CrO_4^{2-}, AND VO_4^{2-} IONS (Abstract), by P. E. Best. [1965] [1]p. (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under [AF 49(638)402], and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 28, Jan. 27, 1965.

New measurements are discussed in terms of electronic-dipole transitions from occupied orbitals in the 1s vacancy in the metal atom. Observed emission lines are attributed to transitions from the metal 3p, the oxygen 2s, and the unresolved valence $1t_2$ and $2t_2$ orbitals. Simple theory accounts semiquantitatively for the relative intensities and energy positions of the lines. The energy separation between the oxygen 2s and the $2t_2$ orbitals in MnO_4^- is 16.0 ± 0.2 ev, a measurement not easily accessible to other techniques. Most of the intensity of the valence emission is attributed to overlap of oxygen 2p with metal 3p orbitals, rather than to metal 4p or 3d covalent mixing in the molecular orbitals.

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Cornell U. [Dept. of Physics] Ithaca, N. Y.

Mn K X-RAY EMISSION SPECTRA FROM AN Fe^{55} K-CAPTURE SOURCE (Abstract), by H. W. Schnopper. [1965] [1]p. (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under [AF 49(638)402], and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 549, Apr. 26, 1965.

Observations of x-ray emission lines arising from transitions $1s \rightarrow 2p_{3/2,\,1/2}$ ($K\alpha_{1,2}$) and $1s \rightarrow 3p_{3/2,\,1/2}$ ($K\beta'_{1,3}$) in Mn^{55}, produced in the K-capture decay of Fe^{55}, have been compared with those produced by electron bombardment of a pure-Mn target. In each case, the lines have the same energy position, width, index of asymmetry and relative intensity. The complex Kβ' appeared unchanged. These observations justify the use of certain simplifying assumptions in the discussion of x-ray spectra: (1) The sudden approximation appears valid for transitions involving an inner hole. This implies that, upon the production of a K hole, the electron configuration of atom Z (Mn) is relaxed to that of atom Z + 1 (Fe); and (2) The occurrence of the complex Kβ' depends only on the mode of decay of the excited Mn atom and not on the means of production of the inner hole. Kβ' appears either as the result of a 2-electron transition of the type ($3p_{3/2,\,1/2} \rightarrow 1s$, valence → bound orbital or continuum) or as the result of angular-momentum coupling between unpaired valence electrons and the final 3p hole. A 2-crystal spectrometer equipped with calcite crystals ($\lambda/d\lambda \approx 10^4$) was used to record all spectra.

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Cornell U. [Dept. of Physics] Ithaca, N. Y.

INVERSE COMPTON RADIATION FROM INTERGALACTIC ELECTRONS AND COSMIC BLACKBODY PHOTONS, by J. E. Felten. [1965] 3p. incl. diagrs. refs. (AFOSR-66-1710) (AF 49(638)1527) AD 639025 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 1003-1005, Dec. 27, 1965.

Cosmic microwave radiation is discussed as a possible source of the isotropic component of cosmic x-rays, via the inverse Compton interaction of the microwave photons with fast electrons in our galaxy. It is shown that a more natural explanation of the x radiation may be given in terms of intergalactic rather than galactic electrons, and also that in this model the presence of the microwave photons may provide an explanation for an otherwide puzzling feature in the cosmic gamma-ray spectrum.

835

Cornell U. Graduate School of Aerospace Engineering, Ithaca, N. Y.

FORCED SOUND PROPAGATION IN GASES OF ARBITRARY DENSITY, by R. J. Mason, Jr. [1965] [22]p. incl. diagrs. refs. (AFOSR-67-0705) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1346, National Aeronautics and Space Administration and Office of Naval Research) AD 648800 Unclassified

Also published in Rarefied Gas Dynamics; Proc. of the Fourth Internat'l. Symposium, Toronto U. (Canada) (July 14-17, 1964), ed. by J. H. de Leeuw. New York Academic Press, v. 1: 48-70, 1965.

The steady-state sound disturbances induced in a monatomic gas by an oscillating plane boundary are examined. Kinetic source terms are developed to represent the effect of particle reflections from the moving boundary. Linearized model equations are employed. Specular reflection and an exp (iωt) time dependence are assumed. The equations are solved with the aid of Fourier transforms. An exact solution is obtained for a model equation which relaxes to a Cauchy distribution. The second model equation relaxes to the Maxwellian velocity distribution but must be solved by approximate techniques. Both solutions exhibit the Navier-Stokes form in the continuum regime and a "free molecule" form when collisions are absent. The Maxwellian solution is in acceptable quantitative agreement with all available data.

836

Cornell U. Graduate School of Aerospace Engineering, Ithaca, N. Y.

SURFACE EFFECTS IN SEEDED COMBUSTION PRODUCTS, by D. L. Turcotte. [1965] [42]p. incl. diagrs. tables, refs. (AFOSR-67-1216) (AF 49(638)1346)
AD 653216 Unclassified

Also published in Proc. Specialists' Meeting, AGARD Propulsion and Energetics Panel, Pisa U. (Italy) (Sept. 6-10, 1965) p. 82-122.

Current-voltage characteristics of a double-probe were obtained in the products of combustion of a seeded, atmospheric-pressure, alcohol-air flame. Sodium hydroxide, potassium hydroxide, and cesium chloride were the seed compounds used. The appropriate continuum sheath theory is developed which predicts ion saturation currents and the resistance to the flow of current between the electrodes. The properties of the combustion products are calculated. It was concluded from the calculation on ion saturation currents that there was electron emission from the electrodes. (Contractor's abstract, modified)

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Cornell U. Graduate School of Aerospace Engineering, Ithaca, N. Y.

ELECTRODE INTERACTIONS IN SEEDED COMBUSTION PRODUCTS, by D. L. Turcotte and W. Friedman. [1965] [11]p. incl. diagrs. table. [AF 49(638)1346]
AD 627155 Unclassified

Also published in Tenth Symposium (Internat'l.) on Combustion, Cambridge (Gt. Brit.) (Aug. 17-21, 1964), Pittsburgh, Combustion Inst., 1965, p. 673-683.

The interaction of a lightly ionized plasma with a cold electrode is studied. Current-voltage characteristics have been measured using cooled electrodes in seeded combustion products. Current-voltage characteristics have also been obtained in lightly ionized air in a shock tube. An isothermal theory for the current-voltage characteristics is presented including the voltage drop in the sheath, the boundary layer, and the plasma. The shock-tube experiments exhibit ion saturation and are in reasonable agreement with theory. No ion saturation is observed in the experiments in seeded combustion products. Agreement between theory and experiment is obtained with the voltage drop across the sheath and boundary layer is neglected. The fact that no ion saturation is observed indicates that there is electron emission from the cooled electrodes in the seeded combustion products. Since cooled copper electrodes are not expected to emit electrons and do not emit electrons in the shock tube experiment, the conclusion is that the electron emission is due to the presence of seeded material. (Contractor's abstract)

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Cornell U. Graduate School of Aerospace Engineering, Ithaca, N. Y.

ISOTOPE EXCHANGE RATES. I. THE HOMOGENEOUS REACTION BETWEEN DEUTERIUM AND AMMONIA, by S. H. Bauer, A. Lifshitz, and C. Lifshitz. [1965] [9]p. (AF AFOSR-63-103) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 143-150, Jan. 20, 1965.

The thermal isotope exchange reaction between deuterium and ammonia (highly diluted with argon) was investigated behind reflected shocks in a single-pulse shock tube. The temperature range covered was 1300° to 1700° K. The reaction orders with respect to ammonia and deuterium, as well as the total reaction order, were determined. The exchange rate was found to be approximately unit order with respect to deuterium and argon, and zero order with respect to ammonia. From the known rates of dissociation of D_2 it is evident that the reaction does not proceed via a 3-center atomic displacement intermediate. A mechanism based on the vibrational excitation of deuterium molecules by argon as the rate-determining step is proposed. (Contractor's abstract)

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Cornell U. Graduate School of Aerospace Engineering, Ithaca, N. Y.

ELECTROHYDRODYNAMIC FLOW OVER A WAVY WALL, by S. Kuwabara. June 1965 [110]p. incl. diagrs. tables, refs. (AFOSR-65-1768) (AF AFOSR-64-399)
AD 624506 Unclassified

Electrohydrodynamic flow of a simple, isothermal gas without dissipative effects over a wavy wall is investigated by the perturbation method. The unperturbed flow has a uniform velocity and nonuniform distributions of density and electric field, which vanish at infinity. For the subsonic flow, the surface pressure, the stream lines and the electric-field lines are calculated. For the supersonic flow, the linearized solution diverges at infinity. This seems to be due to the nonuniform density distribution of the undisturbed flow. Numerical solutions of an oscillating-piston problem, which is a simplified model for the high supersonic flow, are obtained. Some related problems are also investigated. (Contractor's abstract)

840

Dartmouth Coll., Hanover, N. H.

[PVT RELATIONS IN SOLID He^3 AND SOLID He^4 FLOW MEASUREMENTS WITH SUPERFLUID HELIUM], by J. N. Kidder. Final rept. Oct. 1, 1962 - Dec. 31, 1964. Feb. 11, 1965, 9p. incl. diagr. (AFOSR-65-0387) (AF AFOSR-63-74) AD 611763 Unclassified

The gravitational flow of superfluid helium through "large" (internal diam greater than 0.01 cm) capillaries at 0.4% has been studied. The primary purpose of this experiment was to find the form of the pressure gradients as a function of fluid velocity. As expected, a critical velocity, below which the pressure gradient was zero, was observed. Over a small range of velocities the pressure gradient varied nearly linearly with velocity, and at higher velocities it varied as the velocity squared. These results are explained in terms of the creation of vortex rings at the capillary wall. The experiments are being continued with straight glass capillaries instead of spiralled metal ones in hopes of obtaining more consistant results. An improved apparatus has been developed to continue measurements begun at Yale University with Air Force support on the PVT relations in solid helium. Microwave cavities are being used to measure the pressure as well as the density. An experiment to study the propagation of second sound in rotating rectangular resonators is also described. Measurement of the Magnus force on superfluid vortices by this technique is expected.

841

Dartmouth Coll., Hanover, N. H.

GRAVITATIONAL FLOW OF SUPERFLUID HELIUM AT 0.45°K, by J. N. Kidder and H. A. Blackstead. [1965] [4]p. incl. diagrs. table. (AFOSR-66-1542) (AF AFOSR-63-74) AD 641263 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31 - Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9 (Pt. A): 331-334, 1965.

Liquid-helium flow at a temperature well below 1°K has been studied to investigate the interaction between the liquid and the capillary walls. The observed pressure gradients at velocities greater than the critical value are similar in form to other measurements of pure superfluid flow at higher temperatures. A simple gravitational flow technique has been used, the fluid being mechanically displaced to induce flow through a round capillary between 2 concentric reservoirs. The experiments have been done at 0.45°K, where the relative normal fluid density is 3×10^{-6}. Calculations indicate that normal-fluid viscosity cannot account for the observed pressure gradients.

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Dartmouth Coll. Dept. of Chemistry, Hanover, N. H.

OXIDATIVE DEGRADATION OF POLYHEDRAL BORANES, by A. Kaczmarczyk, G. B. Kolski, and W. P. Townsend. [1965] [1]p. (AFOSR-65-0887) [AF AFOSR-64-589] AD 617593 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 1413, Mar. 1965.

It is discovered that oxidation of $B_{10}H_{10}^{-2}$ and $B_{20}H_{18}^{-2}$ by potassium permanganate: (1) proceeds readily to completion at room temperature at pH 7 and (2) results in the quantitative conversion to boric acid. A summary of results is presented for the yield of boric acid from the oxidation of $B_{10}H_{10}^{-2}$, $B_{12}H_{12}^{-2}$, $B_{20}H_{18}^{-2}$, $B_{20}H_{18}^{-4}$, and $B_{20}H_{17}OH^{-4}$ ions and their organic and halo derivatives by dilute permanganate. One set of data was collected without pH control, and another in weakly acidic to neutral solutions.

843

Dartmouth Coll. Dept. of Chemistry, Hanover, N. H.

THE POLARIZABILITIES AND DIAMAGNETIC SUSCEPTIBILITIES OF POLYHEDRAL BORANES AND HALOBORANES, by A. Kaczmarczyk and G. B. Kolski. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-1369) (AF AFOSR-64-589) AD 622854 Unclassified

Also published in Inorg. Chem., v. 4: 665-671, May 1965.

The electronic polarizabilities of the $B_{10}Cl_{10}^{-2}$, $B_{10}Br_{10}^{-2}$, $B_{12}H_{12}^{-2}$, $B_{12}Cl_{12}^{-2}$, $B_{12}Br_{12}^{-2}$, and $B_{20}H_{18}^{-2}$ ions were determined and an attempt was made to relate them to the structural features of the ions. From the magnetic susceptibilities of the $B_{10}H_{10}^{-2}$ and $B_{20}H_{18}^{-2}$ ions a Pascal constant was derived for boron in these systems and used to estimate the magnetic susceptibilities of the above listed hydrides and halides. These estimated values were compared and found to be in good agreement with magnetic susceptibilities calculated from the experimental polarizabilities. The great success of a conducting-sphere model in accounting for the physical properties of these ions is demonstrated, and simple general equations for calculating the polarizabilities and magnetic susceptibilities of polyhedral ions are derived. (Contractor's abstract)

844

Delaware U. Center for Research on Social Behavior, Newark.

STRENGTH OF THE RELATIONSHIP BETWEEN THE VALUE OF AN EVENT AND ITS SUBJECTIVE PROBABILITY AS A FUNCTION OF METHOD OF

MEASUREMENT, by D. G. Pruitt and R. D. Hoge. [1965] [7]p. incl. diagr. tables. (AFOSR-65-1584) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1441 and National Science Foundation) AD 623290 Unclassified

Also published in Jour. Exper. Psychol., v. 69: 483-489, May 1965.

This study was designed to evaluate the strength of the relationship between the value of an event and the subjective probability of that event as measured by 3 distinct techniques. A positive relationship was found between these 2 variables under all conditions but diminished in strength as pressures for accuracy increased. The results are discussed in the light of Rotter's criticism of earlier studies. In addition, a comparison was made of the 3 methods of measurement, from which probability ratings emerge as the most reliable technique for studying reactions to objective probability displays.

845

Delaware U. Dept. of Chemistry, Newark.

THERMODYNAMICS OF THE HIGHER OXIDES. I. THE HEATS OF FORMATION AND LATTICE ENERGIES OF THE SUPEROXIDES OF POTASSIUM, RUBIDIUM, AND CESIUM, by L. A. D'Orazio and R. H. Wood. [1965] [8]p. incl. tables, refs. (AFOSR-65-1956) (AF AFOSR-63-325) AD 626884 Unclassified

Also published in Jour. Phys. Chem., v. 69: 2550-2557, Aug. 1965.

The heats of formation of KO_2, RbO_2, and CsO_2 were determined at 25.0°C. They were -68.0 ± 0.4, -68.0 ± 0.6, and -69.2 ± 0.5 kcal/mol, respectively. The lattice energies of these compounds and the electron affinity of molecular oxygen (EA = 14.9 kcal/mol) were calculated using various approximations. The accuracy resulting from the use of the approximations is assessed. The heats of formation (ΔH_f^o = - 62 kcal/mol) and decomposition of hypothetical lithium superoxide are estimated. The results indicate that this compound should be very unstable. (Contractor's abstract)

846

Delaware U. Dept. of Chemistry, Newark.

THERMODYNAMICS OF THE HIGHER OXIDES. II. LATTICE ENERGIES OF THE ALKALI AND ALKALINE EARTH PEROXIDES AND THE DOUBLE ELECTRON AFFINITY OF THE OXYGEN MOLECULE, by R. H. Wood and L. A. D'Orazio. [1965] [4]p. incl. tables, refs. (AFOSR-65-1958) (AF AFOSR-63-325) AD 626885 Unclassified

Also published in Jour. Phys. Chem., v. 69: 2558-2561, Aug. 1965.

The Madelung constants for the alkali metal peroxides and the van der Waals sums for both the alkali and alkaline earth peroxides were calculated. The results are used to evaluate the lattice energies of the peroxides and the double electron affinity of the oxygen molecule, $E(O_2 - O_2^{-2})$ = - 145 ± 15 kcal/mol. The covalent bond energy in the peroxide ion (D = -95 kcal/mol) is discussed.

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Delaware U. Dept. of Chemistry, Newark.

THERMODYNAMICS OF THE HIGHER OXIDES. III. THE LATTICE ENERGY OF POTASSIUM OZONIDE AND THE ELECTRON AFFINITY OF OZONE, by R. H. Wood and L. A. D'Orazio. [1965] [2]p. incl. tables, refs. (AFOSR-65-1959) (AF AFOSR-63-325) AD 625886 Unclassified

Also published in Jour. Phys. Chem., v. 69: 2562-2563, Aug. 1965.

The Madelung constant, van der Waals sums, and lattice energy of the potassium ozonide structure were calculated. The results were used to evaluate the electron affinity of ozone $EA(O_3)$ = 44 ± 10 kcal/mol and the heat of formation of the gaseous ozonide ion $\Delta H_f^o (O_3^-)_g$ = - 11 ± 10 kcal/mol. The heat of formation of the hypothetical lithium ozonide is estimated (ΔH_f^o = - 63 kcal/mol) and the energy of its decomposition evaluated.

848

Delaware U. Dept. of Electrical Engineering, Newark.

A QUANTUM FIELD DESCRIPTION OF COMMUNICATION SYSTEMS, by L. F. Jelsma and L. P. Bolgiano. [1965] [8]p. incl. refs. (AFOSR-65-2038) (AF AFOSR-65-2) AD 627488 Unclassified

Also published in IEEE Ann. Commun. Convention Conf. Record, June 1965, p. 635-642.

Basic techniques in quantum field theory are used to determine the statistical properties of a communication system. Since the conceptual model of a communications system is an electromagnetic fields system, the problem is reduced to one in quantum electrodynamics. In the formulation, Maxwell's equations are replaced by the simple operator equations of motion of the forced harmonic oscillator whose solutions are in terms of the destruction operator, the creation operator, and the current density. It is demonstrated that the statistics of field amplitude measurements at the receiver in a communication system are the familiar statistics of Gaussian additive noise. In general the statistics of a communication system depend on the type of measurement made by the receiver.

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Delaware U. Dept. of Electrical Engineering, Newark.

QUANTUM FIELD THEORETICAL MODELS OF

COMMUNICATION SYSTEMS, by L. F. Jelsma. June 1965, 202p. incl. diagrs. refs. (Technical rept. no. Q52) (AFOSR-66-0294) (AF AFOSR-65-2) AD 628711 Unclassified

Basic concepts in quantum field theory are used to represent communication systems. Maxwell's equations are reduced to the equations of motion of the forced simple harmonic oscillator and quantized in the Heisenberg picture. The state of a communication system is represented by a statistical density operator satisfying the postulate that the system can be in either a vacuum state or a maximum entropy state. Probability functions are derived representing the statistics of a communication system.

850

Delaware U. Dept. of Electrical Engineering, Newark.

PHOTOELECTRON STATISTICS FOR VARIABLE TIME AND BANDWIDTH, by A. Q. Haideri. Sept. 1965, 47p. incl. diagrs. tables, refs. (Technical rept. no. Q53) (AFOSR-66-0308) (AF AFOSR-65-2) AD 628808 Unclassified

The photoelectric measurement of optical signals may be limited both by random fluctuations in signal strength and by the probabilistic nature of the photoelectric detector. The mean square fluctuation, in number of electrons released in a photoelectric detector, illuminated by a coherent light signal in the presence of thermal noise, is calculated. The results are illustrated by a graph which shows how the dependence of the relative fluctuation in number of photoelectrons on signal strength is affected by both the time-bandwidth product and the mean number of photoelectrons per observation time.

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Delaware U. Dept. of Electrical Engineering, Newark.

MAXIMIZATION OF TRANSINFORMATION IN PHOTODETECTION, by J. C. Murray, Jr. June 1965, 65p. incl. diagrs. refs. (Technical rept. no. Q51) (AFOSR-66-0309) (AF AFOSR-65-2) AD 628807 Unclassified

A photodetector is considered as a communication channel and a study made of the maximum information per degree of freedom I which can be transmitted through the channel. Application of the calculus of variations yields a necessary equation which the input probability must satisfy when I is a maximum. It is found that for large average signal energy this necessary equation is satisfied when the input signal energy has an exponential probability density. The dependence of I, an average signal energy with an input probability of this maximizing form, is calculated numerically.

852

Delaware U. [Dept. of Electrical Engineering] Newark.

INFORMATION CAPACITY OF A PHOTOELECTRIC DETECTOR, by B. E. Goodwin and L. P. Bolgiano, Jr. [1965] [1]p. (AFOSR-66-0528) (AF AFOSR-65-2) AD 641042 Unclassified

Also published in Proc. IEEE, v. 53: 1745-1746, Nov. 1965.

A simple expression was obtained for the information capacity of a photodetector. Defining I (E;N) as the average information transmitted through a channel (the transinformation), it was found that this could be expressed by a simple power series.

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Delaware U. [Dept. of Psychology] Newark.

THE LEADER'S PERCEPTION OF THE MARGINAL MEMBER, by R. C. Ziller. [1965] [6]p. incl. illus. tables, refs. (AFOSR-65-0709) (AF AFOSR-62-95) AD 617241 Unclassified

Also published in Personnel Admin., v. 28: 6-11, Mar.-Apr. 1965.

Results of the research suggest that the leaders of higher rated training teams show more concern for and encourage the development of the members whose performance is marginal. The results also suggest that the leader is most successful in working with these less effective team members if he does not perceive, categorize and condemn the less talented or less motivated members as untrainables or incorrigibles. This positive attitude may be attributed, in part, to greater cognitive complexity or to less narrowly and less rigidly defined standards of acceptance within an evaluation system or style that includes more than dichotomized rating scales such as good-bad and trainable-untrainable. Similar results to these may be expected with regard to similar groups. Thus, it is hypothesized that in any teams compelled by economic or labor conditions to accept and utilize a high percentage of job applicants, the leaders of the more productive teams will be found to possess similar perceptual proclivities with regard to the less desirable employees. Similarly, it is hypothesized that in the early elementary school grades and particularly in schools with a high percentage of underprivileged children, the most successful teachers (in terms of student performance at given minimum standards of achievement by the maximum number of students) are less severe in their adjectival descriptions of the least preferred student. Under these conditions the limitation model of leadership is presumed to apply.

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Delaware U. [Dept. of Psychology] Newark.

MOTIVATIONAL AND PERCEPTUAL EFFECTS IN

ORIENTATION TOWARD A NEWCOMER, by R. C. Ziller and R. D. Behringer. [1965] [12]p. incl. tables. (AFOSR-65-1582) (AF AFOSR-62-95) AD 624012 Unclassified

Also published in Jour. Social Psychol., v. 66: 79-90, 1965.

Two laboratory experiments are reported which analyze the regular group-member's reaction to the advent of an imminent newcomer under varying characteristics of the host group, the host-group members, and the new member. Recall of biographical information concerning the imminent newcomer serves as the dependent variable. The first experiment concerned the relationship of high and low achievement-motivation members and Negro-White newcomers to interest in the newcomer. It was found that more information was recalled about the White than about the Negro newcomer. The results are interpreted as supporting Allport's theory of prejudice toward Negroes: that the race category tends to be overgeneralized, thereby rendering further information search less salient. The second experiment was designed to study in a more systematic fashion the effects of need achievement on recall of biographical data of a Negro or White newcomer under conditions of varying group size. All 3 independent variables were found to be related to recall, but the effects were interactional.

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Delaware U. [Dept. of Psychology] Newark.

DOGMATISM AND PREDECISIONAL INFORMATION SEARCH, by B. H. Long and R. C. Ziller. [1965] [3]p. incl. table, refs. (AFOSR-66-1150) (AF AFOSR-62-95) AD 640274 Unclassified

Also published in Jour. Appl. Psychol., v. 49: 376-378, Oct. 1965.

Rokeach's Dogmatism Scale and 4 decision measures of tendencies to reserve judgment were administered to 72 freshmen women. A significant negative relationship was found between dogmatism and each of the 4 decision measures. The non-dogmatic individual tended to delay decision and engage in predecisional search, to require more time for psychophysical judgments, and to respond "don't know" to statements of opinion under conditions of inadequate information. Accordingly, dogmatism was interpreted as a defense mechanism which interferes with processing of predecisional information.

856

Delaware U. Dept. of Psychology, Newark.

TOWARD A THEORY OF OPEN AND CLOSED GROUPS, by R. C. Ziller. [1965] [19]p. incl. refs. (AFOSR-66-1168) (AF AFOSR-62-95) AD 640276 Unclassified

Also published in Psychol. Bull., v. 64. 164-182, Sept. 1965.

Four characteristics differentiate groups in which membership is in a constant state of flux (open groups) as opposed to groups in which the membership is relatively stable (closed groups): time, perspective, equilibrium, frame of reference, and changing group membership. The significance of these characteristics for social behavior was explored. A number of tested and testable propositions concerning group stability and social behavior emerged from a rapprochement of research, relevant sub-theories, and concepts associated with open and closed-group behavior. The failure to consider the dimension of group stability in most previous social-psychological research poses a question concerning the generality of social-psychological theories which are based upon research which ignores the pervasive dimension of group stability.

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Documentation, Inc., Bethesda, Md.

AUTOMATIC INDEXING FROM MACHINE READABLE ABSTRACTS OF SCIENTIFIC DOCUMENTS, by P. Zunde. Sept. 1965, 211p. incl. diagrs. tables, refs. (AFOSR-65-1425) (AF 49(638)4236) AD 481148L Unclassified

State-of-the-art of machine indexing is reported. Various proposed machine indexing methods are reviewed and evaluated. Methods for comparing machine and human indexing as well as machine indexing systems among themselves are described. Possible approaches to various problem solutions in machine indexing are indicated. The report describes the design of the formal autoindexing of scientific texts (fast) system. Characteristics of uniterm co-ordinate indexes are investigated and generalizations to scientific indexes made. Laws for the formation of words in the indexing language are derived and verified. The operational principles of the fast system and test results of various system components are reported. Indexes produced by the fast method are compared with those produced by human indexers for inter-indexer and intra-indexer consistency. A method of formal evaluation of indexes using the information theory approach is presented and applied to the fast and conventional indexes. It is concluded that the fast system can produce uniterm co-ordinate indexes adequate to user's requirements better and faster than human indexers can do.

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Dublin U. Coll. (Ireland).

ACTIVE TRANSPORT OF IONS, by E. J. Conway. Final rept. Jan. 27, 1965, 48p. incl. diagrs. tables. (AFOSR-65-0871) (AF 61(052)435) AD 617700 Unclassified

In the present context the interpretation given to active transport of ions is their movement from a lower to a higher chemical or electrochemical potential, work being done in the process. This process can be represented as occurring in 3 stages: (1) The ion attaches itself to a carrier. This attachment involves electrical adsorption to an ion or ions of opposite charge. Also, in order to enter into or cross membrane barriers the complex of ion and carrier may be assumed to be lipoid

soluble. (2) The ions are released from their attachment to the complex by the release in some way of the electric charges attaching to the carrier ions. (3) The release of charge may be considered as accomplished by the activity of the redox pump or alternatively by some special action of an ATPase enzyme, the process occurring in a cyclical manner, and involving the input of free energy. (Contractor's abstract)

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Dublin U. Coll. (Ireland).

ASTRONOMICAL OBSERVATIONS FROM SPACE VEHICLES. UPPER LIMITS TO THE FLUX OF HIGH ENERGY GAMMA-RAYS FROM SELECTED QUASI-STELLAR AND OTHER SOURCES USING THE CERENKOV TECHNIQUE, by C. D. Long, N. A. Porter and others. [1965] [2]p. incl. table. (AFOSR-65-1840) (AF EOAR-63-80) AD 626092 Unclassified

Also published in Ann. Astrophys., v. 28: 263-264, Jan.-Feb. 1965.

Upper flux limits at the earth for γ rays of energy greater than about 5×10^{12} ev have been established for the quasi-stellar sources 3C 147, 3C 196, 3C 273, the Crab Nebula, and the magnetic variable 53 Cam. They are all of the order 10^{-10} photons cm^{-2} s^{-1}. Corresponding upper energy limits at emission are of the order 5×10^{47} ergs s^{-1} for the quasi-stellar sources, and 5×10^{35} ergs s^{-1} for the Crab Nebula, if γ-ray absorption is assumed negligible. Possible absorption mechanisms are discussed.

860

Dublin U. Coll. (Ireland).

DETECTION OF RADIO PULSES FROM EXTENSIVE AIR SHOWERS, WITH A WIDE-BAND RECEIVING SYSTEM, by N. A. Porter, C. D. Long and others. [1965] [3]p. (AFOSR-66-0455) (AF EOAR-63-80) AD 630139 Unclassified

Also published in Phys. Ltrs., v. 19: 415-147, Nov. 1965.

Radio pulses associated with extensive air showers of moderate size physically similar to Cerenkov radiation and consistant with a coherent emission of radiation have been reported. Radio detection methods may therefore be suitable for the detection of very large showers at great distances from the core. To investigate the possibility of wide band operation an experiment was set up in a sheltered valley site with relatively low artificial background using a helical aerial centered at 70 mc/s. The overall beamwidth of the system is 20 mc/s, and the full beam width of the aerial 50°, centered at the zenith. Showers are selected by a plastic Cerenkov particle detector of 4,200 cm^2 sensitive area, set at a threshold particle density of about 7 particles/m^2. The counting rate is about 20 events per hr. It is probable that a significant proportion of these are due to local showers or μ-meson induced events. The system was operated for 37 days, with an effective running time of 650 hr. On 5 of the 12,000 traces recorded, bandwidth limited pulses, at least 5 times the average noise fluctuation, were observed in the expected position. No comparable pulses were observed at any other position on any of the traces, or on the comparison traces. It is concluded that radio pulses associated with air showers may be detected with a wide-band system, in the presence of some interference. The observations are in reasonable agreement with a coherent emission model, but could be due either to a negative excess in the showers or to geomagnetic effects.

861

Dublin U. Trinity Coll. (Ireland).

ROUGH COMBUSTION IN LIQUID FUEL ROCKET MOTORS, by P. D. McCormack, S. Birch, and L. Crane. Final technical rept. Jan. 1965, 52p. incl. illus. diagrs. tables, refs. (AFOSR-65-1316) (AF EOAR-63-76) AD 619526 Unclassified

A theory for combustion instability based on fuel flow velocity modulation produced by injector vibration is postulated. The research mainly covers the effects of vibration on liquid jet breakup. A theoretical analysis of boundary layer instability in the presence of the tangential mode, leading to a large increase in heat transfer to the combustion chamber walls, is also given.

862

Dublin U. Trinity Coll. (Ireland).

AN EXPERIMENTAL AND THEORETICAL ANALYSIS OF CYLINDRICAL LIQUID JETS SUBJECTED TO VIBRATION, by P. D. McCormack, L. Crane, and S. Birch. [1964] [38]p. incl. illus. diagrs. (AFOSR-65-2049) (Bound with its AFOSR-65-1316; AD 619526) (AF EOAR-63-76) AD 629243 Unclassified

Also published in Brit. Jour. Appl. Phys., v. 16: 395-408, Mar. 1965.

It is established that the Rayleigh-Weber capillary type instability on liquid jets may be triggered by velocity modulation at the injector. It is shown that by application of mechanical vibration in the appropriate frequency range, such velocity modulation can be induced. A second-order analysis is developed to cover the case of very small initiating modulation amplitudes. With finite velocity modulation it is demonstrated that considerable liquid bunching occurs which results in the formation of disks on the jet. A modified Rayleigh analysis is carried out which qualitatively covers characteristics observed in the region of finite velocity modulation. Vibration acceleration values of 200 g and more are found necessary to enter the region where the liquid bunching mechanism predominates over the surface tension mechanism.

863

Dublin U. Trinity Coll. (Ireland).

THE TANGENTIAL MODE AND ROCKET ENGINE BURN-OUT, by L. J. Crane, S. Birch, and P. D. McCormack. [1965] [13]p. incl. diagrs. table. (Bound with its AFOSR-65-1316; AD 619528) (AF EOAR-63-76) Unclassified

It is suggested that the impingement of rotating gas on the wall of a cylindrical rocket engine chamber, will result in a 3-dimensional type of boundary layer instability. The formation of the regular and well ordered pattern of Taylor-Görtler vortices, with axes parallel to the chamber wall, is shown to result in a very large, albeit oscillating, increase in heat flux to the wall over that due to normal convection. Görtler's coordinate system and Schlichting's formula for the boundary layer on a smooth plate are used. Observations on heat transfer to the rocket engine wall in the presence of tangential instability indicate a fractional increase in the region of ten. It is concluded that experimental evidence supports the contention that the tangential mode of instability in a rocket engine can initiate this type of disturbance in the boundary layer on the wall, and lead to an independent and significant increase in heat transfer.

864

Dublin U. Trinity Coll. (Ireland).

THE QUANTIZATION OF FIELDS WITH MAXIMUM SPIN 3/2 AND THE APPLICATION TO SU_{12}, by L. Castell. [1965] [3]p. (AFOSR-65-2869) (AF EOAR-64-61) AD 629305 Unclassified

Also published in Nuovo Cimento, Series X, v. 37: 1236-1238, July 1, 1965.

It is shown that a single field equation of the type $\partial[\gamma\alpha^{\alpha'}\psi_{\alpha'\beta\gamma} + \gamma_\beta{}^{\beta'}\psi_{\alpha\beta'\gamma} + \gamma_\gamma{}^{\gamma'}\psi_{\alpha\beta\gamma'}] = 3m\psi_{\alpha\beta\gamma}$ leads to mass eigenvalues m and 3 m, and that the associated "particle states" have positive and negative norms, respectively.

865

Dublin U. Trinity Coll. (Ireland).

SU(12) MASS FORMULA, by L. Castell. [1965] [1]p. incl. table. (AFOSR-65-2870) (AF EOAR-64-61) AD 628341 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 753-754, May 3, 1965.

An alternative derivation is given for the Su(6) mass formula relating baryon masses first derived by M. A. Bég and V. Singh (Phys. Rev. Ltrs., v. 13: 418, 1964). (Math. Rev. abstract)

866

Dublin U. Trinity Coll. (Ireland).

METHODS AND RESULTS OF A GENERAL THEORY OF PARTICLES WITH SPIN AND ITS CONNECTION WITH SU_{12}, by L. Castell. [1965] [2]p. incl. diagr. (AFOSR-65-2953) (AF EOAR-64-61) AD 628339 Unclassified

Also published in Zeitschr. Naturforsch., v. 20a: 737-738, 1965.

The results of previous attempts to combine the charge symmetries of elementary particles with space-time structure are reviewed and presented in a new form. The connections with the Bargmann-Wigner equation along with some later developments in the theory of field equations for particles with arbitrary spin are pointed out.

867

Dublin U. Trinity Coll. (Ireland).

THE GENERALIZED KEMMER EQUATION, by L. Castell. [1965] [3]p. (AFOSR-66-1572) (AF EOAR-64-61) AD 639535 Unclassified

Also published in Nuovo Cimento, Series X, v. 39: 344-345, Sept. 1, 1965.

The extension of the ordinary field theoretical concept of an elementary particle to a 'relativistic rotator' which possesses a certain moment of inertia, leads to a new type of first-order relativistic field equations. One of their important features is the fact that one can calculate nontrivial energy level trajectories for arbitrary high spin. Consideration is given to the 5-dimensional Kemmer equation to which different angular momentum states are intrinsically coupled. The resulting energy level trajectories are compared with a simple classical model.

868

Dublin U. Trinity Coll. (Ireland).

DERIVATION OF JET VELOCITY MODULATION CAUSED BY INJECTOR VIBRATION, by P. D. McCormack, L. Crane, and S. Birch. [1965] [3]p. incl. illus. (AFOSR-66-0351) (In cooperation with Dartmouth Coll., Hanover, N. H.) (AF EOAR-65-43) AD 632447 Unclassified

Also published in Brit. Jour. Appl. Phys., v. 16: 1911-1913, Dec. 1965.

A method of establishing the velocity modulation produced in a jet as a result of transverse vibration is described. Results are quoted for water and paraffin jets. The method is based on measuring the diameter of the disks, or plates, produced on the jet and using Hartman's formula to deduce the velocity modulation at the orifice. (Contractor's abstract)

869

Dublin U. Trinity Coll. (Ireland).

MECHANICAL VIBRATION - A DRIVING MECHANISM FOR COMBUSTION INSTABILITY IN ROCKET ENGINES, by P. D. McCormack, D. Cochrane, and L. Crane. Nov. 1965 [31]p. incl. diagrs. (AFOSR-66-0404) (AF EOAR-65-43) AD 628920 Unclassified

The mixing and burning of gas/air jets in the presence of mechanical vibration of the injector was studied. Initial photographic Schlierer and spectroscopic observations of a H_2/air and coal gas/air flame vibration conditions have been carried out. The vibration obviously enhances the rate of mixing and higher mean flame temperatures result. A closed solution was obtained for the case of a vibrated gas jet mixing with its surroundings, in the near-field (potential core) region. Generally speaking, the theory predicted that the vibration, treated as a source of velocity, would raise the mean axial component of velocity at any point inside the mixing region. This was verified by a hot-wire anemometer investigation. Furthermore, it was established that the vibration drives the vortex shedding mechanism in the flow from an orifice.

870

Duke U., Durham, N. C.

THE DUKE ALGOL COMPILER AND SYNTACTIC ROUTINE METHOD FOR SYNTAX RECOGNITION, by T. M. Gallie, Jr. Apr. 5, 1965 [33]p. incl. diagrs. tables, refs. (AFOSR-65-0715) (AF AFOSR-62-164) AD 614794 Unclassified

This project is concerned with (a) methods for specifying the meaning of a mechanical language, (b) classification and simplification of the grammars of mechanical languages, (c) methods of systematizing the construction of translators which can be used to construct other translators, and (d) description of an Algol computer in an appropriate extension of Algol. Chapter I of this report gives the author's opinions of various methods for syntax recognition and explains why he has chosen to use one which was suggested by work of Lucas and Schai. Chapter II explains the method in some detail. Chapter III outlines our practical experience using this method. The list of references forms a minimal recommended reading list.

871

Duke U. [Dept. of Mathematics] Durham, N. C.

SECOND ORDER LINEAR AND NONLINEAR DIFFERENTIAL EQUATIONS, by J. J. Gergen and F. G. Dressel. [1965] [7]p. (AFOSR-66-0081) (AF AFOSR-62-162) AD 640272 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 767-773, Aug. 1965.

Herbst proved the following theorem: If u, v are variable independent solutions with Wronskian w of the linear equation $Y'' = w'w^{-1}Y' + qY$, where w and q are given functions of x, then the equation (1) $y'' = w'w^{-1}y' + f(y, y', w, q)$ has general solution $y = F(u, v)$ if and only if f has the form (2) $f = qZ(y) + A(y)(y')^2 + C(y)w^2$, where Z, A, C satisfy (3) $Z'-AZ = 1$, $ZC' + (3-AZ)C = 0$. In Herbst's paper, F is determined only as a solution of a system of four partial differential equations. In the present paper, the authors give a simple characterization of F, and on the basis of information obtained, a method is developed for the solution of (1) when f has the form (2) and Z, A, C satisfy (3). (Math. Rev. abstract)

872

[Duke U. Dept. of Mathematics, Durham, N. C.]

ON THE NON-EXISTENCE OF L^2 SOLUTIONS OF A CLASS OF NON-LINEAR DIFFERENTIAL EQUATIONS, by J. Burlak. [1965] [12]p. incl. refs. (AFOSR-66-1351) (AF AFOSR-63-435) AD 641556 Unclassified

Also published in Proc. Edinburgh Math. Soc., v. 14: Ser. II: 257-268, Dec. 1965.

The purpose of this paper is to obtain properties of solutions of the nnn linear differential equation $y^{11} + f(x)g(y) = 0$. In particular, conditions are established under which solutions of the differential equation above fail to be of class L^2.

873

Duke U. Dept. of Physics, Durham, N. C.

MOLECULAR FORCE FIELD AND CENTRIFUGAL DISTORTION CONSTANTS OF NITROSYL FLUORIDE, by R. L. Cook. [1965] [7]p. incl. tables, refs. (AFOSR-65-2136) (AF AFOSR-64-493) AD 629797 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Also published in Jour. Chem. Phys., v. 42: 2927-2933, Apr. 15, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 491, Apr. 26, 1965.

The microwave spectrum of nitrosyl fluoride, NOF, has been reinvestigated in the microwave region and extended into the millimeter wave region. Some 80 transitions, consisting of both "a"- and "b"-type transitions, have been measured and assigned. These data provide the information required for a centrifugal distortion analysis which yields the following ground-state rotational parameters (mc/sec): A = 95 189.77, τ_{xxxx} = -0.099630, τ_{xxzz} = -0.289581; B = 11 844.12, τ_{zzzz} = -15.586926, $H_{JK} = 2.339 \times 10^{-6}$; and C = 10 508.31, $\tau_{xxzz} = 0.418629$, $H_{KJ} = -4.946 \times 10^{-5}$. Combination of infrared data and microwave data yields the following quadratic potential constants millidynes per angstron,

$f_{r1} = 2.09$, $f_{r2} = 15.08$, $f_{\alpha/d}{}^2 = 1.08$, $f_{r1r2} = 1.85$, $f_{r1\alpha/d} = 0.17$. Here f_{r1} and f_{r2} are the N-F and N-O bond force constants, respectively, and f_α is the bond-bending force constant.

874

Duke U. Dept. of Physics, Durham, N. C.

MILLIMETER-WAVE MOLECULAR-BEAM SPECTROSCOPY: ALKALI FLUORIDES, by S. E. Veazey and W. Gordy. [1965] [9]p. incl. illus. diagr. tables, refs. (AFOSR-2137) (AF AFOSR-64-493) AD 629796 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 491, Apr. 26, 1965.

Also published in Phys. Rev., v. 138: A1303-A1311, May 31, 1965.

Rotational transitions of the alkali metal fluorides CsF, $Rb^{87}F$, $Rb^{85}F$, $K^{39}F$, NaF, and Li^7F have been measured in the millimeter- and submillimeter-wave regions where no previous measurements existed. The work was accomplished with a high-resolution molecular-beam absorption spectrometer, previously utilized for study of the other alkali halides. A more reliable oven was constructed and used to vaporize the alkali fluorides at temperatures up to 1100°C. Measurements on rotational transitions as high as $J = 27 \rightarrow 28$ in the first 3 vibrational states gave Y_{01}, Y_{11}, and Y_{21} more accurately, for the most part, than they were previously known, and gave Y_{02} and Y_{12} for the first time. From these Dunham rotational constants were derived potential coefficients, moments of inertia, internuclear distances, and vibrational constants. (Contractor's abstract)

875

Duke U. Dept. of Physics, Durham, N. C.

SOME RADIATION EFFECTS ON DNA AND ITS CONSTITUENTS, by W. Gordy, B. Pruden, and W. Snipes. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-2138) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-493 and Army Research Office (Durham)) AD 618434 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 53: 751-756, Apr. 1965.

ESR evidence indicates that hydrogen-addition reactions on the ringed groups, especially on the thymine ring, are possibly of great significance in radiation damage to DNA. The production of secondary free radicals in DNA by H-addition reactions depends upon physical condition as well as upon chemical impurities and probably on the nature and constitution of DNA itself, i. e., upon the relative amounts and the sequence of the different nucleotides in the DNA polymer and upon the number of its strands, whether single or double.

876

Duke U. Dept. of Physics, Durham, N. C.

ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF THYMIDINE, by B. Pruden, W. Snipes, and W. Gordy. [1965] [8]p. incl. diagrs. table, refs. (AFOSR-65-2139) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-493 and Army Research Office (Durham)) AD 618435 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 507, Apr. 26, 1965.

Also published in Proc. Nat'l. Acad. Sci., v. 53: 917-924, May 1965.

ESR measurements on γ-irradiated single crystals of thymidine show that the free radical detected earlier in the powder is formed by an H addition reaction to the $C_{(6)}$ on the thymidine ring. The hyperfine structure is isotropic and arises from a triplet isotropic splitting of 40.4 G by the 2 equivalent $C_{(6)}H_2$ protons and from a quartet substructure arising from an equivalent isotropic coupling of 20.3 G by the CH_3 protons. The coupling of both sets of protons occurs primarily through hyperconjugation with π-orbital spin density on the ring, most of which is on $C_{(5)}$. The ring is planar with the $C_{(6)}H$ bonds oriented above and below the plane, approximately 35 from the normal to it. The spin density on $C_{(5)}$ is 0.71. The g tensor is axially symmetric, approximately, with principal values of 2.0026 and 2.0042. In powdered samples, production of this radical was enhanced by irradiation in molecular hydrogen.

877

Duke U. Dept. of Physics, Durham, N. C.

FREE RADICALS FORMED BY HYDROGEN ATOM BOMBARDMENT OF THE NUCLEIC-ACID BASES, by J. N. Herak and W. Gordy. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-66-0376) (AF AFOSR-64-493) AD 626396 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 54. 1287-1292, Nov. 1965.

The study provides objective proof that free hydrogen atoms combine directly at room temperature with ring carbons not only of thymine but also of uracil and of the purine bases adenine and guanine. In contrast, no corresponding evidence could be found for H-addition on the ring carbons of cytosine. These results are in agreement with work in progress in this laboratory

which shows that the electron spin resonance (ESR) patterns of irradiated single crystals of cytidine do not resemble those expected for free radicals formed by such H addition on $C_{(6)}$ or $C_{(5)}$.

878

Duke U. [Dept. of Physics] Durham, N. C.

DIPOLE MOMENTS OF HNCO AND HN_3 (Abstract), by D. White and R. L. Cook. [1965] [1]p. [AF AFOSR-64-493] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 491, Apr. 26, 1965.

The dipole moment of HNCO and HN_3 have been precisely measured from the Stark effect of their millimeter-wave rotational spectra. A parallel-plate, semi-free space 30-in. Stark cell with optically ground quartz spacers was employed. Sectional horns and Teflon lenses were used for focusing the millimeter-wave energy. Both molecules are nearly symmetric rotors. Since only a-type transitions were observed, the symmetric top notation is applicable. For a given J transition, the dipole moment of HNCO was found to decrease with increasing rotation about the a axis. As an example, the $J = 3 \rightarrow 4$ transition yields $\mu_a = 1.57$, 1.540, and 1.5000 Debye for the effective K values of 1, 2, and 3, respectively. So far, only the $J = 3 \rightarrow 4$, $K = 2$ transition has been observed for HN_3. For it, $\mu_a = 0.825$ Debye.

879

Duke U. [Dept. of Physics] Durham, N. C.

ELECTRON SPIN RESONANCE OF ATOMIC As AND P AND OF PH_2 RADICALS IN AN INERT MATRIX AT LOW TEMPERATURE (Abstract), by W. Gordy, R. Morehouse, and J. J. Christiansen. [1965] [1]p. [AF AFOSR-64-493] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 506-507, Apr. 26, 1965.

The ESR of atomic As has been detected in a γ-irradiated Kr matrix containing small concentrations of AsH_3 molecules. The radicals are produced mainly by energy absorbed by the matrix and transferred to the AsH_3. The As^{75} atoms have an isotropic nuclear coupling of 11.1 G and an isotropic g of 1.9975. Similar energy migration of PH_3 molecules in the Kr matrix was found to produce PH_2 free radicals as well as P and H atoms. A coupling constant of 30 G is observed for the P atoms with an isotropic g of 2.0027. For PH_2 the observed P^{31} coupling is 80 G, the H coupling is 18 G, and the average g is 2.0087. The ESR of the PH_2 indicates a bond angle of about 120°. In contrast, small concentrations of NH_3 in the Kr matrix did not produce detectable ESR signals. Atomic P^{31} splitting has been previously measured in the gas to be 20.0 G and in an argon matrix at 4.2°K to be 23.3 G.

880

Duke U. [Dept. of Physics] Durham, N. C.

ELECTRON SPIN RESONANCE OF γ-IRRADIATED SINGLE CRYSTALS OF CF_3COONH_4 (Abstract), by F. Srygley and W. Gordy. [1965] [1]p. [AF AFOSR-64-493] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 507, Apr. 26, 1965.

Electron-spin-resonance studies of γ-irradiated single crystals of CF_3COONH_4 reveal CF_2COONH_4 free radicals, which are produced by loss of an F from the parent molecule. There are 4 molecules in the unit cell, but there are only 2 distinguishably different orientations of the free radicals. The ESR indicates that the free radicals are planar, with the 2 distinguishable orientations approximately at right angles, 88.5°. The nuclear couplings of the 2 F atoms are equivalent and axially symmetric, with $A_{\parallel} = 188 \pm 3$ G and with $A_{\perp} = 14 \pm 3$ G. Likewise, g is symmetric about the same axis, with $g_{\parallel} = 2.004$ and with $g_{\perp} = 2.007$. The magnetic axes of symmetry are found to be normal to the 2 planes containing CCOO groups of the undamaged molecules in the crystal. Analysis of the nuclear coupling indicates that the 2p spin density on the F is 0.12 and the 2s density is 0.0044. A singlet resonance which may arise from the radical CF_3CO_2 is also observed.

881

Duke U. [Dept. of Physics] Durham, N. C.

ELECTRON SPIN RESONANCE OF SiH_3, GeH_3, AND SnH FREE RADICALS IN A KRYPTON MATRIX (Abstract), by R. Morehouse, and W. Gordy. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-493] and Army Research Office (Durham)) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 507, Apr. 26, 1965.

Disintegration of XH_4-type molecules by energy migration and transfer in an inert Kr matrix at 4.2°K has been investigated through the ESR of the resulting free radicals. The SiH_4 dissociates into SiH_3 and H; the GeH_4 into GeH_3 and H; but the SnH_4 dissociates into SnH radicals and H atoms. The SiH_3 and GeH_3 have

quartet patterns arising from the equivalent coupling of their protons. The proton coupling is 8.2 G in SiH_3 and 15 G in GeH_3. The SnH radical has a doublet ESR pattern arising from its proton coupling of 32 G. From the shape of the resonance of the polyoriented radicals, the g tensors of SiH_3 and GeH_3 are estimated to be axially symmetric with $g_{\parallel} = 2.0055$ and $g_{\perp} = 2.0032$ for SiH_3 and with $g_{\parallel} = 2.0170$ and $g_{\perp} = 2.0104$ for GeH_3. The g of SnH is isotropic, with a value of 2.0022. The SiH_3 radical has been previously detected in the argon matrix with a component splitting of 7.6 G.

882

Duke U. [Dept. of Physics] Durham, N. C.

HIGHER-ORDER DISTORTION EFFECTS IN THE ROTATIONAL SPECTRUM OF ISOTHIOCYANIC ACID (Abstract), by J. J. Christiansen, R. L. Cook, and M. Winnewisser. [1965] [1]p. [AF AFOSR-64-493] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 491, Apr. 26, 1965.

The millimeter-wave rotational spectrum of the slightly asymmetric rotor, HNCS has been reported and a number of $K_{-1} = 0$, 1, 2, and 3 transitions were measured and assigned. However, it was not possible to obtain a satisfactory fit of the spectrum even with the inclusion of P^6 distortion terms in the energy expression. Furthermore, the analysis yielded $K_{-1} = 4$ transition frequencies, which were not among the observed frequencies, even though these lines should have sufficient intensity to be detected. This anomalous K pattern has been reinvestigated and it has been found that the introduction of P^8 distortion terms is essential to account accurately for the observed rotational-frequencies. Consideration of these effects has enabled the measurement and assignment of a number of $K_{-1} = 4$ lines. This appears to be the first time that such high-order distortion effects have been observed.

883

Duke U. [Dept. of Physics] Durham, N. C.

MILLIMETER-WAVE SPECTRUM OF THE SH RADICAL (Abstract), by M. Winnewisser, G. Winnewisser, and W. Gordy. [1965] [1]p. [AF AFOSR-64-493] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 491, Apr. 26, 1965.

The millimeter-wave Λ-type spectrum of the gaseous free radical SH in the $^2\pi_{3/2}$ electronic ground state has been detected with an improved version of the fast-flow millimeter-wave spectrometer. SH radicals were generated with a yield of roughly 50% by the passage of H_2S gas through a rf discharge with 200 W input power. The following transitions between Λ-type doublets in the $^2\pi_{3/2}$ state have been observed and assigned mc/sec, N = 17, J = 35/2 84 855.41; N = 18, J = 37/2 96 791.30; N = 19, J = 39/2 112 753.46; N = 20, J = 41/2 130 653.88, and N = 21, J = 43/2 152 359.74. The preliminary spectroscopic constants are $B_0 = 255\,000$ mc/sec, q = 330 mc/sec, $\delta = -30$, $A = -120 \times 10^5$ mc/sec. The lifetime of the SH radicals has been found to be of the order of 0.5 sec.

884

Duke U. [Dept. of Physics] Durham, N. C.

SUBMILLIMETER WAVE SPECTRUM OF HBr (Abstract), by G. Jones and W. Gordy. [1965] [1]p. [AF AFOSR-64-493] Unclassified

Presented at meeting of the Amer. Phys. Soc., Chattanooga U., Tenn., Nov. 5-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 246, Feb. 25, 1965.

The J = 0 → 1 rotational transitions of HBr^{79} and HBr^{81} have been measured with high precision at the submillimeter wavelength λ = 0.599 mm. The molecular constants derived for HBr^{79} are $\nu_0 = 500\,675.24 \pm 0.26$ mc/sec, $B_0 = 250\,360.78 \pm 0.13$ mc/sec, $eQq = 535.4 \pm 1.4$ Mc/sec, and $C = 0.29 \pm 0.20$ Mc/sec. The corresponding values for HBr^{81} are $500\,519.41 \pm 0.26$ mc/sec, $250\,282.88 \pm 0.13$, 447.9 ± 1.4 mc/sec, and 0.31 ± 0.20 mc/sec, respectively. The lines were observed and measured on the cathode-ray scope.

885

Duke U. Dept. of Physics, Durham, N. C.

MICROWAVE SPECTROSCOPY IN THE REGION OF 4-0.4 MILLIMETERS, by W. Gordy. [1965] [32]p. incl. illus. diagrs. tables, refs. (AFOSR-67-0076) (AF AFOSR-66-493) AD 646182 Unclassified

Presented at Eighth European Cong. on Molecular Spectroscopy, Copenhagen (Denmark), Aug. 14-20, 1965.

Also published in Pure and Appl. Chem., v. 11: 403-434, 1965.

A review is given of spectroscopic studies in the 4-0.4 mm wavelength region, with particular attention to the development and operation of a new 0.43 mm high purity energy source. Topics include: extension of high-resolution spectroscopy to the 4-0.4 mm region; instruments and techniques; hydrogen halides and the velocity of light: precision spark spectrometer; spectroscopy of

unstable molecular species; high-temperature molecular beam spectrometer; symmetric and asymmetric rotors; solids, liquids, and flames.

886

Durham U. Dept. of Geology (Gt. Brit.).

CRUSTAL STRUCTURE OF GREAT BRITAIN, by A. L. Lucas. Feb. 2, 1965, 13p. incl. refs. (Scientific rept. no. 3) (AFOSR-65-2314) (AF 61(052)733) AD 616093
Unclassified

The report describes the progress made in constructing a transportable seismic array system for use in crustal studies. A review of published work relating to the research aims of this project is included.

887

Durham U. Dept. of Geology (Gt. Brit.).

CRUSTAL STRUCTURE OF GREAT BRITAIN, by M. H. P. Bott and A. L. Lucas. Aug. 3, 1965, 6p. (Scientific rept. no. 4) (AFOSR-65-2929) (AF 61(052)-733) AD 627840 Unclassified

The research aim of this project is the investigation in Great Britain of local variations in crustal structure with particular reference to granite batholiths, and the effects of such variations on the propagation of seismic energy. This investigation is to be carried out by crustal refraction explosion studies. The hardware consists of a ten channel seismometer array with digital magnetic tape recording. The prime consideration during the period of this report has been to get the equipment in the field and operational by September, 1965 in order to take advantage of a series of depth charge explosions in the Irish Sea and St. George's Channel.

888

Durham U. Dept. of Physics (Gt. Brit.).

THE FERMI MOMENTA OF SOME FACE CENTERED CUBIC RARE EARTH COMPOUNDS, by M. I. Darby and K. N. R. Taylor. [1965] [2]p. incl. diagrs. refs. (AFOSR-65-1896) (AF EOAR-63-75) AD 626363
Unclassified

Also published in Phys. Ltrs., v. 14: 179-180, Feb. 1, 1965.

Using the indirect exchange theory of Ruderman, Kittel (Phys Rev., 96: 99, 1954) and Yosida (Phys. Rev., v. 106: 893, 1957), the Fermi momenta are determined for Re-X compounds where Re is Gd, Tb, Dy, Ho, Tm, or Yb and X is N, P, As, Sb, or Bi. The Fermi momenta are plotted against lattice spacing a_o. The equation of the resulting straight line can be written in the form $k_F = (3\pi^2 \times 1.42)^{1/3} a_o$. This suggests that if the effective number of valence electrons per rare earth ion is taken to be 1.42 for all compounds, then the values of k_F and consequent widely differing paramagnetic Curie points of these compounds can be accounted for entirely by differences in lattice spacings. It is concluded that the use of the indirect exchange theory enables the paramagnetic Curie temperatures of these compounds to be correlated with lattice spacings via their fermi momenta values.

889

Dynamic Science Corp., Monrovia, Calif.

COMBUSTION INSTABILITY. Final technical rept. [1965] 74p. incl. diagrs. refs. (Rept. no. SN-1800) (AFOSR-65-1683) (AF 49(638)1151) AD 623847
Unclassified

The principal objective of the program was to relate combustion stability to injector design variables through a consideration of droplet dynamics and combustion. The basic model treats the individual droplets as energy and mass sources. Stability or instability is determined by the relationship between energy and mass addition and the characteristics of the chamber or of a disturbance introduced into the chamber. Depending upon such relationships, a disturbance will be either amplified or dumped. A determination of the stability of a system will depend not only upon the frequency response of the energy and/or mass source but may also depend upon its spatial relationship. One of the first efforts in the study was to determine whether propellant droplets would assume specific patterns with respect to a disturbance and whether these patterns could affect the stability of the combustion process.

890

Edinburgh U. Dept. of Physiology (Gt. Brit.).

A RELATIONSHIP BETWEEN ADRENALINE AND THE MODE OF ACTION OF OXYTOCIN AND OESTROGEN ON VASCULAR SMOOTH MUSCLE, by A. L. Haigh, S. Lloyd, and M. Pickford. [1965] [14]p. incl. diagrs. table, refs. (AFOSR-65-2949) (AF EOAR-62-79) AD 628389 Unclassified

Also published in Jour. Physiol., v. 178: 563-576, June 1965.

Hind-leg blood flow was measured in dogs and monkeys, in acute experiments by means of a Pavlov stromuhr in series with the femoral veins, and in chronic experiments by venous occlusion plethysmography. When a reduction in hind-limb blood flow in response to administration of oxytocin was induced by lumbar sympathectomy, the normal dilator response to oxytocin was restored if the oxytocin was given either during a period of stimulation of the peripheral end of the divided lumbar chain, or during an infusion of adrenaline. Infusions of noradrenaline did not restore the normal response to oxytocin. When a reduction in hind-limb blood flow in response to administration of oxytocin was induced by giving an estrogen, the normal dilator response was restored if the oxytocin was given either during a period of stimulation of the sympathetic supply to the limb, or during an infusion of adrenaline provided that in both cases atropine or hyoscine was first given. In no circumstances did nonadrenaline restore the normal response to oxytocin and, in the absence of atropine or hyoscine, adrenaline and nerve stimulation were also ineffective. It is suggested that the fraction of adrenaline released by sympathetic nerves is of functional significance, and is essential for the dilator effect of oxytocin. It is also suggested that estrogens interfere with the manufacture of adrenaline in or its release from the sympathetic nerves, as well as having the previously described effect of increasing the ACh-like content of organs.

891

Electro-Optical Systems, Inc., Pasadena, Calif.

PROTON BEAM TECHNIQUE FOR MEASURING THE ION DENSITY IN A PLASMA, by D. P. Duclos. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-2258) (AF 49-(638)1063) AD 626344 Unclassified

Also published in Rev. Scient. Instr., v. 36: 803-809, June 1965.

A technique is described for obtaining localized measurements of the ion density in a plasma which is not affected by the presence of a magnetic field or the absence of thermodynamic equilibrium. The technique consists basically of exciting the ions with a proton beam and relating the measured absolute intensity of certain spectral lines to the ion density. Three requirements are discussed which must be satisfied in order to apply the method to a particular gas. The technique appears to be well suited to measuring the density of helium ions. The possible sources of error are examined and, for helium plasmas, none of the errors are large provided that the gas pressure is less than 1 mm Hg and the temperature is over 10,000°K. A preliminary experiment is described. (Contractor's abstract)

892

Electro-Optical Systems, Inc., Pasadena, Calif.

I. STUDIES OF ELECTRICALLY EXPLODING WIRES AND FILMS, by N. C. Chase. II. STUDIES OF CROSSED-FIELD PLASMA ACCELERATORS AND PLASMA DIAGNOSTIC TECHNIQUES, by D. P. Duclos. Final summary rep. Apr. 1, 1961-Sept. 30, 1965, Oct. 1965 [207]p. incl. illus. diagrs. tables, refs. (EOS rept no. 1690) (AFOSR-66-0154) (AF 49(638)1063) AD 628034 Unclassified

The results of experiments designed to produce a directed, metal-derived plasma with high kinetic energy, which might result in development of a high-performance propulsive device, are presented. The plasma source is a small wire, rapidly exploded by discharging through it the energy stored in a capacitor. The experiment was designed to direct and accelerate the plasma in one direction and to produce a high specific impulse. Three experimental methods used in an attempt to achieve the desired result are described. The design of the ballistic pendulum used to measure thrust of kinetic energy, can introduce measurement inaccuracies. Most of the contributing factors resulting in these errors are discussed and an improved pendulum design suggested together with advantages and disadvantages of this type of thrustor. The performance and operating characteristics of dc crossed-field plasma accelerators operated at low (0.001 atm) and high (0.1 atm) channel pressures and an ac low-pressure crossed-field plasma accelerator were determined. The measured to ideal thrust ratio and the efficiency for both dc accelerators were about the same. A technique for measuring the ion density in a plasma which was not affected by the presence of a magnetic field or the absence of thermodynamic equilibrium was developed. The technique consisted basically of exciting the ions with a proton beam and relating the measured absolute intensity of certain spectral lines to the ion density. It was found that the technique is well suited to measuring the density of helium ions at pressures less than about 1 mm Hg and temperatures over about 10,000°K.

893

Electro-Optical Systems, Inc., Pasadena, Calif.

PHYSICAL PROPERTY DISTRIBUTIONS IN A LOW-PRESSURE CROSSED-FIELD PLASMA ACCELERATOR, by D. P. Duclos, Y. C. Lin Wu and others. [1965] [7]p. incl. illus. diagrs. refs. (AFOSR-66-0358) (AF 49(638)1063) AD 632183 Unclassified

Also published in AIAA Jour., v. 3: 2026-2032, Nov. 1965.

The physical phenomena that occur in a steady crossed-field accelerator were studied both experimentally and analytically. Experiments were conducted on a

crossed-field accelerator of conventional design employing a single electrode pair and operated with argon at a channel static pressure of about 1-mm Hg and a magnetic field of up to 5000 gauss. Measurements of the current distribution over the anode and cathode surfaces and the potential and electron temperature distributions between the anode and cathode were obtained. An approximate theoretical analysis of the accelerator was developed which accounts for Hall effects, ion slip, viscosity, and elevated electron temperature. From this analysis, the potential current density, and electron and atom temperature distributions were calculated. The calculations agreed reasonably well with the measurements except in the region near the electrode surfaces. As expected, at large values of the Hall parameter, the current distribution was found to be unsuitable for producing a high accelerator efficiency. (Contractor's abstract)

894

Electro-Optical Systems, Inc., Pasadena, Calif.

ON THE ACCLERATION OF SPHERES BY ONE-DIMENSIONAL NON-UNIFORM GAS FLOWS, by D. P. Duclos. [1965] [26]p. incl. diagrs. (Bound with its AFOSR-66-0154; AD 628034) (AF 49(638)1063) Unclassified

The problem of determining the velocity given to a sphere, initially at rest, by the sudden expansion of a one-dimensional non-uniform gas flow, due to aerodynamic drag, is considered. The problem is formulated in terms of the mass of gas which has flowed past the sphere, m. The case of uniform flow, where every element of gas moves with the same velocity but the local density at a point varies arbitrarily, is solved. The velocity of the sphere can also be determined when the gas mass velocity V(m, t) is a monotonically decreasing function of m only. In this case, the gas density must have the form

$$\rho(x,t) = \frac{1}{c+dt}\left[G\ \frac{a+bx}{a+dt}\right]$$

where G is any function and a, b, c, and d are arbitrary constants. The velocity of the sphere, due to the non-uniform expansion of a one-dimensional gas into vacuum, is treated analytically. In this case, the terminal velocity of the sphere can be greater than the average gas velocity. (Contractor's abstract)

895

Electro-Optical Systems, Inc., Pasadena, Calif.

PHYSICAL PHENOMENA IN CROSSED-FIELD PLASMA ACCELERATORS (Abstract), by M. R. Denison, D. P. Duclos, and Y. C. Lin Wu. [1965] [1]p. (Bound with AFOSR-65-1266; AD 622527) (AF 49(638)1063) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

A 20 kw crossed-field accelerator has been operated with both dc and 60 cycle ac current applied to the channel electrodes and magnet. The working fluid was argon at a channel static pressure of from 1 to 9 mm Hg. The thrust increment produced by the accelerator was about 0.4 times the ideal value for both ac and dc modes of operation. The accelerator operated reliably under ac conditions with very little electrode erosion. The time delay due to breakdown phenomena during voltage reversal was negligible, and nearly sinusoidal current resulted. Further diagnostic investigations have been carried out for dc operation. Measurements were obtained of the current distribution over the electrode surfaces as well as the potential and electron temperature distributions between anode and cathode. These measurements were compared with an approximate theory which accounts for Hall effects, ion slip, viscosity and elevated electron temperature. Agreement was reasonably good except in the region near the electrode surfaces. As expected at large values of the Hall parameter, the current distribution was found to be unsuitable for producing a high accelerator efficiency. Experiments are currently in progress to determine the performance and physical property distributions of a 300-kw dc crossed-field accelerator which is operated at a channel static pressure of 0.1 atm with the Hall parameter limited to about unity or less.

Enrico Fermi Inst. for Nuclear Studies, Chicago, Ill. see Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

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[Federation of American Societies for Experimental Biology] Washington, D. C.

1965 CONGRESS, INTERNATIONAL FEDERATION FOR DOCUMENTATION (FID); ABSTRACTS, Washington, D. C., Oct. 10-15, 1965. [1965] 96p. incl. refs. (AFOSR-65-1891) (AF 49(638)1561) AD 625498 Unclassified

The booklet contains abstracts of symposium papers and contributed papers presented at the 1965 Congress. Symposium abstracts are grouped in 5 topic areas: (1) education and training of documentalists, (2) organization of information for documentation, (3) information needs of science and technology, (4) information needs of society, and (5) principles of documentation and systems design. Contributed abstracts are arranged alphabetically by name of the first author. An author index is included.

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Florence U. (Italy).

ASTRONOMICAL ORIENTATION OF CRUSTACEA, by L. Pardi. Scientific rept. June 30, 1965, 6p. (AFOSR-65-2010) (AF EOAR-64-55) AD 627404 Unclassified

Previous studies of the solar and lunar astronomical orientation of animals have indicated that in the period in which the sun or moon culminates in the south, the animals compensate perfectly for the apparent azimuthal clockwise motion of the celestial body. However, the closer the azimuth of the sun or moon approaches the north, the more evident become disturbances to orientation. Observations of a group of specimens subjected to an experimental environment in which the sun culminated in the north showed that after the equinox of September, when the sun had barely begun to culminate in the south, the animals began to demonstrate a perfect orientation. The present work was undertaken to ascertain on what basis do the animals "know" that after the equinox of September the sun begins to culminate in the south, that is, at midday its azimuth is exactly that of the Theoretical Line of Escape (TLE)? Results demonstrated that a population with TLE south, in clockwise phase, compensates perfectly for the apparent clockwise motion, while in a population with TLE north, the compensation is imperfect and disturbed. It seems probable that in the populations precisely subequatorial, the affirmed and valid compensation mechanism differs according to the TLE. Work is continuing to confirm this conclusion.

898

Florida State U. [Dept. of Chemistry] Tallahassee.

FACTORS CONTROLLING PROTEIN SYNTHESIS, by J. R. Fisher. Final rept. May 25, 1965, 4p. (AFOSR-65-1198) (AF AFOSR-63-233) AD 620235 Unclassified

The purpose of this investigation is to understand the mechanism by which enzyme synthesis is controlled in developing systems. Efforts were made to confirm the RNA induction of enzymes in Ehrlich ascites cells (Niu, Cordova, Niu and Radbill, 1962). Attempts to develop a system of measuring the biological activity of RNA in this respect were unsuccessful. Studies were conducted on xanthine dehydrogenase in developing chick-embryo liver. It was concluded that the appearance of this enzyme is under hormonal control. Injections of prolactin, growth hormone, luteinizing hormone, follicle-stimulating hormone and thyroid-stimulating hormone, individually, or as a mixture, did not give stimulation of activity. It is further concluded that either there is a new factor in the crude extract, or that a proper balance of 2 or more hormones is required. Similar studies were also conducted on mouse Ehrlich ascites cancer cells. First, crude anterior pituitary extract produced an increase in specific activity from 2- to 5-fold. Injections of the same hormones, either individually or in a mixture approximating pituitary tissue, caused a 2- to 7-fold increase in xanthine oxidase activity with only one injection 24 hr before harvest of ascites cells, and a 9-fold increase after a series of three injections.

899

Florida State U. [Dept. of Physics] Tallahassee.

LEVEL STRUCTURE OF THE ODD-A ISOTOPES OF SAMARIUM, by R. A. Kenefick and R. K. Sheline. [1965] [21]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-423, and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 139: B1479-B1499, Sept. 20, 1965.

The levels of Sm^{145}, Sm^{149}, Sm^{151}, Sm^{153}, and Sm^{155} have been studied with 0.1% resolution by the (d,p) reaction at 12-mev incident energy. Levels in Sm^{147} have been observed by (p,p') reactions at 12 mev. A large number of previously unknown levels have been observed at excitation energies up to 4 mev. The ground state for Sm^{155} is assigned as the $\frac{3}{2}^-$(521) orbital. The previously unobserved (11/2)$^-$ (505) orbital, whose depopulation is hypothesized to cause the sudden onset of deformation at N = 90, has been tentatively assigned at 65 kev in Sm^{153}. The ground-state Q values observed in the experiments are: $Sm^{144}(d,p)Sm^{145}$, Q +4.533 ± 0.012 mev; $Sm^{148}(d,p)Sm^{149}$, Q = +3.648 ± 0.012 mev, $Sm^{150}(d,p)Sm^{151}$, Q = +3.369 ± 0.016 mev; $Sm^{152}(d,p)Sm^{153}$, Q = +3.645 ± 0.012 mev; $Sm^{154}(d,p)Sm^{155}$, Q = +3.584 ± 0.012 mev.

900

Florida State U Dept. of Physics, Tallahassee.

THEORY OF ISOBARIC-SPIN ANALOGUE RESONANCES, by D. Robson. [1965] [12]p. incl. diagrs. refs. (AFOSR-66-0968) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-440 and Office of Naval Research) AD 635351 Unclassified

Also published in Phys. Rev., v. 137: B535-B546, Feb. 1965.

A theory of isobaric-spin analogue resonances is developed by considering a potential model which has an isobaric-spin-dependent component. The occurrence of isobaric states as compound-nucleus resonances is shown to be a natural consequence of the formalism previously used to explain the excitation of isobaric analogue states by the direct-interaction charge-exchange mechanism. The results are then generalized on the basis of the R-matrix theory of nuclear reactions because of the expectation that isobaric spin is relatively pure within a sphere of dimensions similar to those of the charge distribution. The interpretation of analogue resonances as giant resonances is considered and shown to be different from the conventional optical giant resonances. Formulas are derived which are mainly applicable to the elastic scattering of protons below the Coulomb barrier. The importance of the external and internal regions with respect to the isobaric-spin mixing is investigated for the case of $Mo^{92}(p,p)Mo^{92}$, and results are obtained which verify the importance of external mixing for this nucleus. Various limitations of the theory are discussed and further developments are indicated. (Contractor's abstract)

901

Florida State U. Dept. of Physics, Tallahassee.

ENERGY LEVELS IN HO^{166}, by G. L. Struble, J. Kern, and R. K. Sheline. [1965] [13]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-440, Atomic Energy Commission, and Nuclear Program of the State of Florida) Unclassified

Published in Phys. Rev., v. 137: B772-B784, Feb. 22, 1965.

The energy levels in Ho^{166} are studied by means of (d, p) reaction spectroscopy and a Q value of 4025 ± 7 kev is obtained for the ground state. A rotational model is used to interpret the energies and generate state vectors for the experimental levels. Using these vectors and the distorted-wave Born approximation, a theoretical (d, p) spectrum is constructed and compared with the experimental data. (Contractor's abstract)

902

Florida State U. Dept. of Physics, Tallahassee.

REACTIONS INVOLVING SIMPLE ISOBARIC ANALOGUE RESONANCES, by D. Robson, J. D. Fox and others. [1965] [3]p. incl. diagrs. (AFOSR-66-0105) (AF AFOSR-65-440) AD 630240 Unclassified

Also published in Phys. Ltrs., v. 18: 86-88, Aug. 1965.

Quantitative applications of the theory of isobaric analogue resonances to a specific class of resonances are reported. It is shown that theoretical treatments which do not take into account the effects of "boundary condition" or external isobaric spin mixing are not in agreement with the experiments performed.

903

[Florida State U. Dept. of Physics, Tallahassee]

ANALYSIS OF SINGLE EXCITATIONS IN INELASTIC DEUTERON SCATTERING FROM Ni^{60}, Zr^{92}, AND Sn^{120} NUCLEI, by R. K. Jolly. [1965] [13]p. incl. diagrs. tables, refs. (AFOSR-66-0486) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-440, National Science Foundation, and Office of Naval Research) AD 630241 Unclassified

Also published in Phys. Rev., v. 139: B318-B330, July 1965.

Inelastic scattering of 15-mev deuterons from Ni^{60}, Zr^{92}, and Sn^{120} nuclei was studied with adequate resolution to enable identification of almost all states of known spin and parity. Detailed angular distributions of deuteron groups corresponding to well-resolved states of these nuclei was measured and compared with distorted-wave Born approximation calculations for single excitations using a deformed optical-model potential. The theoretical predictions, including Coulomb excitation and for a complex coupling, are found to be quite successful for strongly excited states. The status of the Blair phase rule is discussed in the context of the aforesaid comparison. Spin and parity assignments are made for several new levels. Excitation energies, differential cross sections, and reduced transition probabilities were tabulated and compared with previously known values. (Contractor's abstract)

904

Florida State U. Dept. of Physics, Tallahassee.

INTERMEDIATE STRUCTURE AND CHANNEL COUPLING THEORY, by M. E. Haglund and D. Robson. [1965] 3p. incl. diagrs. refs. (AFOSR-66-0973) (AF AFOSR-65-440) AD 635366 Unclassified

Also published in Phys. Ltrs., v. 14: 225-227, Feb. 1965.

A new approach to the investigation of intermediate structure phenomenon is proposed. The conventional shell model with harmonic oscillator functions is not appropriate for describing intermediate structure because the physical boundary conditions involved are ignored, i.e., cross sections are not predicted. The present approach uses the language of R-matrix theory and so involves a complete set of discrete 'compound nucleus' states which are independent of physical boundary conditions. The quantities involved are derived from the dynamics of the situation using the familiar techniques of the shell model, i.e., a set of basis functions is found using a simple potential and the matrix involving 'residual interactions' diagonalized to yield the exact R-matrix. Cross sections are obtained using the usual relation between the collision matrix and the R-matrix by the approximate matrix inversion.

905

Florida State U. Dept. of Physics, Tallahassee.

ENERGY FOR SURFACE MOBILITY OF THIN, DISCONTINUOUS GOLD FILMS ON MICA SUBSTRATES, by J. G. Skofronick and W. B. Phillips. Nov. 1965, 2p. incl. diagrs. (AFOSR-66-0975) (AF AFOSR-65-440) AD 635365 Unclassified

Also published in Appl. Phys. Ltrs., v. 7: 249-250, Nov. 1965.

Electron microscopy studies have previously shown that very thin metallic films formed by evaporation are not continuous but consist of an island-like structure upon the substrate. Measurements of the time and temperature dependence of the resistance of discontinuous gold films prepared in vacua on mica substrates were made. Analysis of the data in terms of a dynamic island model indicates that the observed changing resistance of the film is a very sensitive function of the gaps between the islands and the temperature of the substrate and, to a lesser extent, the size of the islands. The model used for the analysis of these data satisfactorily represents the strong systematic dependence of resistance on temperature and time and establishes a value for an activation energy which is interpreted as a threshold for surface mobility of the islands.

906

Florida State U. [Dept. of Physics] Tallahassee.

Ca^{42}(p, n) REACTION THRESHOLD (Abstract), by H. S. Plendl and J. W. Nelson. [1965] [1]p. [AF AFOSR-65-440] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 479, Apr. 26, 1965.

The Ca^{42}(p, n) threshold was determined by bombarding thick, pressed $Ca^{42}CO_3$ targets with protons from the FSU tandem accelerator and observing the β^+ activity from the superallowed Sc^{42}GS decay as a function of proton energy. The threshold energy, 7394 ± 10 kev, corresponds to a Q value of 7208 ± 10 kev and to a Sc^{42} mass excess in close agreement with the mass excess obtained from the β^+ end-point energy measurement and from the most recent $Ca^{40}(He^3, p_0)$ Q-value determination. The discrepancy between (p, n) and (α, n) threshold results is of the same magnitude as observed previously for Cl^{35}(p, n)Ar^{35} and S^{32}(α, n) Ar^{35}. Probable reasons for this effect are discussed.

907

Florida State U. [Dept. of Physics] Tallahassee.

DEPENDENCE OF RESISTANCE ON TIME AND TEMPERATURE FOR VERY THIN GOLD FILMS ON MICA (Abstract), by W. B. Phillips, J. G. Skofronick and others. [1965] [1]p. [AF AFOSR-65-440] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 127, Jan. 1965.

The resistance of very thin gold films deposited on baked, cleaved-mica substrates and maintained under high vacuum has been measured as a function of time and temperature. An increase of film resistance by a factor as great as 1000 has been observed in 1000 min after deposition on a substrate kept at room temperature. This effect is independent of applied electric field. At liquid-nitrogen temperature, the time dependence vanishes. Upon warming a film deposited at this temperature, two distinct regions are noted: an initial (reversible with temperature) decrease of resistance followed by a sharp (irreversible with temperature) increase of resistance over several orders of magnitude. The negative temperature coefficient of resistance of the first region is probably due to an increase in the number of conduction electrons in the tail of the Fermi distribution. The second region (above 160°K) may be explained by assuming that the films consist of small "islands" that may move about on the substrate and coalesce with near neighbors, increasing the average distance between islands. This island mobility is strongly temperature-dependent. Calculations based upon this model explain qualitatively the observed increase of resistance with time.

908

Florida State U. [Dept. of Physics] Tallahassee.

ELECTRON-TRANSPORT MECHANISMS IN VERY THIN, DISCONTINUOUS GOLD FILMS (Abstract), by J. G. Skofronick, W. B. Phillips and others. [1965] [1]p. [AF AFOSR-65-440] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 364, Mar. 24, 1965.

The conductance of very thin, discontinuous gold films prepared in vacua on mica substrates has been measured as a function of temperature and applied electric field. A thermal-activation process reversible below a characteristic temperature, an ohmic region for small applied fields, and an exponential dependence linear with (applied field)$^{\frac{1}{2}}$ for larger fields are observed. An island-gap-island configuration is assumed for the film, and conductance properties are calculated using an approach similar to that of Simmons. If tunneling is assumed in the calculation, the predicted activation does not agree with experiment. If the calculation for tunneling considers only charges passing from one excited level to another, the activation process agrees with experiment but the log conductance vs (applied field)$^{\frac{1}{2}}$ have minima that are not observed experimentally. For conductance

curves calculated by assuming thermionic emission, there is good qualitative agreement with the data; however, the barrier heights over which the charges move appear to be anomalously small considering the bulk properties of gold. This is partially explained by the image effects that are included in the calculation. A typical experimentally determined barrier height is 0.0404 ev.

909

Florida State U. [Dept. of Physics] Tallahassee.

LOW-LYING ENERGY LEVELS IN ODD-A SCANDIUM ISOTOPES (Abstract), by H. S. Plendl, L. J. Defelice, and R. K. Sheline. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-440] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., Columbia U., New York, June 23-25, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 610, June 23, 1965.

The reactions $Ti^{46}(p,\alpha)Sc^{43}$, $Ti^{48}(p,\alpha)Sc^{45}$, $Ti^{50}(p,\alpha)Sc^{47}$ were initiated with 9- to 10-mev protons from the FSU tandem accelerator on enriched and natural targets. Reaction products were analyzed at several angles with a Browne-Buechner spectrograph to determine Q values, excitation energies (up to 1550 kev), and absolute cross sections in preparation for complete angular distribution measurements. The Q_{gs} values were found to agree with values calculated from masses to within the experimental error of ± 20 kev. Excitation energies in Sc^{43}, Sc^{45}, and Sc^{47} were determined to within ± 5 kev. Most of the levels reported in previous work were observed; several were resolved into 2 or 3 levels. In particular, the excitation energies of the $d3/2^+$ states were found to be 153 ± 5 kev for Sc^{43}, 12 ± 5 kev for Sc^{45}, 772 ± 5 kev for Sc^{47}, in agreement with concurrent work at Argonne. The results are compared with theoretical predictions.

910

Florida State U. [Dept. of Physics] Tallahassee.

SCATTERING OF α PARTICLES BY Ca^{40} (Abstract), by C. P. Robinson, J. S. O'Neall and others. [1965] [1]p. [AF AFOSR-65-440] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 539, Apr. 26, 1965.

Angular distributions of elastically scattered α particles by Ca^{40} have been measured at α-particle energies 7.0, 8.0, 10.0, and 15.0 mev. Deviations from Rutherford scattering appear at all energies. Optical-model fits to the angular distribution data are in good agreement at forward angles. Modification of the theory is required to fit the back-angle scattering data. In addition to narrow anomalies (approximately 100 kev wide), measured excitation curves show broad structure after the narrow anomalies are averaged out. Excitation-curve data are discussed in terms of a coupling between single α-particle resonances and more-complicated modes of excitation.

911

Florida State U. [Dept. of Physics] Tallahassee.

SCATTERING OF α PARTICLES BY Mg^{24} (Abstract), by S. S. So, C. Mayer-Boricke and others. [1965] [1]p. [AF AFOSR-65-440] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 539, Apr. 26, 1965.

Excitation curves and angular distributions of α particles elastically scattered by Mg^{24} have been measured in the bombarding energy range 4-19 mev. Many anomalies appear in the excitation curves with fluctuation correlation widths of 80 kev (experimental width) and approximately 400 kev. In the bombarding energy region 12.3-14 mev, 7 detailed angular distributions were measured and fitted with the nuclear optical model. Satisfactory agreement was found for real well depths of 110 mev with a volume imaginary parameter of 5 mev.

912

Florida State U. Inst. of Molecular Biophysics. Tallahassee.

THE ROLE OF LIGHT IN EVOLUTION: THE TRANSITION FROM A ONE QUANTUM TO A TWO QUANTA MECHANISM, by H. Gaffron. [1965] [24]p. incl. diagrs. table, refs. (AFOSR-65-1287) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-190, Atomic Energy Commission, and Office of Naval Research) AD 621465 Unclassified

Also published in The Origins of Prebiological Systems and of their Molecular Matrices, New York, Academic Press, Inc., 1965, p. 437-440

The importance of light's role in evolution is investigated. It is hypothesized that the porphyrin pigments antedated the earliest living cell and that the anaerobic process, photoreduction, preceded and evolved into photosynthesis. The main problem in this evolutionary step was the photolysis of water. It is known that it is impossible to separate H from OH irreversibly and to release them as hydrogen and oxygen with the energy of only one red light quantum. Therefore it is suggested and evidence is presented to show that the main evolutionary step from an anaerobic process to an aerobic process was the transition from a one quantum to a two quanta mechanism.

913

Florida State U. Inst. of Molecular Biophysics, Tallahassee.

RESEARCH IN PHOTOBIOLOGY AND PHOTOCHEMISTRY, by H. Gaffron and P. Homann. Final rept. May 1, 1964-Apr. 30, 1965. May 27, 1965, 4p. incl. refs. (AFOSR-65-1167) (AF AFOSR-64-662) AD 620240 Unclassified

Work on the specificity of manganese catalysis during the oxidation of ascorbate or of diketogulonate respectively to oxalic acid and threonate has been concluded. The selective catalysis by manganese is not restricted to oxidations sensitized by illuminated flavin, and other dyes, but appears in several types of variously induced autoxidations. The essence is an autocatalytic chain reaction driven by an electron transport system in which the most active role is given to an oscillation between Mn^{3+} and Mn^{2+} ions, often in complex bindings. The same hypothetical mechanism seems to fit all cases studied with the exception of photoxidation induced by fresh chloroplasts, where the conditions appear to be even more complicated. The explanation given earlier for the paradoxical rate enhancement produced by the herbicide DCMU (N-3, 4-dichlorophenyl-N', N'-dimethyl urea) in the flavin sensitized oxidation of diketogulonate appears to hold also in the context of the new much extended observations on the action of manganese. (Contractor's abstract)

914

Florida State U. Inst. of Molecular Biophysics, Tallahassee.

SPECIFIC ACTION OF Mn^{++} IN PHOTOCHEMICAL, ENZYMATIC AND NON-ENZYMATIC REACTIONS (Abstract), by P. Homann. [1965] [1]p. (AFOSR-65-1585) (AF AFOSR-64-662) Unclassified

Presented at Federation of Amer. Soc. of Experimental Biologists Meeting, Atlantic City, N. J., Apr. 9-14, 1965.

Also published in Federation Proc., v. 24. 609, Mar.-Apr. 1935.

Manganese is an essential cofactor of photosynthesis. Manganous ions serve as specific mediators in the reaction between molecular oxygen and a photosensitizer-substrate couple. With 2, 3-diketogulonate as oxidizable substrate, it was found that the specific action of Mn^{++} is also displayed in dark oxidations, when, in place of light, an enzyme, a complex with catalytic activity, or just trivalent manganese serve as oxidation inducing species. Mn^{++} could not be replaced by any other metal as catalyst, and Cu^{++} was found to be highly inhibitory in all systems. Vanadyl sulfate induces an oxidation of diketogulonate, but its action differs from that of Mn^{++}. In view of the unknown role of Mn^{++} for oxygen evolution in plants, manganese is discussed as a catalyst on the basis of a 1-electron carrier mechanism for peroxidase mediated oxidations. Theoretically the peroxy anion O_2^- should be oxidized by free Mn^{++} to oxygen, but O_2^- apparently oxidizes Mn^{++}. This hypothesis might explain the catalytic action of the Mn^{++}/Mn^{+++} couple in any manganese catalyzed oxidation of diketogulonate. (Contractor's abstract)

915

Florida State U. Inst. of Molecular Biophysics, Tallahassee.

MANGANESE-CATALYZED OXIDATIONS OF 2, 3-DIKETOGULONATE, by P. H. Homann. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-2859) (AF AFOSR-64-662) AD 629845 Unclassified

Also published in Biochemistry, v. 4: 1902-1911, Sept. 1965.

Autoxidations of 2, 3-diketogulonate can be induced by light and a sensitizing dye or by chemical means in the dark provided manganous ions are present in the reaction mixture. 3-(p-Chlorophenyl)-1, 1-dimethylurea specifically stimulates the flavin-sensitized photoreaction, whereas the product formed from 3-(p-chlorophenyl)-1, 1-dimethylurea by a flavin-sensitized photooxidation usually acts as an inhibitor. The action of manganese as a catalyst is discussed on the basis of the mechanism of manganese catalysis in certain peroxidase oxidase reactions as proposed by I. Yamazaki and L. H. Piette (Biochim. et Biophys. Acta, v. 77, 47, 1963). Trivalent manganese appears to be an essential intermediate chain carrier in all oxidations of 2, 3-diketogulonate studied. The surprising specificity of the Mn (II)-Mn(III) couple to catalyze the oxidations of 2, 3-diketogulonate is very probably a result of its oxidation-reduction potential, which allows the oxidation of Mn(II) by O_2^- radicals to supplant chain-breaking removals of O_2^-. A chelation of 2, 3-diketogulonate may enable Mn(III) to accomplish efficiently a splitting of the 2, 3-diketogulonate molecule by attracting an electron. (Contractor's abstract)

916

Florida State U. Inst. of Molecular Biophysics, Tallahassee.

PHOTOSYNTHESIS, by H. Gaffron. 1965, 36p. incl. diagrs. (Biological Sciences Curriculum Study pamphlet no. 24) (AFOSR-65-2976) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-662, Atomic Energy Commission, National Science Foundation, Office of Naval Research, and Samuel S. Fels Fund) AD 627950 Unclassified

Photosynthesis, the reaction in which light is used in green plants to recombine water and carbon dioxide into digestible food, has been studied for almost 200 yr. During the past 40 yr, diligent research by scientists the world over has answered many questions and posed many others. The author reviews our fundamental knowledge of photosynthesis and describes some of the most recent advances. Finally he gives examples of problems that must be solved before we will have a complete understanding of this complex process. (Contractor's abstract)

917

Florida U. Dept. of Physics, Gainesville.

ANGULAR AND ENERGETIC STUDIES OF REACTIVE ION-NEUTRAL COLLISIONS (Abstract), by T. L. Bailey, R. L. Champion and others. [1965] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-471] and National Aeronautics and Space Administration) Unclassified

Published in Fourth Internat'l. Conf. on Physics of Electronic and Atomic Collisions: Abstracts of Papers, Laval U., Quebec (Canada) (Aug. 2-6, 1965), New York, Science Bookcrafters, Inc., [1965] p. 237-238.

An apparatus has been constructed for the study of the energetics, and product-ion angular distributions, of ion-molecule reactions and other reactive ion-neutral collisions. The essential parts of this apparatus are an ion gun, which produces a mass- and velocity-selected ion beam; a collision region, containing scattering gas at low density; and a product-ion analyzer and detector system. The apparatus can also be used for the measurement of differential elastic and inelastic scattering cross sections, and for charge-transfer studies at very low energies. Initial studies have been concerned with collisions of Ar^+ and Ar^{++} ions with D_2 molecules. (Contractor's abstract, modified)

918

Florida U. Dept. of Physics, Gainesville.

ON THE DEGENERACY OF THE TWO-DIMENSIONAL HARMONIC OSCILLATOR, by V. A. Dulock and H. V. McIntosh. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-1119) (AF AFOSR-64-471) AD 620486 Unclassified

Also published in Amer. Jour. Phys., v. 33: 109-118, Feb. 1965.

A further study of the degeneracy of the 2-dimensional harmonic oscillator is made, both in the isotropic and anisotropic cases. By regarding the Hamiltonian as a linear operator acting through the Poisson bracket on functions of the coordinates and momenta, it is shown how all possible rational constants of the motion may be generated. Canonical coordinates, which may be visualized geometrically for the isotropic oscillator in terms of the Hopf mapping, place the symmetry group responsible for the accidental degeneracy clearly in evidence. Surprisingly, one finds that the unitary unimodular group SU_3 is the symmetry group in all cases, even including that of an amsotropic oscillator with incommensurable frequencies. The lack of a quantum-mechanical analogy in the latter case is due to a lack of the necessary transcendental roots of the operators involved in attempting to use the correspondence principle, rather than to the lack of a symmetry group for the classical problem.

919

Florida U. Dept. of Psychology, Gainesville.

AN ELECTROENCEPHALOGRAPHIC STUDY OF THE EFFECTS OF MEPROBAMATE ON HUMAN SLEEP, by F. R. Freeman, H. W. Agnew and others. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-65-2680) (AF AFOSR-62-13) AD 629563 Unclassified

Also published in Clin. Pharmacol. and Therapeut., v. 6: 172-176, Mar.-Apr. 1965.

The effect of meprobamate on human sleep and dreaming was assessed in a double-blind, placebo-controlled study by means of all-night electroencephalography. On nights when meprobamate was ingested in a dose of 400mg at 9:00 p. m. and 800mg at 12:00 a. m., normal subjects spent significantly less time in sleep accompanied by low-voltage fast EEG than when receiving placebo. The time spent in rapid eye movement periods, which are related to visual dreaming, was decreased by meprobamate. This study shows that meprobamate characteristically alters the amount of time spent in each sleep stage and significantly decreases inferred visual dreaming. Comparisons are made between the changes in the human electroencephalogram during sleep produced by meprobamate and those produced by the barbiturates. (Contractor's abstract)

920

Florida U. [Dept. of Psychology] Gainesville.

THE SLEEP OF DEPRESSED PATIENTS, by S. C. Gresham, H. W. Agnew, and R. L. Williams. [1965] [5]p. incl. diagrs. tables. (AFOSR-66-1169) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-395 and National Institutes of Health) AD 641525 Unclassified

Also published in Arch. Gen. Psychat., v. 13: 503-507, Dec. 1965.

Eight depressed psychiatric inpatients were selected on the basis of six objective tests for this study. They were closely matched with normal controls. Both patients and controls were studied for four consecutive nights of sleep during which time the EEG and EOG were recorded. The patients obtained more wakefulness, less Stage 4 sleep, and showed a slightly longer sleep latency than the controls. Four patients studied again at discharge showed a decrease in all differences from the control values.

921

Florida U. Dept. of Psychology, Gainesville.

SLEEP: EFFECTS OF A RESTRICTED REGIME, by H. W. Agnew and W. B. Webb. [1965] [3]p. incl. table, refs. (AFOSR-66-1149) (AF AFOSR-65-395) AD 641057 Unclassified

Also published in Science, v. 150: 1745-1747, Dec. 1965.

Eight young male subjects were permitted to sleep only 3 hr out of each 24 for 8 days. Electroencephalographic recordings were made during each sleep period. During the restricted sleep subjects did not minaturize their sleep but rather they continued to show a sleep pattern consistent with the first 3 hr of normal nighttime sleep. There was an increase in Stage IV sleep during the restricted period. On a recovery night the first 6 hr of sleep also showed a significant increase in deep sleep.

922

Florida U. Engineering and Industrial Experiment Station, Gainesville.

DIGITAL SIMULATION OF RANDOM VIBRATIONS, by D. J. Belz. June 1965 [62]p. incl. diagrs. tables. (AFOSR-65-0608) (AF AFOSR-64-675) AD 469187 Unclassified

A physically realizable stationary, Gaussian, random load is simulated digitally and employed as the forcing function in the equation of motion of a damped, elastic beam whose resistance to deformation is due to bending and stretching. The power residue method for generating pseudo-random numbers is employed for constructing the random functions, whose statistical properties correspond closely to those of pressure signals measured in the noise field of a turbulent, supersonic air jet. The nonlinear equation of motion is solved in finite-difference form with a forcing function representing a time-random concentrated load applied transversely at midspan. From numerical solutions, statistical measures of response at midspan and at the quarter points of the beam are computed. Response autocorrelation functions, power spectra, and probability density functions are obtained for a range of load mean-square values. The technique used in this paper can in principle be applied to more complicated structural components and random-load configurations. (Contractor's abstract)

923

Fordham U. Dept. of Chemistry, New York.

THE DIMETHYL SULFOXIDE OXIDATION OF 2,3-BIS(BROMOMETHYL)QUINOXALINE, by E. J. Moriconi and A. J. Fritsen. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-1452) [AF AFOSR-62-18] AD 622637 Unclassified

Also published in Jour. Org. Chem., v. 30 1542-1547, May 1965.

The reaction of 2,3-bis(bromomethyl)quinoxaline with dimethyl sulfoxide produced in varying amounts 3-methyl-, 3-bromomethyl-, and 3-dibromomethyl-2-quinoxalinecarboxaldehyde, in addition to 2,3-bis(dibromomethyl)quinoxaline, and 2,3-quinoxalinedicarboxaldehyde isolated as the intramolecular hemihydrate. The Hunsberger and Tien general mechanism of dimethyl sulfoxide oxidation can account for the formation of all these products. A similar oxidation of 2,3-bis(iodomethyl)quinoxaline led to 2- and 3-iodomethyl-2-quinoxalinecarboxaldehyde. In the presence of 1,2-epoxy-3-phenoxypropane, dimethyl sulfoxide oxidation of 2,3-bis(bromomethyl)- and 2,3-bis(iodomethyl)quinoxalines led to compounds tentatively identified as dl-1,2-dibromo- and dl-1,2-diiodo-1,2-bis(3-methyl-2-quinoxalyl)ethane; both were dehalogenated to trans-1,2-bis(3-methyl-2-quinoxalyl)ethylene whose structure was determined by independent synthesis and degradation. Bromination of the latter product yielded meso-1,2-dibromo-1,2-bis(3-methyl-2-quinoxalyl)ethane. Dimethyl sulfoxide oxidation of dl-1,2-dibromo-, dl-1,2-diiodo-, and meso-1,2-dibromo-1,2-bis(3-methyl-2-quinoxalyl)ethane led to the same product, bis(3-methyl-2-quinoxalyl)glyoxal. A number of 6- and 6,7-substituted quinoxaline derivatives are also reported.

924

[Franklin Inst.] Bartol Research Foundation [Swarthmore, Pa.]

ANGULAR DISTRIBUTION OF γ-RAYS ARISING FROM $Ge^{70,72}(p,p'\gamma)$ REACTIONS (Abstract), by R. K. Mohindra and D. M. Van Patter. [1965] [1]p. [AF AFOSR-63-401] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 36, Jan. 27, 1965.

To study $(p,p'\gamma)$ radiations, enriched targets of $Ge^{70,72}$ each 3 mgm/cm^2 thick have been bombarded with 5 to 7 mev protons from the University of Pennsylvania tandem accelerator. Transitions from most of the known levels up to 4-mev excitation have been observed in Ge^{70}. Spectra from Ge^{72} become quite complex above E_p 6 mev because of its low (p,n) threshold. The angular distributions of γ-rays of 0.67, 1.04, 1.12, 1.26, 1.51, 1.71, 2.16 mev in Ge^{70} and of 0.63, 0.835, 1.04, 1.20, 1.465, 1.71 mev in Ge^{72} have been studied. The angular distributions show little change with bombarding energy, except for cascade feeding. It has been possible to find the mixing ratios δ for $2_2^+ \rightarrow 2_1^+$ transitions in $Ge^{70,72}$ from the ratio of A_2 coefficients for the cascade and crossover transitions. This ratio should be independent of statistical averaging and cascade feeding, and provides a good method for determining δ in such cases. For Ge^{70}, $\delta = +(5_{-1.5}{}^{+4})$ and for Ge^{72}, $\delta = -(5_{-2}{}^{+10})$ – (the sign of δ is reversed). An earlier radioactivity measurement agrees with our present value of δ for Ge^{72}.

925

Free U. of Brussels (Belgium).

ON THE RELAXATION EFFECT IN THE LIMITING CONDUCTANCE OF ELECTROLYTES, by P. Résibois and N. Hasselle-Schuermans. [1965] [11]p. incl. diagrs. refs. [AF EOAR-62-16] Unclassified

Published in Jour. Chem. Phys., v. 43: 1016-1026, Aug. 1, 1965.

The theory of the relaxation effect in electrolytes is improved by taking into account the interaction of the

solvent with the ions. This is made possible if it is assumed that the ions have a large mass (M) with respect to the solvent molecules (m), in which case the recent developments of the microscopic theory of Brownian motion may be used. It is shown that the results of the classical theory of Onsager-Debye-Falkenhagen are recovered provided that the following conditions are satisfied: $(m/M) \ll 1$, $(e^2C^{\frac{1}{3}}/D_0kT) \ll 1$, in such a way that $(e^2/D_0) \ll \zeta^2/M$ where ζ is the friction coefficient of the fluid. The connection between the various statistical-mechanical approaches which have been recently proposed is also discussed. (Contractor's abstract, modified)

926

Free U. of Brussels (Belgium).

STATISTICAL MECHANICS OF FERROMAGNETISM, by R. Brout. [1965] [61]p. incl. refs. (AFOSR-65-2169) (AF EOAR-63-51) AD 629504 Unclassified

Also published in Magnetism, ed. by G. T. Rado and H. Suhl. Academic Press, New York and London, v. 2A: 43-103, 1965.

A correlation and a compromise between ferromagnetism and the general theory of phase transitions is presented. The principal aim was to extract out of the formalism of statistical mechanics the main qualitative aspects of ferromagnetism as well as semiquantitative estimates of quantities of interest. Topics discussed include the Ising model, Heisenberg model, band theory of ferromagnetism, and random spin systems.

927

Free U. of Brussels (Belgium).

REMARK ON THE HYDROXYL ION SYSTEM IN ALKALI HALIDES, by R. Brout. [1965] [2]p. (AFOSR-65-2820) (AF EOAR-63-51) AD 629240 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 175-176, Feb. 1965.

The dielectric constant of the hydroxyl ion is interpreted in terms of a random antiferroelectric array.

928

Free U. of Brussels (Belgium).

PHASE TRANSITIONS IN MATTER, by R. Brout. [1964] [9]p. incl. diagrs. (AFOSR-65-2951) (AF EOAR-63-51) AD 629237 Unclassified

Also published in Statistical Mechanics of Equilibrium and Non-equilibrium, Proc. Internat'l. Symposium on Statistical Mechanics and Thermodynamics, Aachen (Germany) (June 15-20, 1964), ed. by J. Meixner. Amsterdam, North-Holland Publishing Co., p. 253-261.

This work presents an approach to the theory of condensation which leans heavily on the original ideas of van der Waals and Weiss. The underlying idea is to improve the mean molecular field approximation of van der Waals and Weiss by correcting it for hard cores and, in the solid, for the periodicity of the lattice.

929

Free U. of Brussels (Belgium).

NEUROPHYSIOLOGIC CORRELATES OF SENSORY PERCEPTION, by J. E. Desmedt. Final rept. Feb. 1, 1964-Jan. 31, 1965. Feb. 28, 1965, 5p. (AFOSR-65-0874) (AF EOAR-64-43) AD 617796 Unclassified

The functional capabilities and mode of operation of several parts of the feedback neural circuit related to acoustic sensory processing were investigated in acute experiments carried out chiefly in cats and pigeons. The limited potency of efferent gating of acoustic input in pigeon has been confirmed and substantiated. Functional differences between the systems of cats and pigeons were related to the peculiar features of the fine structural organization of the corresponding synapses in the inner ear. Electrical signs of activity in the efferent olivo-cochlear system were obtained in the congenital deaf albino cat. The effect of hypothermia on the operation of the feedback system was analyzed in the cat and a temperature coefficient was determined for the dissipation kinetics. Neuropharmacological studies were also carried out. It was found that the alcaloid coniine antagonizes the efferent inhibitory process but in a way unlike that of the alcaloid strychnine. Somatosensory and acoustic evoked potentials were recorded from the scalp in normal man with a Mnemotron digital computer, and their features were correlated with psychophysical data obtained for the same stimuli, with particular reference to the signal detection capabilities of the human operator. (Contractor's abstract)

930

Free U. of Brussels (Belgium).

FUNCTIONAL PROPERTIES OF THE EFFERENT COCHLEAR BUNDLE OF THE PIGEON REVEALED BY STEREOTAXIC STIMULATION, by J. E. Desmedt and P. J. Delwaide. [1965] 26p. incl. illus. diagrs. refs. (AFOSR-65-2527) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-43 and National Institutes of Health) AD 629095 Unclassified

Also published in Exper. Neurol., v. 11: 1-26, Jan. 1965.

The function of the efferent cochlear bundle (ECB) has been studied in over a hundred pigeons with the spinal cord transected at C2-C3, local anesthesia and muscle paralysis. The excellent biological status of the animals was carefully assessed throughout the experiments, which

frequently lasted several hours. Electrical responses evoked by click or tone pip were picked up chiefly at the exposed round-window membrane. Bipolar needles were inserted stereotaxically into the brain stem with the ECB as target (histological controls). Repetitive electrical stimulation of the ECB before delivery of the testing sound potentiates markedly the cochlear microphonic receptor potential of the hair cells and inhibits simultaneously the auditory nerve response. This dual effect results in a reduction of acoustic input to the brain. These and other observations suggest that the ECB of the bird is homologous functionally to the olivocochlear bundle of mammals. Important quantitative differences have nevertheless, been found. The potency of the efferent inhibition is much smaller in the pigeon than it is in the cat, which raises the question of its behavioral significance in the former species. The potentiation of the cochlear microphonic component is relatively more prominent in the pigeon and it dissipates more slowly than the simultaneously recorded inhibition of the neurals. Such different kinetics might be related to the peculiar synaptic organization of the bird's inner ear. (Contractor's abstract)

931

Free U. of Brussels (Belgium).

GENERAL EQUATIONS OF EVOLUTION AND KINETIC EQUATIONS FOR NON-UNIFORM SYSTEMS, by G. Severne. [1965] [31]p. incl. diagrs. refs. (AFOSR-66-0392) [AF EOAR-64-52] AD 630141 Unclassified

Also published in Physica, v. 31: 877-907, June 1965.

The methods developed by Prigogine and coworkers are used to establish a rigorous statistical mechanical theory for non-uniform classical systems. The general equations of evolution for the singlet distribution and for the s-body correlation functions are derived, and for the former, an equivalent master equation is written. For large systems these equations are essentially exact: they are non-Markoffian in form and introduce a delocalization in space as well as a displacement in time. The corresponding long time kinetic forms are obtained. In a lowest order approximation, the asymptotic master equation is shown to reduce to the Boltzmann equation, and generalized kinetic equations can immediately be obtained. The resulting formulation of linear transport theory is briefly discussed.

932

Free U. of Brussels (Belgium).

RELATIVISTIC EFFECTS IN STATISTICAL HYDRODYNAMICS, by Ph. De Gottal and I. Prigogine. [1965] [11]p. incl. diagrs. refs. (AFOSR-66-0393) [AF EOAR-64-52] AD 629690 Unclassified

Also published in Physica, v. 31: 677-687, May 1965.

A classical relativistic electron gas and the effect of the particle interaction on the macroscopic behavior of the system are studied. It is shown that due to the non-validity of the principle of action and reaction the field surrounding the particles acts as a reservoir of impulsion and energy for the matter; new kinds of motion are permitted due to a source term appearing in the equation of hydrodynamics. (Contractor's abstract)

933

Free U. of Brussels (Belgium).

[MODIFICATION OF RIBOSOME BEHAVIOR BY A SUPPRESSOR MUTATION. III. ELECTROPHORETIC STUDY OF RIBOSOMAL PROTEINS] Alteration du comportement des ribosomes a la suite d'une mutation superpresseur. III. Etude electrophoretiques des proteines ribosomiales, by A. Bollen, A. Herzog, and R. Thomas. [1965] [2]p. (AFOSR-65-2040) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-20, Foundation of Collective Fundamental Scientific Research, and National Science Foundation) AD 627942 Unclassified

Also published in Arch. Internat'l. Physiol. et Biochim., v. 73. 557-558, 1965.

The proteins from the 30 S ribosome fractions of 2 different strains of E. coli K 12, which differ only by a suppressor mutation, yield different electrophoretic patterns. Electrophoresis of the 50 S particles gives identical patterns, but the 30 S fraction of one of the strains (112-12^{+} pm) has a rapidly migrating protein fraction that is either missing or substituted by a slow band in the other strain (112-12^{-}pm). (Contractor's abstract)

934

Free U. of Brussels (Belgium).

OLIVO-COCHLEAR FUNCTION IN A DEAF ALBINO CAT, by J. E. Desmedt. [1965] [2]p. incl. illus. (AFOSR-65-2968) (AF EOAR-65-57) AD 627941 Unclassified

Also published in Acta oto-laryngol., v. 59: 168-169 [1965].

Experiments suggest that while the innervation of the cochlea may be largely preserved in human congenital deafness it undergoes degeneration in acquired deafness. Albino cats with congenital deafness also disclose a pathological cycle which destroys the organ of corti but only involves the nerve cells in the spinal ganglion to a limited extent and after a considerable latent period. The data suggested that efferent olivo-cochlear axons may be excitable and functional in congenital deafness and they emphasized the potential interest of such cases for the analysis of synaptic interactions within the inner ear.

935

Free U., of Brussels (Belgium).

[THE RELATIONSHIP BETWEEN THE TACTILE PERCEPTION AND EVOKED POTENTIALS IN THE SOMATO-SENSORY CEREBRAL CORTEX OF MAN] Sur la relation entre le seuil de perception tactile et les potentiels évoqués de l'ecorce cérébrale somatosensible chez l'Homme, by J. Debecker, J. E. Desmedt, and J. Manil. [1965] [3]p. incl. refs. (AFOSR-66-0741) [AF EOAR-65-57] AD 639834 Unclassified

Also published in Compt. Rend. Seances Acad. Sci., v. 260: 687-689, Jan. 11, 1965.

Cerebral potentials evoked by electric shocks on the fingers of normal awake human subjects have been analyzed by a Mnemotron calculating machine. The psychometric curve illustrating the subject's percentage of detection of these stimuli has also been drawn. Under optimal technical conditions, a primary evoked potential which is well-localized on the scalp is obtained for only 10-50% of the stimuli which are perceived by the subject. The statistical psychophysical threshold may then be correlated with the cerebral electrical signal. (Contractor's abstract)

936

Free U. of Brussels (Belgium).

[THE NEUROPHYSIOLOGY OF SENSORY PERCEPTION] La neurophysiologie de la perception sensorielle, by J. E. Desmedt. [1965] [16]p. (AFOSR-66-0747) (AF EOAR-65-57) AD 639833 Unclassified

Also published in Bull. Acad. Roy. Med. Belg., v. 5: 461-475, 1965.

The influence of higher CNS centers on peripheral sensory perception is discussed. It is stated that "sensory processing" begins at the start of the afferent pathways and is not the exclusive domain of higher centers. The processing of sensory messages in peripheral relay areas may be of a plastic nature which is dependent on centrifugal control.

937

Free U. of Brussels. Lab. of Animal Morphology (Belgium).

SULFUR COMPOUNDS IN MORPHOGENESIS, by J. Brachet. Final rept. Sept. 30, 1963-Mar. 31, 1965. May 4, 1965, 5p. incl. refs. (AFOSR-65-1336) (AF EOAR-63-103) AD 621165 Unclassified

The effects of sulfur compounds on morphogenesis and nucleic acid synthesis were investigated. Experimentally it is shown that oxidized lipoic acid inhibits the reduction of ribonucleosides to deoxyribonucleosides, while mercaptoethanol increases DNA synthesis and blocks the methylation of RNA. Such deviations of nucleic acid metabolism could conceivably lead to the synthesis of abnormal proteins and, as a result, to an arrest of cell division and morphogenesis. The experiments made on the incorporation of various amino acids into the proteins of in vivo treated cells or embryos are in good agreement with such an interpretation. A list of resulting publications, with brief summaries, is presented.

938

Free U., of West Berlin (Germany).

INTERACTION OF THREE HYDROGEN ATOMS, by R. G. Wrzesinsky. Final technical rept. Feb. 1, 1965, 131p. incl. diagrs. tables, refs. (AFOSR-65-1684) (AF EOAR-61-22) AD 625500 Unclassified

Using the valence bond method, the 2 lowest energy terms and the corresponding eigenfunctions of the system of 3 hydrogen atoms were calculated. A general survey about the global structure of the energy surfaces is given using a simple calculating procedure. The coupling coefficients are calculated for the non-adiabatic motion of the nuclei, confining to the neighborhood of the constellation the nuclei forming an equilateral triangle. For an investigation of the non-adiabatic H_2 - H scattering problem this constellation is of particular interest due to energy surfaces which are degenerated in the equilateral triangle giving a strong contribution to the coupling effect. (Contractor's abstract)

939

Free U. of West Berlin (Germany).

DIURESIS INDUCED BY WATER INFUSION INTO THE CAROTID LOOP AND ITS INHIBITION BY SMALL HEMORRHAGE, by J. O. Arndt. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-1543) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-75 and German Research Foundation) AD 624008 Unclassified

Also published in Pflügers Arch. ges. Physiol., v. 282: 313-322, 1965.

In 5 unanesthetized trained dogs the effect on urine flow of the osmotic stimulus of a slow intracarotid water infusion alone and combined with a mild hemorrhage of 8% of the estimated blood volume was investigated. The blood loss was too small to cause any change in blood pressure or heart rate. In contrast to the effect of intracarotid infusion of 3 ml water/min over a 30 min period no diuresis occurred when this infusion was combined with a slow hemorrhage of 150 ml applied during the first 10 min of the infusion period. In the majority of cases restoration of blood volume by retransfusion of the hemorrhaged blood was promptly followed by water diuresis. In all maneuvers the diuresis was entirely due to a change in free water clearance. The excretion of osmotically active material was unchanged. It is concluded that during a competition of the control systems of osmotic pressure and fluid volume the former is acutely overruled if the homeostasis of fluid volume is jeopardized.

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Free U. of West Berlin (Germany).

DIURESIS INDUCED BY WATER INFUSION INTO THE CAROTID LOOP OF UNANAESTHETIZED DOGS, by J. O. Arndt and O. H. Gauer. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR-65-1544) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-75 and German Research Foundation) AD 623379 Unclassified

Also published in Pflügers Arch. ges. Physiol., v. 282: 301-312, 1965.

In 5 unanaesthetized trained dogs the effect of injection of small amounts of water into a carotid loop on the excretion of urine was investigated. The infusion rates were 3.0, 2.5, and 2.0 ml/min. Infusion time was 30 min, so that a total of 90, 75, and 60 ml of water was injected. Identical water infusions were made into a peripheral vein as controls. Diuresis occurred only with intracarotid infusions, which suggests a central location of osmoreceptors. The diuresis was a function of the amount of water infused and was due solely to an increase in free water clearance. The excretion of electrolytes and the osmotic clearance remained unchanged. Although antidiuretic hormone, ADH, was not determined in the plasma of the dogs, it is probable that the diuresis is due to a reduction of the level of this hormone.

941

Free U. of West Berlin (Germany).

RESEARCH ON VOLUME CONDITIONED STIMULI AFFECTING SALT AND WATER EXCRETION, by O. H. Gauer. Final rept. no. 2, Feb. 1, 1964-Jan. 31, 1965 [Mar. 21, 1965] [4]p. (AFOSR-65-0669) (AF EOAR-64-16) AD 614912 Unclassified

Results of the following investigations are given: (1) Competition of osmotic and volume conditioned stimuli in trained dogs. (2) ADH and a diuretic factor during simulated weightlessness (water immersion). (3) The possible role of the portal circulation in osmo- and volumo control.

942

Free U. of West Berlin (Germany).

[CONCERNING THE OSMORECEPTOR MECHANISM ACTIVITY IN THE LIVER] Uber einen osmoreceptorisch tätigen Mechanismus in der Leber, by F. J. Haberwich, O. Aziz, and P. E. Nowacki. [1965] [17]p. incl. illus. diagrs. tables, refs. (AFOSR-66-1107) (AF EOAR-64-16) AD 638057 Unclassified

Also published in Pflügers Arch. ges. Physiol., v. 285: 73-89, July 1965.

By a specially devised technique, indwelling catheters have been placed in the portal veins and inferior venae cavae of rats, permitting infusions and sampling in unanaesthetized animals, which can be used and reused for a longer period of time. Not sooner than 2 days after recovery from the operation, the diuretic response of the unanaesthetized animals to infusions of water and salt solutions (0.3;0.6;0.9 and 1.2% saline) into the 2 sites were compared. The infusion rate of 3 ml/hr corresponded to the known normal rate of water absorption from the gut. When the duration of water infusion is limited to 20 min, a diuresis is observed during portal infusion only. If the infusion time is extended to 1 hr, caval infusion also leads to a diuresis after a latent period of approximately 30 min. Since the "caval" diuresis remains below the "portal" diuresis curve cuts below the "caval" diuresis leading to a pronounced oliguria. The diuretic response is diminished with rising concentrations of NaCl in the infusate. The differences between intraportal and intracaval infusion are maintained. Isotonic infusion has no diuretic effect. The higher the control flow rate, the greater is the urinary volume excreted in excess of the control (which reflects the state of hydration). The experimental results indicate the presence of an osmoreceptor mechanism in the liver, whose sensitivity characteristic has been worked out. This mechanism contributes to the control of diuresis through unknown pathways. This osmoreceptor mechanism in the portal circulation may represent the first line of defense against gross disturbances of water balance during water absorption from the gut, which would respond before the cerebral osmoreceptors become involved.

943

Free U. of West Berlin (Germany).

[ON THE ANTIDIURETIC ACTIVITY IN THE LYMPH OF THE CAT] Uber die antidiuretische Aktivitat in der Lymphe von Katzen, by P. Tata, J. Heller, and O. H. Gauer. 1964 [9]p. incl. illus. tables, refs. (AFOSR-66-1142) (AF EOAR-64-16) AD 638057 Unclassified

Also published in Pflügers Arch. ges. Physiol., v. 283: 222-229, Feb.-Apr. 1965.

In cats anesthetized with sodium pentobarbital the thoracic duct was cannulated and the antidiuretic activity (ADA) of lymph was assayed in rats in alcohol anesthesia. The ADA was also determined in the plasma and serum of the same cat. In normally hydrated cats the ADA in plasma was equivalent to about 1μ U/ml Pitressin, whereas in lymph the ADA was not detectable. In cats deprived of fluid for 24 hr the ADA in lymph was about 20% of that in plasma, the latter having an ADA of ca 3μ U/ml Pitressin. One hour after a single injection of high dosages of Pitressin an ADA in the lymph was not detectable. During Pitressin infusions of long duration an ADA could be measured in the lymph. It was about one third to one fifth of that found at the same time in the plasma. Incubation of Pitressin (10μ U/ml) in plasma at 37°C did not result in a loss of ADA. Incubation with lymph or serum under identical conditions led to a reduction of the ADA to about one quarter of the original value within 30-60 min. The very similar ratio of the ADA in plasma and in lymph of dehydrated animals and animals treated with a continuous infusion of Pitressin may depend on the filtration rate of ADA into the interstitium and the rate of its inactivation by the lymph.

944

Galway U. Coll. Dept. of Biochemistry (Ireland).

ALGAL BILIPROTEINS AND THEIR PHYCOBILIN PROSTHETIC GROUPS, by C. ÓhEocha. Final rept. Sept. 29, 1965, 31p. incl. tables, refs. (AFOSR-65-2651) (AF EOAR-63-18) AD 628032 Unclassified

Two crystalline urobilins were prepared from phycoerythrobilin and their spectral and optical properties determined. A derivative of phycoerythrobilin was obtained by methanolic extraction of Red Algae. A thermolabile aqueous of a Red Alga formed a bilin from a haemtype substrate.

945

Galway U. Coll. Dept. of Biochemistry (Ireland).

R-PHYCOCYANIN, A DISTINCT TYPE OF BILIPROTEIN, by P. O'Carra and C. ÓhEocha. [1965] [4]p. incl. diagrs. (AFOSR-66-0848) (AF EOAR-63-18) AD 639620 Unclassified

Also published in Phytochemistry, v. 4: 635-638, 1965.

It was shown by fractionation and analytical methods, spectrophotometric and denaturation studies, and microscopic examination of crystalline samples, that R-phycocyanin is a distinct type of biliprotein, contrary to the suggestion of Hattori and Fujita who claimed that it is impure C-phycocyanin. (Contractor's abstract)

946

Galway U. Coll. Dept. of Biochemistry (Ireland).

PHYCOBILINS, by C. ÓhEocha. [1965] 22p. incl. diagrs. tables, refs. (AFOSR-66-1106) (AF EOAR-63-18) AD 639621 Unclassified

Also published in Chemistry and Biochemistry of Plant Pigments, ed. by T. W. Goodwin, London, Academic Press, 1965, p. 175-196.

The phycobilins are tetrapyrroles which occur as prosthetic groups of photosynthetically-active conjugated proteins (biliproteins) in some groups of algae. None of the phycobilins has been crystallized as yet and our knowledge of them is based mainly on spectral studies, both as free pigments and as constituents of their parent biliproteins. These studies indicate that at least 3 phycobilins occur in nature as prosthetic groups of algal biliproteins, and while a definite structure cannot yet be assigned to any of them, it is possible to make some suggestions on the basis of the known structures of animal bile pigments, or bilins.

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Galway U. Coll. Dept. of Biochemistry (Ireland).

BILIPROTEINS OF ALGAE, by C. ÓhEocha. [1965] [25]p. incl. table, refs. (AFOSR-66-1127) (AF EOAR-63-18) AD 637623 Unclassified

Also published in Ann. Rev. Plant Physiol., v. 16: 415-434, 1965.

This article reviews recent advances in the chemistry of algal biliproteins. These proteins are primary absrobers of the light used in photosynthesis by Phodophyta and Cyanophyta whose properties of being reasonably stable in solution, colored and fluorescent have led to extensive use in physical chemical studies.

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Galway U. Coll. Dept. of Chemistry (Ireland).

PURIFICATION AND N-TERMINAL ANALYSES OF ALGAL BILIPROTEINS, by P. O'Carra. [1965] [4]p. incl. table, refs. (AFOSR-65-1282) (AF 61(052)409) AD 620716 Unclassified

Also published in Biochem. Jour., v. 94: 171-174, Jan. 1965.

R-, B- and C-phycoerythrins and R- and C-phycocyanins were isolated and purified on a preparative scale by calcium phosphate chromatography, ammonium sulphate fractionation and crystallization. The N-terminal residues of these biliproteins were analyzed. Methionine is the only N-terminal residue of all the phycoerythrins, there being about 14 N-terminal residues per molecule of R- and B-phycoerythrins and about 8 N-terminal residues/molecule of C-phycoerythrin. Threonine is N-terminal in C-phycocyanin, and both threonine and methionine are N-terminal in R-phycocyanin. Results suggest that the apoproteins of the various phycoerythrins are closely related, whereas C-phycocyanin has quite a different gross structure, and that R-phycocyanin contains 2 types of sub-unit, one related to C-phycocyanin and the other to the phycoerythrins.

949

Galway U. Coll. Dept. of Chemistry (Ireland).

AMINO ACID COMPOSITION AND C-TERMINAL RESIDUES OF ALGAL BILIPROTEINS, by M. A. Raftery and C. ÓhEocha. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-65-1289) (Sponsored jointly by Air Force Office of Scientific Research under AF 61-(052)409 and Public Health Service) AD 621403 Unclassified

Also published in Biochem. Jour., v. 94: 166-170, Jan. 1965.

R-phycoerythrin from Ceramium rubrum and C-phycocyanin from Nostoc muscorum have been obtained in purified form by fractional crystallization, followed by chromatography and gel-filtration. The amino acid composition of both chromoproteins was determined; 85% of the total weight of both was recovered as amino acids. Alanine was identified as the only C-terminal amino acid of R-phycoerythrin, each molecule of which contained about 12 terminal groups. Serine was identified as the only C-terminal group of C-phycocyanin.

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General Applied Science Labs., Inc., Westbury, N. Y.

THE IGNITION OF FLOWING HYDROCARBON/AIR MIXTURES BY A HYDROGEN PILOT FLAME, by J. A. Schetz and J. Jannone. [1965] [14]p incl. diagrs. refs. (AFOSR-64-2008) (AF 49(638)991) AD 626243 Unclassified

Also published in Pyrodynamics, v. 2: 1-14, Jan. 1965.

The paper is concerned with an analytical study of the mechanism of ignition of a flowing hydrocarbon/air mixture by a hydrogen pilot flame in fully turbulent flow. Particular attention is directed to igniting such a mixture under static conditions precluding spontaneous thermal ignition. It is shown that a jet of a combustible mixture at a temperature sufficient to initiate reaction with the free stream air provides a more effective ignition source than a jet of inert gas at a considerably higher initial static temperature. (Contractor's abstract)

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General Applied Science Labs., Inc., Westbury, N. Y.

RESEARCH STUDIES FOR SUPERCONIC COMBUSTION, by J. Tamagno. Mar. 1965, 50p. incl. illus. diagrs. table, refs. (GASL Technical rept. no. 518) (AFOSR-65-1311) (AF 49(638)991) AD 619091 Unclassified

A summary is presented of research on supersonic combustion conducted during a 4-yr period by GASL. The research discussed is oriented toward fuels and conditions pertaining to supersonic combustion in ramjet engines. Fields encompassed are: (1) reaction kinetics of a hydrogen air system, (2) diffusion and combustion of reacting gases, and (3) the testing of highly idealized combustion processes. Studies in the latter field indicate the speed range for supersonic combustion ramjets can be lowered to the 3-6 Mach number range. It is concluded that sufficient progress has been made on the understanding and analysis of supersonic combustion processes to give a sound basis for application to the design of a practical ramjet engine.

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General Applied Science Labs., Inc., Westbury, N. Y.

AN EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF IGNITION AND AXISYMMETRIC TURBULENT FLAME PROPAGATION IN PREMIXED HYDROGEN-AIR FLOWS WITH APPLICATION TO SUPERSONIC COMBUSTION, by S. Slutsky, J. Tamagno, and N. Trentacoste. [1965] [16]p. incl. illus. diagrs. refs. (AFOSR-65-1434) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)991 and National Aeronautics and Space Administration) AD 456147 Unclassified

Presented at AIAA Second Aerospace Sciences Meeting, New York, Jan. 25-27, 1965.

Also published in AIAA Jour., v. 3: 1599-1605, Sept. 1965.

This paper is concerned with the experimental determination of the overall structure of the combustion process which takes place in a jet flow of combustible gas mixture, and with the description of the mathematical procedure which has been successfully applied for analysis and prediction of the above experimental results. The mathematical analysis is valid for both subsonic flows and is based on an axisymmetric flow with diffusion, conduction and finite rate hydrogen-air chemistry based on phenomenological models of turbulent gas transport properties and reaction rates. It was shown experimentally that a supersonic combustible mixture of hydrogen and air with temperatures far below autoignition levels may be burned in stable flame configuration without use of any flame-holding obstructions, but employing instead a small pilot flame It was found that the stability of the resulting combustion configuration could be assured by means of pilot flames with relatively small dimensions and small total energy liberation.

953

General Dynamics/Astronautics, San Diego, Calif.

ROCKET MOTOR WITH ELECTRIC ACCELERATION IN THE THROAT, by J. Rosciszewski. [1965] [3]p. incl. diagrs. (AFOSR-65-1437) (AF 49(638)1357) AD 622672 Unclassified

Also published in Jour. Spacecraft and Rockets, v. 2: 278-280, Mar.-Apr. 1965.

A rocket motor with an electric accelerator in the throat which is capable of specific impulses on the order of 1000 to 2000 is examined. Equations defining the flow are developed assuming 1-dimensional flow at low magnetic Reynolds number. It is found that the electric field at the critical section cannot be too large as there are two opposing effects: gas acceleration due to Lorentz force and heat generation due to joule heating. Using the isentropic flow relations the maximum velocities are calculated for K = 0, 0.1 and 0.5 and are found to be 3.6, 4.47, and 8.7 respectively.

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General Dynamics/Astronautics, San Diego, Calif.

ENERGY PARTITION IN THE CURRENT LAYERS IN PLASMA, by J. Rosciszewski. [1965] [3]p. incl. diagrs. (AFOSR-65-1438) (AF 49(638)1357) AD 622673 Unclassified

Also published in AIAA Jour., v. 3: 373-375, Feb. 1965.

Many plasma propulsion systems are based on the principle that the moving current layer sweeps out the gas. In the present paper, this type of discharge layer and the stationary rarefaction or deflagration type are discussed from the gasdynamic point of view. Conservation relations across the discharge layer are derived

from the differential equations for a 1-dimensional nonsteady multifluid model obtained by taking the moments of Boltzmann's equations. It is concluded that: (1) the current layer sweeping up the gas leads to significant losses; (2) the velocity distribution characteristic for an expanding layer leads to smaller losses; and (3) the deflagration type of stationary discharge layer is in principle very efficient and can provide high specific impulse.

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General Dynamics/Astronautics, San Diego, Calif.

SELECTED PROBLEMS OF PLASMA PROPULSION AND POWER GENERATION SYSTEMS (Abstract), by J. Rosciszewski. [1965] [1]p. (Bound with its AFOSR-65-1266; AD 622527) (AF 49(638)1357) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Theoretical considerations of different kinds of discharge layers lead to the conclusion that the stationary discharge layer should be more efficient than the magnetic piston type of discharge layer. An attempt is being made to find the structure of this kind of layer taking into account ionization phenomena. The multifluid equations are the basis for such calculations. The generalized Ohm's law has been derived taking into account ion current due to the motion of freshly born ions in an electromagnetic field. An analysis of a new concept of steady state fissionable gas power generator has been performed. This system is a combination of the principle of a supersonic wind tunnel with ram-jet nuclear reaction concentrated behind the supersonic diffusor. The fissionable gas expands and passes through an MHD generator. The multistrip integral method has been used to calculate boundary layers. Initial profiles have been obtained on the basis of analysis of singularity at the boundary layer leading edges. The method developed is general and can be used to calculate the flow at an MHD generator entrance or the boundary layer flow with mass injection on blunt or sharp edge bodies.

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General Dynamics/Fort Worth, Tex.

MAGNETOPLASMA WAVEGUIDE WITH VISCOSITY AND HEAT CONDUCTION, by B. A. Sodek. [1965] [15]p. incl. diagrs. (AFOSR-66-1081) (AF 49(638)1428) AD 640775 Unclassified

Also published in Plasma Phys., Accelerators, Thermonuclear Research (Jour. Nuclear Energy, Pt. C), v. 7. 547-561, Sept./Oct. 1965.

A 2-fluid analysis of the modes of propagation in a magnetoplasma-filled waveguide may be based upon the solution of a pair of coupled partial differential equations for the longitudinal components of the hydromagnetic field. A method of solving these equations, which involves a system of transcendental equations for a set of undetermined parameters, is indicated. Approximate solutions are obtained with pressure, resistivity, viscosity, heat conduction, and current inertia treated exactly, while neglecting certain effects, such as Hall effect. The effects of viscosity and heat conduction on the dispersion relations are shown explicitly.

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General Dynamics Corp. Convair Div., San Diego, Calif.

THE DECAMETRIC ARRAYS AT THE CLARK LAKE RADIO OBSERVATORY, by W. C. Erickson. [1965] [6]p. incl. illus. diagrs. (AF 49(638)561) Unclassified

Published in IEEE Trans. Antennas and Propagation, v. AP-13. 422-427, May 1965.

An antenna has been built for the purpose of studying radio astronomical phenomena at long wavelengths. The beamwidth of this antenna is 14 min E-W and 92 min N-S at a wavelength of 11.4 meters. Therefore, its resolution is comparable to that of present day arrays operating in the meter wavelength range and to that of large parabolas operating at decimeter and centimeter wavelengths.

958

General Dynamics Corp. General Atomic Div., San Diego, Calif.

NON-LINEAR THEORY OF PLASMA DYNAMICS, by R. E. Aamodt. Final thechnical rept. Feb. 1, 1964-Jan. 31, 1965. Mar. 1, 1965, 35p. incl. diagrs. refs. (Rept. no. GA-6179) (AFOSR-65-1054) (AF 49(638)-1356) AD 628018 Unclassified

The effects of the non-linear process of resonant wave-wave scattering for unstable modes in a homogeneous plasma system with a constant external magnetic field are evaluated. It is shown that this particular non-linear mechanism may provide a partial explanation of some existing experimental results, and in addition, provides an experiment to verify the non-linear theory.

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General Dynamics Corp. General Atomic Div., San Diego, Calif.

WAVE-WAVE SCATTERING OF BEAM AND PLASMA OSCILLATIONS, by R. E. Aamodt and W. E. Drummond. [1965] [6]p. incl. diagrs. (AFOSR-65-2502) (AF 49-(638)1356) AD 626392 Unclassified

Also published in Phys. Fluids, v. 8: 171-176, Jan. 1965.

The spreading of the high-frequency electron plasma oscillation energy spectrum due to nonlinear interactions with a low-frequency beam mode is calculated for a homogeneous collisionless plasma with a large external magnetic field. (Contractor's abstract)

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General Dynamics Corp. General Atomic Div., San Diego, Calif.

NON-LINEAR THEORY OF PLASMA DYNAMICS (Abstract), by R. E. Aamodt. [1965] [1]p. (Bound with its AFOSR-65-1266; AD 622527) (AF 49(638)1546 and AF 49(638)1356) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Many of the plasma configurations occurring in the Van Allen belt, solar winds, high altitude nuclear explosions, and would-be fusion devices are known to be unstable to initially small excitations. The amplitudes of these unstable excitations grow until limited by the non-linear terms in the equations of motion. The plasma is then fully turbulent and the dynamics are determined by non-linear processes. The important non-linear processes for "weak" instabilities in low - collisionless plasma systems will be discussed and the time development of the energy spectrum described. The concomitant effects on particle containment and coupling to external radiation fields will also be presented.

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General Dynamics Corp. General Atomic Div., San Diego, Calif.

INTERACTIONS BETWEEN HYDROGEN AND OXYGEN ATOMS AND SURFACES, by J. N. Smith, Jr. Annual technical summary rept. Oct. 1, 1964-Sept. 30, 1965, Oct. 25, 1965, 9p. (Rept. no. GA-6749) (AFOSR-65-2310) (AF 49(638)1435) AD 628066 Unclassified

Research is summarized on molecular-beam scattering experiments performed under well-defined and reproducible surface conditions. The microscopic details of the gas-surface interaction mechanism are discussed.

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General Dynamics Corp. General Atomic Div., San Diego, Calif.

CHEMICAL REACTIONS ON CLEAN SURFACES USING MODULATED ATOMIC BEAM TECHNIQUES (Abstract), by H. Saltsburg and J. N Smith, Jr. [1965] [2]p. (Bound with its AFOSR-65-2238; AD 627978) (AF 49-(638)1559) Unclassified

Presented at Sixth AFOSR Contractors' meeting on Chemical Kinetics of Propulsion, New York, Sept. 20-21, 1965.

The study of heterogeneous chemical reactions utilizing molecular beam techniques offers certain obvious advantages in terms of reaction mechanism studies but certain difficulties remain. Specifically, studies of such reactions always involve some determination of the surface of the solid Usually, one specifies an adsorption isotherm from which such concentration can be deduced. A technique was developed to prepare and maintain, in steady state, a metallic surface upon which the concentration of impurities resulting from background gas adsorption can be made arbitrarily small. A new surface is created by continuous deposition of metal at a rate which greatly exceeds the background gas impingement rate. Since this is possible even at 10^{-5} torr, these clean surfaces can be prepared in conventional molecular beam machines and have been used for studies of physical scattering. Since the surface concentration of adsorbed species can be varied by varying the ratio of metal deposition rate to background gas impingement rate, these surface concentrations can be controlled independently of the background gas pressure. If one reactant in a heterogeneous reaction is present as the background gas and the other in the molecular beam, mechanistic studies of the classic form can be carried out using metal deposition rates to vary surface concentrations. One can also study reactions between the beam and the surface both on clean surfaces and with known and controllable impurity concentrations. Experimental studies of the H_2-D and D_2-H exchange on nickel surfaces are in progress.

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General Dynamics Corp. General Atomic Div., San Diego, Calif.

SCATTERING OF RARE GASES FROM THE [111] PLANE OF SILVER (Abstract), by H. Saltsburg and J. N. Smith, Jr. [1965] [1]p. [AF 49(638)1559] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 69, Jan. 28, 1965.

The angular distribution of thermal neutral beams of rare gases scattered from an epitaxially grown [111] plane of silver has been examined using freshly deposited films and also during continuous silver deposition, the latter condition providing a clean surface. Scattering distributions for He from freshly deposited films are essentially independent of beam energy ($T \cdot 300\,^{\circ}K$) and incident angle, the distribution being sharply peaked at the specular angle The scattering of Ar and Xe ($T = 300\,^{\circ}K$) exhibits a maximum intensity between the normal and specular angle, and a dependence of scattering on incident angle, the deviation from specularity being most pronounced toward glancing incidence For a given incident angle, an increase in beam energy causes a shift of the maximum scattered-beam intensity toward the specular and at beam temperatures of $\sim 1525\,^{\circ}K$ the maximum intensity lies beyond the specular angle. Unlike gold surfaces the scattering from silver during deposition does not differ markedly in prominent features from that on freshly deposited films. However, over long periods of time ($\cdot$ 12h) the directional scattering is degraded in a manner similar to that observed on contaminated gold films.

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General Electric Co. Defense Electronics Div., Ithaca, N. Y.

RESEARCH PROGRAMS FOR ALERTING, DETECTION, AND IDENTIFICATION OF PATHOGENS, by J. R. Gould. Status rept. Oct. 1, 1964-Mar. 31, 1965, 24p. incl. illus. diagrs. tables. (AFOSR-65-1284) (AF 49-(638)1418) AD 620224 Unclassified

The purpose of this program is to assess the feasibility of detecting bacteria by an investigation of their unique metabolic activities, using gas chromatography in conjunction with ultrasensitive detectors for the determination of volatile products or derivatives of products of bacterial metabolism. A standard procedure was developed for the growth of the test organisms and for the extraction and detection of bacterial metabolites. This procedure involves: (1) growth of the bacteria in a synthetic medium in shallow layers at 35°C for 36 hr; (2) extraction of the cultures with ether and concentration of the ether extract 10-fold by evaporation; and (3) injection of the anhydrous extracts into the dual channel gas chromatograph, using a 6 ft x 1/4 in. column of 10% carbowax 4000 terminated with terephthalic acid on 60/80 chromosorb U plus hexamethyldisilazane.

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General Electric Co. Defense Electronics Div., Ithaca, N. Y.

RESEARCH PROGRAMS FOR ALERTING, DETECTION, AND IDENTIFICATION OF PATHOGENS, by J. R. Gould. [Final] status rept. Oct. 1, 1964-June 30, 1965, 54p. incl. illus. diagrs. tables. (AFOSR-65-1728) (AF 49(638)1418) AD 624242 Unclassified

Although a high percentage of the background particulate matter is expected to be bacterial in nature, less than one viable organism per liter is normally present in the atmosphere. Therefore, a method of detecting and identifying the viable agents in the background containing a large number of nonviable agents and nonbiological materials may prove to be very useful information in the event of a BW attack. Such information may be determined by witnessing the presence and uniqueness of excreted metabolic products formed by specific organisms after development in a selective test medium. The methodology, to demonstrate the feasibility of the above, involves the selectivity of a gas-liquid-chromatography in conjunction with ultrasensitive detectors, for the analysis of gases, volatile products, or other products of metabolism that can be converted into volatile derivatives. Using this approach it was found possible to not only distinguish among genera, and among species, but also among the strains of microorganisms investigated. The survey included: Escherichia coli (5 strains), Aerobacteriaerogenes, Pseudomonasaeruginosa, Bacillus subtilis (11 strains), B. pumilus, B. licheniformis, B. polymyxa, B. megaterium, B. circulans, B. globigii, Streptomyces griseus, S. fradiae, S. viridochormogenes, S. albus, and S. griseolutus. Further, it has been demonstrated that the electron capture detector has a detection capability equivalent to the metabolic products of less than two bacteria. There is considerable promise for increased sensitivity inasmuch as only partial extraction of products have been employed, and product conversion has not been attempted. On the basis of present results, it is believed that the technique of gas chromatography is very promising for detecting very small numbers of organisms and also for the detection of metabolic differences among genera, species, and even among strains of a species.

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General Electric Co. General Electric Research Lab., Schenectady, N. Y.

CHEMISORPTION ON SOLIDS, by G. Ehrlich. [1965] [33]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1451) (AF 49(638)1362) AD 621450 Unclassified

Also published in Proc. Third Internat'l. Cong. on Catalysis, Amsterdam (Netherlands) (July 20-25, 1964), Amsterdam, North-Holland Publishing Co., 1965, p. 113-145.

Progress in the understanding of chemisorption phenomena involving molecular gases on solids is reviewed. Particular emphasis is placed on two topics: (1) the theoretical foundations and their failings and (2) experimental studies of structural effects.

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[General Electric Co.] General Electric Research Lab., Schenectady, N. Y.

CHEMISORPTION ON SINGLE-CRYSTAL PLANES; NITROGEN ON TUNGSTEN, by T. A. Delchar and G. Ehrlich. Jan. 1965, 37p. incl. illus. tables, refs. (Rept. no. 65-RL-3864 M) (AFOSR-65-1643) (AF 49-(638)1362) AD 624287 Unclassified

Also published in Jour. Chem. Phys., v. 42: 2686-2702, Apr. 15, 1965.

The effects of surface structure on the adsorption of nitrogen are examined by contact-potential measurements on macroscopic planes cut from single-crystal tungsten. The effects of room-temperature chemisorption on the work function are studied on the (100), (111), and (110) faces. It is found that macroscopic surfaces can be prepared showing extreme structural specificity. Previous correlations between the work-function changes and electronegativities are examined and found insufficient. The effects of structure on the surface dipole are, however, correlated by the empirical rule that nitrogen atoms on flat planes lower the work function, whereas on rough surfaces the work function is increased.

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[General Electric Co.] General Electric Research Lab., Schenectady, N. Y.

ATOMIC DISPLACEMENTS IN ONE- AND TWO-DIMENSIONAL DIFFUSION, by G. Ehrlich. Oct. 1965 [13]p. incl. diagrs. table. (Rept. no. 65-C-039) (AFOSR-65-2769) (AF 49(638)1362) AD 628016 Unclassified

Also published in Jour. Chem. Phys., v. 44: 1050-1055, Feb. 1, 1966. (AFOSR-66-1050; AD 636373)

The statistics of surface diffusion phenomena are developed for the conditions appropriate to measurements in the ion microscope. Examined in detail are: (1) the effect of boundaries (lattice steps) on the mean square displacement in a random walk; (2) the probability density for distances traversed in a 2-dimensional walk along nonorthogonal surface channels; and (3) the distribution of distances for random walks in which the number of jumps is subject to fluctuation, as it is in real systems. Both reflecting and adsorbing boundaries are found to diminish the mean square displacement in the same fashion. The effect of nonorthogonality, and even more so of fluctuations, is to enhance the frequency of small displacements when compared with a Rayleigh distribution.

969

General Electric [Co.] [General Electric Research Lab.] Schenectady, N. Y.

AN ATOMIC VIEW OF SURFACE SELF-DIFFUSION: TUNGSTEN ON TUNGSTEN, by G. Ehrlich and F. G. Hudda. Oct. 1965, 21p. incl. illus. diagrs. refs. (AFOSR-65-2883) (AF 49(638)1362) AD 627837 Unclassified

Presented at Conf. on Sorption Properties of Evacuated Metal Films, Liverpool, Apr. 1963.

Surface diffusion of tungsten adatoms on several smooth, low index planes of the tungsten lattice has for the first time been followed by direct observation of individual atoms in the ion microscope. Contrary to expectation, the mobility at room temperature is found to increase in the order (211) > (321) ~ = (110) > (310) ~ (111). Migrating atoms are reflected at the boundaries of the (110), (211), and (321) planes; on the latter two, motion along atomic rows is favored over diffusion across lattice steps. From quantitative determinations of the rate of change of the mean square displacement, diffusion coefficients were obtained. Differences in diffusion on the (211) and (321)-planes of very similar structure suggest a weakening of interatomic forces at lattice edges. (Contractor's abstract)

970

General Electric Co. Space Sciences Lab., Philadelphia, Pa.

STRUCTURAL RESPONSE TO INTENSE ELECTROMAGNETIC RADIATION, by R. C. Good, Jr. Final rept. Mar. 1, 1961-Feb. 28, 1965. June 1965, 186p. incl. illus. diagrs. tables, refs. (AFOSR-65-0988) (AF 49-(638)1030) AD 616336 Unclassified

An exploding wire apparatus was used to study conversion of electrical energy into strain energy in glass, plastic, and metal samples that had been either irradiated by the electromagnetic waves emitted by the wire or enveloped by plasma formed by the wire. The strain energy left permanent marks on the sample in the form of discoloration, weight loss, erosion, and surface cracks. These were used to confirm the theoretical analysis as to method and to dimensions. Thus, a new method for measuring absorption coefficients was demonstrated. For glass samples, the surface crazed to a depth of 10^{-3} cm. Photomicrographs and profilometer measurements of the surface are presented to support the following conjectures as to the cause of cracking: the energy radiation by the hot wire is absorbed by a thin surface layer of the glass, the associated temperature rise generates thermal stresses, flaws below the glass surface form stress raisers according to the Griffith crack theory, and the cracks subsequently propagate to the surface. The theoretical derivation of the adapted thermoelastic stress theory predicts the dimensions of the cracks and the power levels required if the absorption coefficient is at least 10^3 reciprocal centimeters. Thus, a cracking phenomenon has been postulated and verified experimentally. The resistance of the exploding wire was measured empirically, and a theoretical justification made of its variation. This study added to a characterization of the exploding wire along with spectral, calorimetric, and photographic studies. (Contractor's abstract)

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[General Electric Co. Space Sciences Lab., Philadelphia, Pa.]

THE DIRECT MEASUREMENTS OF MOLECULAR VELOCITY DISTRIBUTION FUNCTIONS, by E. P. Muntz. Final rept. Mar. 31, 1965, 3p. (AFOSR-65-0808) (AF 49(638)1152) AD 622591 Unclassified

A brief summary of the research conducted is presented. During the investigation it was demonstrated that the Doppler profile of the 5015.67A helium line excited by a beam of 20 kv electrons can be used to measure distribution functions. The first interference free measurements of a distribution function in a free jet expansion were made, and resonance diffusion of the emission by an electron beam was considered relative to a decrease in spacial resolution. The etalon system and the recording system were improved so that nonequilibrium distribution function measurements will be possible in wind tunnel laboratory environments.

972

General Electric Co. Space Sciences Lab. [Philadelphia] Pa.

SHOCK-TUBE STUDY OF THE THERMAL DISSOCIATION OF NITROGEN, by B. Cary. [1965] [10]p incl. illus. diagrs. tables, refs. (AFOSR-65-1231) (AF 49-(638)1157) AD 622759 Unclassified

Also published in Phys. Fluids, v. 8: 26-35, Jan. 1965.

The dissociation of nitrogen behind shock waves was studied over a temperature range of 6000 to 10,000°K. A time-resolved Mach-Zehnder interferometer measured the density profiles in the reaction zone. Rate expressions based on classical collision theory and the hydrodynamic constraint equations were used to fit the

experimental profiles. Inferred rate constants are presented with N_2, N, Ne, and Ar as third bodies. This work differs from previous studies of nitrogen in that a measurement of the forward dissociation rate was made in N_2 with N_2 as the third body and in that the new data indicates that N is about as effective a third body as N_2. Vibrational relaxation data indicates that to a first approximation there is no significant coupling between vibrational relaxation and dissociation over the temperature range covered. Vibrational relaxation times in N_2-Ne mixtures behind combustion driven shocks indicate that Ne is about 1.4 times as effective as N_2 in vibrationally exciting N_2, agreeing well with predictions of the Landau theory. This agreement between theory and experiment is as good as that obtained for Ar utilizing pressure breaks, vindicating the combustion technique. (Contractor's abstract)

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General Electric Co. Space Sciences Lab., Philadelphia, Pa.

DENSITY OF PULSED PLASMA, by [P. Gloersen] Final rept. June 1965, 17p. incl. illus. diagrs. (AFOSR-65-1732) (AF 49(638)1174) AD 628516 Unclassified

An absorption spectroscopy technique in the vacuum ultraviolet region was developed to measure the ion and neutral particle densities in the exhaust stream of a repetitively pulsed 2-stage coaxial plasma propulsion engine by monitoring their various resonance absorption lines. The development of the plasma accelerator progressed to the point where argon was definitely ruled out as a suitable propellant. Xenon was found to be suitable and efforts were shifted towards extending the measuring techniques for use with xenon and other heavier propellants. In order to provide a better model for coaxial gun operation than hitherto available, some analytical effort was applied to the problem. The special case of the stationary current sheet was brought to a successful conclusion both on the basis of energetics and the application of Faraday's law, starting from first principles. Extension of this analysis to cover the moving current sheet has been only partly successful to date in that a reasonable statement of the energetics could be made, but no consistent means has yet been found for applying Faraday's law.

974

General Electric Co. Space Sciences Lab., Philadelphia, Pa.

DENSITY OF PULSED PLASMA (Abstract), by P. Gloersen and S. Collins. [1965] [1]p. (Bound with its AFOSR-65-1266; AD 622527) (AF 49(638)1174) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

The nature of the plasma source (a repetitively pulsed coaxial gun) in which density measurements are to be made has changed considerably over the past year. The present status of the gun performance characteristics and knowledge of the plasma composition are summarized as a basis for describing the density measurements contemplated by means of vacuum ultraviolet absorption spectroscopy. Since the best operation of the gun has been obtained with xenon, attention has shifted away from one aspect of a previous program to determine the oscillator strength of the argon atom. A summary of what is known about the oscillator strengths of the resonance lines of some other rare gases is described.

975

General Electric Co. Space Sciences Lab., Philadelphia, Pa.

A DISCRETE ORDINATE TECHNIQUE FOR THE LINEARIZED BOLTZMANN EQUATION WITH APPLICATION TO COUETTE FLOW, by B. B. Hamel and M. Wachman. Nov. 1964 [48]p. incl. diagrs. tables, refs. (AFOSR-64-1593) (AF 49(638)1283) AD 604749 Unclassified

Also published in Rarefied Gas Dynamics; Proc. Fourth International Symposium, Toronto U. (Canada) (July 14-17, 1964), ed. by J. H. de Leeuw. New York, Academic Press, v. 1: 370-393, 1965.

A numerical method for the solution of the linearized Boltzmann equation of hard sphere molecules is developed here, in which approximations are made only in sense of numerical truncations. The distribution function is considered at n discrete points in velocity space, and a closed symmetric set of differential equations is developed which describe the evolution of the distribution function at each of these discrete points. The key point of the method is the approximation, by a finite sum, of the collision integral, utilizing Gauss quadrature (integration) formulas. The method is applied to the problem of linearized Couette flow of hard sphere molecules. Numerical results are obtained for the moments and for the perturbation distribution function at the discrete points.

976

General Electric Co. Space Sciences Lab., Philadelphia, Pa.

HYPERSONIC RAREFIED PLASMA FLOWS, by S. M. Scala. Final progress rept. Nov. 1965, 5p. (AFOSR-66-0365) (AF 49(638)1283) AD 628924 Unclassified

The report deals with research in hypersonic rarefied gas dynamics. For a single component gas techniques for a hypersonic approximation to the moment equations were considered and a paper written on their application to the problem of source flow expansion. For gas mixtures a multifluid hydrodynamic theory was developed for a disparate mass mixture. In addition, work on the numerical solution of the non-linear Boltzmann equation was continued.

977

General Electric Co. Space Sciences Lab., Philadelphia, Pa.

TWO-FLUID HYDRODYNAMIC EQUATIONS FOR A NEUTRAL, DISPARATE MASS BINARY MIXTURE, by B. B. Hamel. Aug. 1965, 42p. incl. refs. (AFOSR-65-1194) (AF 49(638)1283) AD 470970
Unclassified

Also published in Phys. Fluids, v. 9: 12-22, Jan 1966.

In gas mixtures with roughly equal masses, self collisions and cross collisions between species are of equal importance in the approach of the mixture to a Maxwellian distribution about a single temperature and velocity and the usual Chapman and Enskog transport theory obtains. In a disparate mass mixture, however, the effects of self and cross collisions are not equal and one has an epochal relaxation, with the temperature relaxation occurring on the longest time scale. The clear distinction between a single molecular relaxation time and a hydrodynamic time scale which makes the usual Chapman and Enskog theory possible is absent for the disparate mass case, and a more complex ordering of time scales is necessary to obtain hydrodynamic solutions. In the present work, for neutral, disparate mass mixtures, the Boltzmann collision integrals are replaced by relaxation type kinetic models; terms in the model equation are carried out in the limit where the masses are disparate. A set of 2-fluid transport equations are derived in this way and the properties and limitations of these equations are described.

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General Electric Co. Space Sciences Lab., Philadelphia, Pa.

RESEARCH IN NON-EQUILIBRIUM IONIZATION AND MHD FLOWS (Abstract), by A. Sherman and J. M. Smith. [1965] [1]p. (Bound with its AFOSR-65-1266, AD 622527) (AF 49(638)1465) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Several studies related to the coupling between non-equilibrium ionization phenomena and the magnetohydrodynamic flow are described. One approach involves preionization of the plasma before the channel. The second involves ionization directly in the channel itself. Several calculations have been made for arbitrary initial conditions. The Hartmann flow problem for infinitely finely segmented electrodes including the Hall effect were solved. Curves showing the velocity profiles are presented. A problem involving a uniform flow and a realistic electrode structure was considered. Accordingly the finite segmented electrode problem, with conductivity taken as a function of the current density, was solved by a perturbation technique. Calculations were based on the first order of perturbation.

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General Electric Co. Space Sciences Lab., Philadelphia, Pa.

EXTRA THERMAL IONIZATION AND MHD FLOWS, by A. Sherman. Final rept. Oct 15, 1965 [4]p. (AFOSR-65-2237) (AF 49(638)1465) AD 628065 Unclassified

The interaction between extra-thermal ionization and MHD flows was studied. The motivation for such research was related experimental tests of crossed field devices utilizing extra-thermal ionization to enhance electrical conductivity.

980

General Electric Co., Santa Barbara, Calif.

ADAPTIVE THRESHOLD LOGIC FOR IDENTIFICATION OF SIMULATED RADAR TARGETS, by A. T Ewald Nov. 1965 [33]p. incl. diagrs refs. (Rept. no. 65TMP-84) (AFOSR-65-2709) (AF 49(638)1520) AD 477861
Unclassified

The application of adaptive threshold logic is considered as a means of establishing simple data transforms that will permit the automatic classification of patterns whose signal properties are too complex to be amenable to explicit analytic description. In an attempt to study the learning characteristics of adaptive logic systems monopulse radar signal returns of multiple targets were computer-simulated to generate different classes of signal patterns. Three levels of pattern complexity were examined. Sum- and difference-transformed data patterns were learned more quickly than the ratio transform for 1- and 2-target patterns. The ratio transform was unsuccessful at the second level of complexity, i.e., the introduction of patterns of three targets one-quarter beamwidth apart versus one target. Difference-transform data produced weight learning plots that exhibited marked oscillation in early trials before converging to a solution. The sum transform showed oscillation in the learning plot similar to the 2-target cases, but of no longer duration. At an S/N of 2, sum and difference transforms were successful in discriminating a 2-target one-quarter beamwidth apart pattern from a five-target, one-quarter beamwidth apart pattern, but exhibited a distribution of weighting functions suggesting that only the first and last few intervals of the radar scan provided useful information.

981

General Precision, Inc. Librascope Div., Glendale, Calif

AN AXIOMATIC CONCEPTUAL FRAMEWORK FOR ASSOCIATION THEORY, by R. F. Reiss. Dec. 1965 [130]p. incl. refs. (AF AFOSR-66-0597) (AF 49(638)1236) AD 630429 Unclassified

A partially developed axiomatic system, called the SSF frame (state-space-function framework), is described, and is intended for use in formulating a general theory of psychological phenomena, particularly a theory based on associationist concepts. The chief primitive entities

of the system are 'states,' 'moments of time,' and 'occurrences' of a state 'at' various moments of time. A class of objects, 'bases,' is introduced for particular groups of states to enable the empirical interpretation of a 'real object' that can have or be in various observed states at various times. The base of a space is a unique object: there cannot be two or more bases in the same space and, by definition, the base of a space cannot be in two states at the same moment. A relation called an 'alinement' enables consideration of the relations between the spaces of x and y. The framework is deterministic; all functions are divided into 'formal' and 'causal,' the latter derived from the former by means of pairing and special interpretations. A main dichotomy of causal functions is that of 'first-order' vs 'second-order' types. The notion of a 'sequential' deterministic system is developed that is consistent with the conceptual framework of state spaces and causal functions. The fundamental temporal property of a causal connection, the 'propagation delay,' is introduced and related with the delays of causal functions. The structure of a sequential function is characterized by 'autopaths' in the co-domain corresponding to subsets of the domain, namely those subsets defined by points in A for a function f AXB-B.

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Genoa U. Neurosurgical Clinic (Italy).

AN EXPERIMENTAL STUDY OF THE CORTICAL REACTIVITY DURING SLEEP AND WAKEFULNESS, by G. F. Rossi, M. Palestini, and others. [1965] [24]p. incl. illus. diagrs. refs. (AFOSR-65-1291) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-106 and Consiglio Nazionale delle Ricerche) AD 621599 Unclassified

Also published in Colloq. Internationaux du Centre Nat'l. de la Recherche Scientifique sur l'Aspects Anatomo-Fonctionnels de la Physiologie du Sommeil, Lyon (France) (Sept. 9-11, 1963), Paris, CRNS, No. 127 509-532. 1965.

In intact cats with chronically implanted electrodes, electrical potentials have been evoked in the visual cortex by single stimuli of the optic radiations and of the lateral geniculate body, and in the sensory-motor cortex by stimulation of the pyramidal tract and of the VPL thalamic nucleus. A comparison has been made between the mean amplitude of the responses recorded during wakefulness, light sleep and deep sleep. The amplitude of the cortical responses evoked by the optic radiations or antidromically by the pyramidal tract is larger during deep sleep than during wakefulness in the great majority of cases, no significant difference is found between the responses recorded during light sleep and deep sleep. The recovery cycle of the visual cortex is more rapid during sleep than during wakefulness in most of the cases, it is similar in the two phases of sleep. The amplitude of the cortical responses to thalamic stimulation is larger during deep sleep than during wakefulness in all the cases, it is, however, relatively small during light sleep. The results reported indicate that the reactivity of the cortical neurons is enhanced during both light sleep and deep sleep. Also the thalamic reactivity appears larger during deep sleep than during wakefulness, but is depressed during light sleep. By considering the present findings with previous ones, the hypothesis is advanced of a facilitation of the thalamocortical excitability during the maximal depth of sleep.

983

Genoa U. Neurosurgical Clinic (Italy).

EXCITABILITY CYCLE OF THE VISUAL CORTEX DURING SLEEP AND WAKEFULNESS, by M. Palestini, M. Pisano and others. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-2837) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-11 and Consiglio Nazionale delle Ricerce) AD 627757 Unclassified

Also published in Electroencephalog and Clin. Neurophysiol. Jour., v. 19. 276-283, Sept. 1965.

The excitability cycle of the visual cortex of intact unanesthetized cats was studied during the states of wakefulness, sleep with EEG synchronization and sleep with EEG desynchronization. The study was made by analyzing the relative amplitudes of 2 potentials evoked in the visual cortical area by the 2 identical stimuli to the optic radiations, separated by a variable time interval The excitability of the visual cortical neurons is higher during sleep than during wakefulness, no significant differences are found between the 2 phases of sleep. The phenomenon is tentatively interpreted by assuming that during sleep the cerebral cortex is released from an inhibitory influence exerted by the reticular activating system. The fluctuations of cortical excitability during synchronized sleep might be due to the varying of the synchronizing thalamo-cortical circuits; its relative stability during desynchronized sleep might be ascribed to an ascending hypnogenic brain-stem influence. Different cortical areas might show different excitability changes during sleep and wakefulness, the excitability changes of the thalamus seem to be partially different from those of the cerebral cortex.

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Genoa U. Neurosurgical Clinic (Italy).

SOME ASPECTS OF THE FUNCTIONAL ORGANIZATION OF THE BRAIN STEM: NEUROPHYSIOLOGICAL AND NEUROSURGICAL OBSERVATIONS, by G. F Rossi. [1965] [6]p. incl. diagr. (AFOSR-66-1141) (AF EOAR-64-11) AD 639522 Unclassified

Also published in Excerpta Med. Internat'l. Cong., Ser. 93: 117-122, Jan. 1965.

The aims of the present report are two: (1) to describe the brain stem mechanisms underlying changes of consciousness as revealed by results of animal experiments; and (2) to analyze whether and to what extent similar mechanisms are at work in man. The report is based largely on personal work in neurophysiological and neurosurgical fields; because of limitations of space it contains only a synthetic account of the most relevant findings.

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Genoa U. Neurosurgical Clinic (Italy).

RELATION BETWEEN BRAIN STEM AND ELECTROCORTICAL ACTIVITY, by G. F. Rossi. Final scientific rept. Oct. 1964-Sept. 1965. Sept. 30, 1965, 11p. incl. refs. (AFOSR-65-2012) (AF EOAR-65-4)
AD 627479 Unclassified

Results are summarized of research on the relationships between brain stem, electrocortical activity and level of consciousness. The findings are subdivided into 7 groups. The research on man included the study of the relation between EEG patterns and depth of sleep; the relation between cerebral potentials evoked by visual stimuli, EEG patterns and degree of awareness; and the electrocortical and behavioral effect of selective barbiturization of the brain stem and frontal brain. Experiments were performed on the rabbit in order to check some of the observations made in man. Other experiments were made on cats to study the sleep inducing effect of electrical stimulation of the cerebral cortex and the influence of the different phases of sleep on the EEG epileptic activity. Finally, the mode of action of a new analgesic drug was experimentally analyzed in the rabbit. (Contractor's abstract, modified)

986

Genoa U. Neurosurgical Clinic (Italy).

INDUCTION OF EEG DESYNCHRONIZED SLEEP BY ELECTRICAL STIMULATION OF THE NEOCORTEX, by M. Di Paola, G. F. Rossi, and J. Zattoni. [1965] [14]p. incl. diagrs. refs. (AFOSR-66-1112) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-4 and Consiglio Nazionale delle Richerche)
AD 639830 Unclassified

Also published in Arch. Ital. Biol., v. 103: 818-831, 1965.

The effects of cortical stimulation on the occurrence of episodes of EEG desynchronized sleep were studied in chronic experiments performed on free-moving cats. The following neocortical areas were explored: anterior and posterior sigmoid gyri, anterior and posterior lateral gyri, syprasylvian gyrus, anterior sylvian gyrus anterior ectosylvian gyrus. Arousal from sleep as well as induction on the EEG desynchronized phase of sleep were obtained following cortical stimulations performed during EEG synchronized sleep. The type of the response was dependent on the general conditions of the animal at the moment on the stimulation: (1) when the stimulation was performed at the beginning of sleep, arousal occurred; and (2) when the cortical stimulus was applied during a well-developed EEG synchronized stage of sleep, an EEG desynchronized episode was obtained The physical parameters of stimulation did not influence the type of the response. The EEG desynchronized sleep was obtained by all the cortical areas stimulated; the arousing effect was induced by most of the areas. These results might suggest, but do not prove, a phasic cortical participation in the mechanism underlying the onset of the EEG desynchronized phase of sleep.

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Genoa U. [Neurosurgical Clinic] (Italy).

BRAIN STEM FACILITATING INFLUENCES ON EEG SYNCHRONIZATION EXPERIMENTAL FINDINGS AND OBSERVATIONS IN MAN, by G. F Rossi [1965] [32]p. incl. diagrs. tables. (AFOSR-66-1123) (AF EOAR-65-4) AD 638073 Unclassified

Also published in Acta Neurochirurg., v. 13: 257-268, 1965.

The report presents a critical review of the data supporting the participation of the brain stem in the mechanism of EEG synchronization. It is concluded that in the cat there are sufficient findings supporting an ascending influence facilitating EEG synchronization which arises from the middle pons (probably from reticular structures) and from the region of the nucleus of the solitary tract. It is stressed that there is a good correspondence between these 2 regions and those which, according to the results of anatomical researches, contain most of the reticular neurones having a long axone ascending rostral to the brain stem. It is likely that the EEG synchronizing function of the pontine neurones is mainly tonic while that of the medullary neurones is mainly phasic. Evidence for a brain stem facilitation of EEG synchronization in man is not yet proven, however, some observations seem to support it.

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Georgetown U. Dept. of Chemistry, Washington, D. C.

ON THE EFFECT OF TRANS-LIGANDS ON THE RATE OF SOME BRIDGED ELECTRON-TRANSFER REACTIONS, by R. D. Cannon and J. E. Early. [1965] [1]p. incl. table. (AFOSR-66-0780) (AF AFOSR-65-133)
AD 633549 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 5264, Nov. 1965.

Using conventional spectrophotometric methods, we have measured the rates of Cr(II) reduction of cis- and trans-$Co(en)_2A(H_2O)^{+3}$ where en is ethylenediamine and A is either NH_3 or H_2O. In perchlorate media at 7 and 30 °C, these rates were inversely proportional to $[H^+]$, which was varied between 0.1 and 1 M. The first acidity constant of each aquo ion was measured by pH titration under similar conditions. It was concluded that factors involved with outward motion of the trans ligand are not totally absent in the Co(III)-Cr(II) system, but they are much less important than in the similar Co(III)-Fe(II) reductions which proceed at slower rates because of less favorable free-energy change.

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Georgetown U. [Dept. of Chemistry] Washington, D. C.

AQUEOUS CHEMISTRY OF CHROMIUM (III), by J. E. Early and R. D. Cannon. [1965] [76]p. incl. diagrs. tables, refs. (AFOSR-66-0783) (AF AFOSR-65-133)
AD 633548 Unclassified

Also published in Transition Metal Chemistry, ed. by R. L. Carlin. New York, Marcel Dekker, Inc., v. 1, 33-109, 1965.

An extensive review was made of the stability and rates of substitution of Cr(III) complexes, Cr(III)-Cr(II) electrode and homogeneous reactions, hydrolysis reactions of Cr(III) complexes, and polynuclear complex formation reactions of Cr. Stability constants and kinetic data for a number of complexes are given.

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Georgetown U., Dept. of Physics, Washington, D. C.

POWER SERIES EXPANSIONS OF VIBRATIONAL POTENTIALS. III. THE WANG POTENTIAL FOR H_2. by C. L. Beckel and J. P. Sattler. [1965] [2]p. incl. table. (AFOSR-65-1340) (AF AFOSR-62-160) AD 621244 Unclassified

Also published in Jour. Chem. Phys., v. 42: 2620-2621, Apr. 1, 1965.

In an analysis of Lyman bands of H_2, a determination is made of the spectroscopic constants of the Wang potential derived from an electronic wavefunction with exchange symmetry and variable screening, but with no explicit ionic term. These constants are compared with Heitler-London, Weinbaum, and experimental values for H_2. The Wang constants are accurate to within 1 in the last digit.

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Georgia Inst. of Tech. [Engineering Experiment Station] Atlanta.

GENERAL CONSIDERATIONS CONCERNING APPARENT MOBILITIES IN MIXED ION POPULATIONS. DRIFT VELOCITIES OF MASS-IDENTIFIED N^+, N_2^+, N_3^+, AND N_4^+ IONS IN NITROGEN, by G. E. Keller, D. W. Martin, and E. W. McDaniel. [1965] [12]p. incl. illus. diagrs. refs. [AF 49(638)1392] Unclassified

Also published in Phys. Rev., v. 140: A1535-A1546, Nov. 29, 1965.

This paper summarizes the difficulties inherent in the measurement of ionic drift velocities in gases, emphasizing the need for careful control of the ionization conditions in the ion source and the necessity for mass analysis of the ions at the end of their flight path. Mass analysis provides a positive determination of the molecular composition of the ions reaching the detector, detects the possible presence of a mixture of charge carriers of various molecular compositions, and is essential to help determine whether or not the charge carriers which have a given molecular composition when they arrive at the detector have had that same composition throughout their transit through the drift region. If examination of the arrival-time spectrum shows that a detected species is involved in an ion-molecule reaction scheme such that the charge carrier has spent an appreciable portion of its total drift time in a different ionic form, then the "apparent drift velocity" derived from the measurement of the transit time and drift distance cannot be meaningfully compared with the existing theory. A drift-tube mass spectrometer used to study the drift of mass-analyzed ions is described, and experimental results are presented for nitrogen ions in the parent gas. The drift-tube pressures used here ranged from 0.05 to 0.25 torr. The E/p_0 range covered was 7 to 50 v/cm torr for N^+ and N_3^+ ions and was 7 to 70 v/cm torr for N_2^+ and N_4^+ ions. The drift distance was varied from 9 to 34 cm. The transit-time spectra for N^+ indicate that its drift velocities measured here are the "true" values characteristic of the N^+ ion undergoing no reactive scattering collisions. The zero-field, reduced mobility of N^+ in N_2 is 2.47 cm^2/v sec. Ion-molecule reactions involving the other ions prevented the determination of their true drift velocities, but the measured apparent drift velocities yield useful information about their drift behavior and the reactions linking the various ions.

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[Georgia U., Bioelectronic Computer Lab.] Athens.

A COMPARISON OF LIVING SEPIOTEUTHIS SEPIOIDEA AND DORYTEUTHIS PLEI WITH OTHER SQUIDS, AND WITH SEPIA OFFICINALIS, by B. B. Boycott. [1965] [10]p. incl. illus. diagrs. refs. (AFOSR-66-0754) (AF 49(638)1011) AD 643590 Unclassified

Also published in Jour. Zool., v. 147: 344-351, Dec. 1965.

Sepioteuthis is unusual among loliginids in that it has a relatively broad body, fins extending along the length of the mantle, a well developed disruptive pattern and a dynamic response. The resemblances to Sepia are probably convergent associated with the assumption of an ecology similar to that of cuttlefishes. A pattern possibly of display of the ripe testis is described for D. plei and the known chromatic behavior of loliginids is summarized.

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Georgia U. Dept. of Chemistry, Athens.

ORGANIC PEROXIDES. IV. KINETICS AND PRODUCTS OF DECOMPOSITIONS OF CYCLOHEXANEFORMYL AND ISOBUTYRYL PEROXIDES. BDPA AS A FREE RADICAL SCAVENGER, by R. C. Lamb, J. G. Pacifici, and P. W. Ayers. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-2759) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-53, National Science Foundation, and Petroleum Research Fund) AD 627830 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 3928-3935, Sept. 5, 1965.

The kinetics and free-radical efficiencies of the thermal decompositions of cyclohexaneformyl peroxide (I) and isobutyryl peroxide (II) in carbon tetrachloride were determined with excess α, γ-bis(diphenylene)-β-phenylallyl (BDPA) at temperatures between 30° and 85° C. The rate constants and efficiencies obtained by

the excess BDPA method are independent of the ratio of initial concentrations of BDPA to peroxide. Product studies were performed on mixtures obtained from the decompositions of I and II in carbon tetrachloride, and in the same solvent containing excess BDPA. Evidence is presented which indicates that inversion compounds (RCOOCOOR) are formed in the decompositions of both peroxides. Rate constants for decompositions of II in several other polar and nonpolar solvents at 40°C were determined by idometric assay. Results suggest that the homolysis and the rearrangement of peroxide to inversion compound are 2 distinct modes of decomposition.

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Georgia U. Dept. of Chemistry, Athens.

THERMAL DECOMPOSITION OF --ALLYLOXYPROPIONYL PEROXIDE. CYCLIZATION OF THE β-ALLYLOXYETHYL RADICAL, by R. C. Lamb, J. G. Pacifici, and P. W. Ayers. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-2760) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-53 and National Science Foundation)
AD 627828 Unclassified

Also published in Jour. Org. Chem., v. 30 3099-3102, Sept. 1965.

Results of kinetics runs are reported for decompositions of β-allyloxypropionyl peroxide in toluene and p-xylene. The kinetics of decomposition in toluene are approximately first order, although very slight curvatures of first-order plots indicates a small amount of induced decomposition. β-Allyloxypropionyl peroxide decomposes somewhat more rapidly in p-xylene than in toluene, and the kinetic behavior is such as to suggest that there is more radical-induced decomposition in the former. Product studies are reported for decompositions of the --allyloxypropionyl peroxide in p-xylene and in the same solvent containing excess galvinoxyl. The main product formed from the β-allyloxyethyl radical is 3-methyltetrahydrofuran, which indicates that this radical, like the 5-hexenyl radical, undergoes cyclization to give a five-membered ring. (Contractor's abstract)

995

Georgia U. Dept. of Chemistry, Athens.

KINETICS IN SOME SYSTEMS IN WHICH STABLE RADICALS FUNCTION AS SCAVENGERS OF REACTIVE RADICALS. THE DECOMPOSITION OF TRANS-γ-BENZYLIDENEBUTYRYL PEROXIDE IN BENZONITRILE CONTAINING α, γ-BISDIPHENYLENE---PHENYLALLYL, by R. C. Lamb, J. G. Pacifici, and L. P. Spadafino. [1965] [4]p. incl. diagrs table, refs (AFOSR-65-2761) (AF AFOSR-62-53) AD 627829 Unclassified

Also published in Jour. Org. Chem., v. 30 3102-3105, Sept. 1965.

Several kinetic equations which have potential use in radical scavenger experiments are presented and discussed. Experimental data for the decomposition of trans-γ-benzylidene butyryl peroxide in benzonitrile containing excess α, γ-bisdiphenylene-β-phenylallyl are presented and treated kinetically. This is an example of a system in which there is a slow decomposition of the scavenger α, γ-bisdiphenylene---phenylallyl in the solvent even in the absence of initiator. The slow decomposition is treated here as a pseudo-first-order process. (Contractor's abstract)

996

Georgia U. Dept. of Chemistry, Athens.

HYDROCARBON DIANION RADICALS, by E. C. Janzen and J. G. Pacifici. [1965] [2]p. incl. diagrs. refs. (AFOSR-66-0305) (AF AFOSR-62-53) AD 629549 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87 5504-5505, Dec. 1965.

4,5-Methylenephenanthrene reacts with K-THF to produce the yellow carbanion. When all the hydrocarbon is converted to the anion, the red dianion radical I forms rapidly. The orange carbanion derived from 9-phenylfluorene is also reduced to a new radical attributed to the dianion radical. Reduction of pentaphenylcyclopentadienyl chloride resulted in a purple solution due to the pentaphenylcyclopentadienide dianion radical or the corresponding ring closed compound.

997

Georgia U. Dept. of Chemistry, Athens

AN UNUSUAL SOLVENT EFFECT ON THE AIR OXIDATION OF A STABLE CARBANION, by J. G. Pacifici, J. F. Garst, and E. G. Janzen. [1965] [1]p. incl. table (AFOSR-66-0313) (AF AFOSR-62-53) AD 632589 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87 3014-3015, July 1965.

The extensive data of Russell and co-workers, on the base-catalyzed air oxidation of many organic compounds, has been interpreted in terms of reaction sequences in which a one-electron transfer from a carbanion to an oxygen molecule is a key step. The direction of the solvent effect in less polar ethers and the presence of a distinct metal ion effect in 2-methyltetrahydrofuran suggest that the transition state tends to be more highly aggregated than the reactant ions.

998

Georgia U. Dept. of Chemistry, Athens

EFFECT OF PRESSURE ON RADICAL YIELDS FROM PHENYLAZOTRIPHENYLMETHANE IN METHYLCYCLOHEXANE, by R. C. Lamb and J. G. Pacifici. [1965] [3]p. incl. diagr. refs. (AFOSR-66-0587) (AF AFOSR-62-53) AD 632328 Unclassified

Also published in Jour. Phys. Chem., v. 70: 314-316, Jan. 1965.

The efficiency of production of phenyl radicals from phenylazotriphenylmethane (PAT) was found to be related to the viscosity of the solvent. While previous investigations have pointed to definite viscosity dependent effects on the extent of the cage reaction, this work is the first example in which the viscosity change has been effected by means of pressure variations.

999

Giannini Controls Corp. Astromechanics Research Div., Malvern, Pa.

PREDICTION OF DYNAMIC RESPONSE FROM FLUTTER ANALYSIS SOLUTIONS, by F. J. Frueh and J. M. Miller. June 1965, 63p. incl. diagrs. tables, refs. (AFOSR-65-0952) (AF 49(638)1015) AD 620867 Unclassified

This report presents the development of a dynamic response prediction method based on the transformation of classical flutter analysis solutions. This development is accomplished through investigation of the equations of motion of the flutter system for the determination of relationships of this system which are also common to the dynamically responding system's equations of motion. Several special operators are discovered to relate these two systems. Theodorsen incompressible aerodynamics and Ackeret's source pulse aerodynamics are used in the development of the dynamic response prediction method. As a result of these efforts, the analyst may predict an aeroelastic system's dynamic response in a manner independent of the system's basic parameters by merely transforming the solutions of a simple-harmonic-motion, required-structural-damping flutter analysis.

1000

Giannini Controls Corp. Astromechanics Research Div., Malvern, Pa.

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF ELASTICITY ON THE STABILITY OF MANNED ROTATING SPACE STATIONS, by J. M. Miller and F. J. Frueh. June 1965, 27p. incl. illus. diagrs. (AFOSR-65-1404) (AF 49(638)1015) AD 620866 Unclassified

An experimental program is presented which investigates the structural dynamic stability of an elastic model of a manned rotating space station. A "cross" model was designed based on the elastic properties of a space station. The model consists of an aluminum bar for each arm to simulate uniform stiffness distribution, steel bars attached to each arm to simulate mass and inertia distribution, a cylindrical hub, nozzles at the arm tips and plastic tubing running from an air supply for simulation of spin up forces. Vibration tests were made for modes and frequencies of the model, and stability tests were made, simulating operational conditions. The instability of the model was demonstrated and the stability criterion were verified.

1001

Giannini Controls Corp. Astromechanics Research Div., Malvern, Pa.

BASIC RESEARCH IN THE INTERNAL AERODYNAMICS OF SENSITIVE FLOWS, by D. J. Liquornik and T. D. Reader. Final technical rept. Jan. 29, 1965, 5p. (AFOSR-65-0283) (AF 49(638)1218) Unclassified

An analytical methodology for the solution of the flow field in a curving channel was developed and shown to compare favorably with experiment. A method of calculating the effects on the primary flow of secondary injection into a straight channel was derived and also shown to agree with experiment. In addition to verification of analytical approaches, an extensive series of tests was conducted on the relative effects of various injection techniques for providing a large change in primary stream characteristics. New experimental techniques for flow visualization and velocity measurements in air and water have been developed.

1002

Giannini Controls Corp. Astromechanics Research Div., Malvern, Pa.

STIFFNESS DESCRIBER OF A FILAMENT WOUND CYLINDER FOR DYNAMIC ANALYSES, by J. M. Miller. Dec. 1965 [37]p. incl. diagrs. refs. (AFOSR-65-2214) (AF 49(638)1509) AD 626226 Unclassified

This report presents a technique for assembling a Stiffness Describer for Filament-Wound Cylinders (FWC) in the form of a Stiffness Matrix. The technique described provides the dynamicist with the means to analyze FWC. The data that would be required are physical properties such as: Poisson's Ratio, Moduli of Elasticity and Rigidity for the filament and resin, winding angles of plies, geometric data such as cylinder length, radius, overall thickness. The technique described produces a method for representing FWC analogous to that developed for beam-plate complex structures. The deviation of the Stiffness Describer of a FWC entails: writing the load-deflection equations for a shell in matrix form, applying boundary conditions for axial lengths (for assembly purposes), and mathematical modeling of FWC in terms of physical material constants. The expressions used to define structural relationships arose from strain energy considerations for shells and for plies at various angles to the cylinder's axis. The mathematical modeling was based on load paths that occur in composite materials.

1003

Giannini Scientific Corp., Santa Ana, Calif.

STUDY OF THE FACTORS AFFECTING THE EFFICIENCY IN THERMAL ACCELERATION OF PROPELLANTS, by A. C. Ducati. Final technical rept. May 1962-Apr. 1965. Aug. 1965, 171p. incl. illus. diagrs. tables, refs. (Rept. no. FR-085-1161) (AFOSR-66-0495) (AF 49(638)1161) AD 629168 Unclassified

The report describes the experimental and analytical

work conducted to study the various influences affecting the operating characteristics of electrothermal accelerators. A survey of the testing facilities, including vacuum systems, resistance heaters, and liquid metal heaters is given. The experimental work conducted with hydrogen, helium, ammonia, nitrogen, oxygen, and argon at temperatures ranging from 300°-3000°K is described. Conical and annular nozzles are compared with simple cylindrical throats, and the experimental and analytical expressions relative to their behavior are included. Outlined are the development of low pressure arc heaters and the experiments which led, for the first time, to the attainment of specific impulse levels of over 10,000 sec using hydrogen. Performance comparisons between resistance and arc heating and associated anomalies using ammonia are also discussed. The behavior of self-magnetic fields in the arc heater is explained, together with the effects of externally applied magnetic fields ranging from 500 to 12,000 gauss. Included are operation at low mass flow rates and the development of arc heaters working without propellant throughput using electrode vapors or residual ambient gas as the working fluid. (Contractor's abstract)

1004

Giannini Scientific Corp., Santa Ana, Calif.

FACTORS AFFECTING THE EFFICIENCY IN THERMAL ACCELERATION (Abstract), by A. C. Ducati. [1965] [1]p. (Bound with its AFOSR-65-1266; AD 622527) (AF 49(638)1161) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

A tentative synoptic classification grouping the factors affecting the efficiency in thermal acceleration is presented. While a definite separation between the various factors is sometimes difficult, 3 categories have been specified. The first category comprises the factors affecting the energy transfer from the electrical source to the propellant. The second is associated with the conversion of the propellant energy to thrust. The third refers to factors still not completely known or explainable which have been brought to light in recent experiments. Various efforts to identify and measure the factors grouped in the 3 main categories are presented. The effort this year has been directed particularly to the study of various influences determined by operation at very low environmental pressures in the presence of magnetic fields of various intensities. Operation without external propellant flow has been obtained and studied in a wide range of conditions. The presence of parasitic effects affecting the operation at the lower mass flows is indicated as a tentative explanation of abnormal values of thrust measured. Suggestions for further improvements in the testing technique and instrumentation are included.

1005

Giannini Scientific Corp., Santa Ana, Calif.

TOROIDAL PLASMA CONTAINMENT (Abstract), by H. G. Loos. [1965] [1]p. (Bound with its AFOSR-65-1266; AD 622527) (AF 49(638)1226) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Experiments on the toroidal containment of plasmas with a rotating magnetic field have been continued over a range of phase shifts between the 0-pinch field and the ring-conductor field. For phase shifts of $\pi/2$, $3\pi/2$, etc. we find a quasi-continuous luminous trace on the smear photographs. The discharge tube is not large enough to avoid wall contact, which occurs as a result of the radial plasma oscillation. The latter is due to the phase shift between the 0-pinch field and the ring-conductor field. The smear pictures obtained suggest, however, that uninterrupted containment would occur in this configuration for larger tube size and higher ionization fraction. No instabilities have been found so far. The smear pictures show that the presence of the ring-conductor field at zero 0-pinch field inhibits further ionization at locations close to the ring conductor. This is due to the reduction of the EE component of the tensor conductivity due to a magnetic field perpendicular to the electric field. Hence, in this configuration, as much ohmic heating as possible should be applied before the ring conductor is switched on.

1006

Gothenburg U. [Dept. of Biology] (Sweden).

CHARACTERISTICS OF THE ATP-ASE ACTIVITY OF ISOLATED NEUTRONS OF RABBIT, by H. Hillman and H. Hydén. [1965] [5]p. incl. diagr. refs. (AFOSR-65-0958) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-28, National Multiple Sclerosis Society, and Torsten and Rahnar Soderberg's Foundation) AD 617980 Unclassified

Also published in Histochemie, v. 4: 446-450, Jan. 1965.

This study describes a technique which allows the measurement of the maximal breakdown of ATP in single isolated neurons. Isolated and homogenized Deiters' neurons from the lateral vestibular nucleus of rabbit in a Krebs-Ringer solution containing no added Mg^{++}, 1.3 μmol/ml and 5μmol/ml Mg^{++}, broke down ATP at the maximal rate of 0.29 ± 0.20, 2.40 ± 0.20, and 5.95 ± 0.63 $\mu\mu$mol/cell/hr. In 1.3 mm Mg^{++} solution the single cell homogenates took up phosphate at the mean rate of 2.6 ± 0.2$\mu\mu$mol/cell/hr. If the rabbits were injected 1 hr before with 20 mg/kg body weight of 2-amino-1-propene-1, 1, 3 tricarbonitrile (triap), the breakdown of ATP in these latter media was 0.82 ± 0.44, 2.5 ± 0.60, and 6.7 ± 1.1 $\mu\mu$mol/cell/hr, respectively, and the quantity of inorganic liberated did not decrease.

1007

Gothenburg U. [Dept. of Biology] (Sweden).

BIOCHEMICAL STUDIES OF NEURONS AND GLIA DURING LEARNING AND DIFFERENT FUNCTIONAL CONDITIONS, by H. Hydén. Final rept. Oct. 1, 1964-Mar. 31, 1965. [May] 1965 [3]p. (AFOSR-65-1486) (AF EOAR-63-28) AD 629340 Unclassified

Two separate investigations are included in this report. First, a study was made with rats of the differentiation in RNA response in neurons early and late during learning. In early learning, nuclear RNA was formed with high adenine and uracil values, i.e., 26 and 28, respectively. Later during learning a 100% RNA/cell increase occurred, but the RNA had changed to a ribosomal type, i.e., A 21 G 35 C 24 U 20. It is concluded that early response with A-U rich RNA production reflects a genic stimulation in a learning situation never before encountered. Similarly, in behavioral tests, vestibular neurons produce nuclear RNA with high adenine and low uracil values when a difficult balancing is being learned. Secondly, a study was made of protein synthesis in isolated neurons and glia during learning. Two separate methods are described for the separation and determination of proteins: (1) an ultramicro method and (2) the use of tricyanoaminopropene to stimulate RNA synthesis in neurons. With these procedures, it is now possible to correlate protein synthesis in isolated neurons with their RNA synthesis and the type of RNA and base composition.

1008

Gothenburg U. [Dept. of Biology] (Sweden).

A DIFFERENTIATION IN RNA RESPONSE IN NEURONS EARLY AND LATE DURING LEARNING, by H. Hydén and P. W. Lange. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-65-2517) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-28, National Multiple Sclerosis Society, and Torsten and Rahnar Soderberg's Foundation) AD 628365 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 53: 946-952, May 1965.

The amount and composition of nuclear RNA formed in cortical neurons and in vestibular neurons of the brain stem in 2 types of learning experiments have been determined. Early during transfer of handedness, the cortical neurons produced a small amount of RNA with high adenine and uracil values. Later during the learning period, but still on the rising part of the performance curve, the RNA formed increased in amount, and changed in base composition to an RNA of a ribosomal type. This differentiation in response was interpreted to reflect a genic stimulation of the neurons with an initial synthesis of adenine-uracil-rich RNA. In the phylogentically older vestibular neurons, a highly asymmetric, adenine-rich nuclear RNA was formed in the rats which increased their performance linearly with time during learning. Some animals showed a non-linear performance curve. The nuclear RNA formed in the neurons of these rats had a ribosomal type of base composition.

1009

Gothenburg U. [Dept. of Biology] (Sweden).

RESEARCH ON INTRA NEURONAL MECHANISMS FOR INFORMATION STORAGE, by H. Hydén. Mar. 31, 1965 [42]p. incl. tables, refs. (Technical rept. no. 1) (AFOSR-66-0364) (AF EOAR-63-28) AD 628899 Unclassified

Different types of micro-chemical methods used for analysis of neurons and glia are discussed. As an introduction to a discussion of a biochemical response in neuron and glia during learning, a few basic problems are mentioned and some pertinent results are given. The neurons are especially rich in RNA and during a life-cycle in man, there can be discerned a rise, steady level and fall in the RNA content of moto-neurons. During physiological stimulation of the nervous system in mammals, an increase of the RNA content, total proteins and enzyme activities have been found in the neurons, and a decrease in the surrounding glia. To elucidate this phenomenon, a kinetic study and other experiments were carried out. The results showed that the neuron and its glia are coupled as a unit from an energetic point of view. Some RNA data from a study of Parkinson's disease are given to show that one part of the unit can influence the other from a biochemical as well as from a functional point of view.

1010

Gothenburg U. [Dept. of Biology] (Sweden).

RHYTHMIC ENZYME CHANGES IN NEURONS AND GLIA DURING SLEEP, by H. Hydén and P. W. Lange. [1965] [35]p. incl. table. (AFOSR-66-2451) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-28 and Swedish State Medical Research Council) AD 641031 Unclassified

Also published in Science, v. 149: 654-656, Aug. 6, 1965.

Rhythmic changes occur in the activities of enzymes in both the neurons and neuroglia isolated from the caudal part of the reticular formation of rabbits killed during sleep and wakefulness. During sleep, enzyme activity is high in the neurons and low in the glia; during wakefulness, this situation is reversed. In the oral part of the reticular formation rhythmic enzyme changes occur only in the neurons. No rhythmic changes occur in the hypoglossal and trigeminal mesencephalic neurons and glia. These findings indicate that the caudal part of the reticular formation reflects in metabolic changes the biological clock behind the sleep rhythm.

1011

Gothenburg U. [Dept. of Biology] (Sweden).

MEMBRANE POTENTIALS IN ISOLATED NEURONS IN VITRO FROM DEITERS' NUCLEUS OF RABBIT, by H. Hillman and H. Hydén. [1965] [13]p. incl. illus. diagrs. table, refs. (Sponsored jointly by Air Force Office of

Scientific Research under AF EOAR-63-28, Multiple Sclerosis Foundation, and Swedish Medical Research Council) Unclassified

Published in Jour. Physiol., v. 177: 398-410, Apr. 1965.

Study is made of the penetration of neurons in vitro at 23°C, isolated from the rabbit Deiters nuclei, resting potentials of 39 mV ± 4.3 (n = 120) were recorded in a Krebs-Ringer bicarbonate-glucose saline, containing 50 mM glucose. Membrane potentials decreased from 41 ± 6.4 to 25 ± 6.2 during hypoxia, and recovered to 35 ± 4.6 mV (n = 40) on reintroduction of 95% O_2 5% CO_2. Resting potentials between 7.4 and 23 mV were recorded in the absence of added substrate; they were maximal (39.5 ± 5 mV) with 50 mM glucose at 10 mM, or 100 mM glucose concentrations, the membrane potentials were smaller. Potassium ions (2-5 mM) allowed the maximum resting potential of means between 37 and 49 mV, of 0, 2, 5, 10 and 150 mM medium K^+ concentrations tested. Sodium ions (110 mM) allowed the maximum membrane potentials, of means between 40.5 and 46 mV and 84 mM the minimum, between 25 and 31 mV, of 0, 26, 84, 110 and 150 mM-Na^+ concentrations tested. A ganglioside preparation (0.3 mg/ml of medium) increased the resting potential from means between 42 and 49 mV to means between 50.5 and 56 mV.

1012

Gothenburg U. Dept. of Pharmacology (Sweden).

BIOCHEMISTRY AND PHYSIOLOGY OF BRAIN DOPAMINE, by A. Carlsson. Final scientific rept. Mar. 13, 1965, 5p. incl. refs. (AFOSR-65-0872) (AF EOAR-64-30) AD 617569 Unclassified

The major part of the brain dopamine, a catecholamine belonging to the monoamine family, occurs in neurons, whose cell bodies are located in the substantia nigra of the brain stem. Their axons ascend in the internal capsule and terminate in the neostriatum. Dopamine is localized also to other neuronal systems in the brain and the retina. Evidence supporting the view that the brain monoamines serve as neurohumoral transmitters has been presented. The functions of the nigro-neostriatal and other dopamine containing pathways are under study, using a multidisciplinary approach.

1013

Gothenburg U. Dept. of Pharmacology (Sweden).

OCCURRENCE OF DIHYDROXYPHENYLALANINE DECARBOXYLASE IN NERVES OF THE SPINAL CORD AND SYMPATHETICALLY INNERVATED ORGANS, by N.-E. Anden, T. Magnusson, and E. Rosengren. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-0960) (AF EOAR-64-30) AD 617978 Unclassified

After transection of the rabbit spinal cord the L-3, 4-dihydroxyphenylalanine decarboxylase activity in the caudal part was reduced by 90-95 and 75-85% when determined in vitro and in vivo, respectively. The drop appeared to be fastest between the second and fifth day, and the activity reached its minimum level after 3 wk. In the rabbit iris the dihydroxyphenylalanine decarboxylase activity fell to approximately 10% of that of the control side in 48 hr after the excision of the superior cervical ganglion. In both tissues the time courses of the disappearance of dihydroxyphenylalanine decarboxylase activity and of noradrenaline were very similar but the amine disappeared somewhat more suddenly and rapidly than the enzyme. Preganglionic sympathectomy did not influence the dihydroxyphenylalanine decarboxylase activity in the iris. The nerve trunk contained only 15-20 times higher activity than the iris. The dihydroxyphenylalanine decarboxylase like noradrenaline probably occurs in the whole neuron but is highly concentrated in the terminals. Postganglionic sympathectomy reduced the dihydroxyphenylalanine decarboxylase activity in the rat submaxillary gland and spleen by 85 and 80%, respectively.

1014

Gothenburg U. Dept. of Pharmacology (Sweden).

FURTHER EVIDENCE FOR THE PRESENCE OF NIGRO-NEOSTRIATAL DOPAMINE NEURONS IN THE RAT, by N-E Adén, A. Dahlström and others. [1965] [6]p. incl. illus. refs. (AFOSR-65-2520) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-30, National Institute of Child Health and Human Development, National Institute of Neurological Diseases and Blindness, and Swedish Medical Research Council) AD 627551 Unclassified

Also published in Amer Jour. Anat., v. 116: 329-333, Jan. 1965.

With the help of the highly specific and sensitive histochemical fluorescence method of Falck and Hillarp for the cellular demonstration of monoamines, the catecholamine-containing cell-bodies within the brain stem have been studied after unilateral removal of a large part of the neostriatum 1 to 28 days after the operation. Most of the catecholamine-containing cell-bodies within the substantia nigra, but no other monamine-containing cell-bodies, appeared to be distinctly increased in fluorescence intensity and somewhat swollen 2 to 4 days after operation while after 3 to 4 wk they showed a marked decrease in fluorescence intensity together with marked degenerative changes. Parallel with the changes in the cell-bodies, there occurred a rapid and marked accumulation of catecholamines within very abundant swollen nerve fibers in the internal capsule. These nerve fibers were traced caudally via the retrolenticular part of the internal capsule down to the crus cerebri. These results together with those in a previous paper seem to provide conclusive evidence for the presence of nigro-neostriatal dopamine neurons

1015

Gothenburg U. Dept. of Pharmacology (Sweden).

IDENTIFICATION AND CELLULAR LOCALIZATION OF THE CATECHOLAMINES IN THE RETINA AND THE CHOROID OF THE RABBIT, by J Häggendal and T Malmfors [1965] [9]p incl. illus. diagrs table, refs.

(AFOSR-65-2521) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-30, National Institute of Neurological Diseases and Blindness, and Swedish State Medical Research Council) AD 629221 Unclassified

Also published in Acta Physiol. Scand., v. 64: 58-66, 1965.

By means of fluorescence microscopical and chemical methods the catecholamines of retinas and choroids were examined in rabbits normally, after treatment with drugs interfering with catecholamine storage, and after bilateral cervical sympathectomy. Dopamine was found to be the dominating catecholamine in the retina, 0.1 - 0.2 μg/g. It was localized to particular neurons. The results support the view that dopamine serves as the transmitter of these neurons. Noradrenaline was found in the choroid, 0.2 - 0.3 μg/g. It was localized to adrenergic vascular nerves.

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Gothenburg U. Dept. of Pharmacology (Sweden).

HISTOCHEMICAL AND BIOCHEMICAL DETECTION OF MONOAMINE RELEASE FROM BRAIN NEURONS, by A. Carlsson, A. Dahlström and others. [1965] [8]p. incl. table, refs. (AFOSR-65-2854) (In cooperation with Karolinska Inst. (Sweden)) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-30, National Institute of Neurological Diseases and Blindness, and Swedish State Medical Research Council) AD 628741 Unclassified

Also published in Life Sci., v. 4: 809-816, Apr. 1965.

Treatment of rats kept at 29 C ambient temperature with pargyline resulted in histochemically detectable release of monoamines from the synaptic terminals of the monoamine neurons in the brain, with histochemically detectable lowering of noradrenaline levels and accumulation of 3-O-methylated metabolites. The accumulation of noradrenaline in nerve terminals in the brain following L-dopa administration to rats pretreated with reserpine and nialamide could be largely prevented by agents blocking the amine transport through the nerve cell membrane (desmethylimipramine or protiptyline), as demonstrated both histochemically and biochemically.

1017

Gothenburg U. Dept. of Pharmacology (Sweden).

THE DISRUPTION OF CONDITIONED AVOIDANCE RESPONSE FOLLOWING SELECTIVE DEPLETION OF BRAIN CATECHOL AMINES, by L. C. F. Hanson. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR-66-2062) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-30, National Institute of Neurological Diseases and Blindness, and Swedish State Medical Research Council) AD 643892 Unclassified

Also published in Psychopharmacologia, v. 8: 100-110, 1965.

Selective depletion of catechol amines (CA) in brain, with little or no depletion of 5-hydroxytryptamine, was induced by x-methyl-tyrosine methylester-HCl. Concomitant disruption of conditioned avoidance responses (CAR) was observed in cats (Shuttle box) and rats (Skinner box). Restoration of the CA levels in the brain by L-DOPA resulted in a restoration of CAR. The data support the view that the CA of the brain are essential for CAR. The relative importance of noradrenaline and dopamine is discussed.

1018

Gothenburg U. Dept. of Pharmacology (Sweden).

BIOCHEMICAL AND BEHAVIORAL EFFECTS OF L-DOPA METHYL ESTER IN CATS TREATED WITH RESERPINE, by L. C. Hanson and J. D. Utley. [1965] [6]p. incl. diagrs. (AFOSR-66-2286) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-30, National Institute of Neurological Diseases and Blindness, and Swedish State Medical Research Council) AD 643121 Unclassified

Also published in Psychopharmacologia, v. 8: 140-144, 1965.

The effects of L-DOPA methyl ester on brain catecholamines and conditioned avoidance response of cats were studied. The effects of the methyl ester were equivalent to those of L-DOPA, which makes the ester a suitable compound for administering L-DOPA in a highly soluble form, thus obviating the need for large injection volumes.

1019

Gothenburg U. Dept. of Pharmacology (Sweden).

MAPPING OUT OF CATECHOLAMINE AND 5-HYDROXYTRYPTAMINE NEURONS INNERVATING THE TELENCEPHALON AND DIENCEPHALON, by N.-E. Anden, A. Dahlström and others. [1965] [5]p. (AFOSR-65-2044) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-56, National Institute of Child Health and Human Development, National Institute of Neurological Diseases and Blindness, and Swedish State Medical Research Council) AD 627493 Unclassified

Also published in Life Sci., v. 4: 1275-1279, July 1965.

By means of electrolytic lesions in various parts of the prosencephalon in rats and subsequent histochemical and biochemical analysis, final evidence was obtained for the view that the vast majority of 5-hydroxytryptamine and catecholamine terminals in the prosencephalon belong to special neurons with their cell bodies in the lower brain stem. A large part of the cell bodies are localized in the mesencephalon and the 5-hydroxytryptamine and noradrenaline axons ascend, to a large extent, in the medial forebrain bundle.

1020

Grafix, Inc., Albuquerque, N. M.

COMPUTER EXPERIMENTS IN MOTOR LEARNING, by G. R. Bussey. [1965] [22]p. incl. tables. refs. (AFOSR-67-0702) (AF 49(638)1476) AD 648267 Unclassified

Also published in 1965 Fall Joint Computer Conf., AFIPS Conf. Proc., Las Vegas, Nevada (Nov. 1965), Washington, Sparian Books, v. 27 (pt. 1): 753-774, 1965.

The paper describes a method of achieving motor learning in a computer environment. Two interactive computer programs are presented and described. PUPIL is a coded-input/coded-output general learning program which interacts with TUTOR, and environment simulating program. Test results of experiments involving elementary spatial orientation, locomotion, accommodation and manipulation are discussed. The primary results presented in this report concern an objective measure of performance, known as effective relative intelligence, which was used to evaluate six elementary creative means of response generation.

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Grumman Aircraft Engineering Corp., Bethpage, N. Y.

MINIMUM IMPULSE COPLANAR CIRCLE-ELLIPSE TRANSFER, by H. G. Moyer. [1965] [4]p. incl. diagrs. (AFOSR-65-1360) (AF 49(638)1207) AD 621189 Unclassified

Also published in AIAA Jour., v. 3: 723-726, Apr. 1965.

A technique devised by Contensou and Breakwell for the generation of optimal N-impulse coplanar orbit transfers is investigated. In this procedure, the problem is transformed so that the calculus of variations can be employed. Applying the technique to circle-ellipse transfer it is found that the properties of the solution family are derived in a straightforward, rigorous, and global manner, in sharp contrast with the earlier derivations. The extremal solutions fall into 2 classes: (1) those that correspond to Hohmann-type transfers and (2) those that correspond to 3-point transfers with the middle point at an infinite distance from the center of attraction. For some final orbits, both classes provide candidates for the absolute minimum, and the better transfer can come from either class. For the other final orbits, only extremals that correspond to the 3-point transfer exist.

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Grumman Aircraft Engineering Corp., Bethpage, N. Y.

NECESSARY CONDITIONS FOR SINGULAR EXTREMALS, by R. E. Kopp and H. G. Moyer. [1965] [6]p. incl. diagrs. (Rept. no. RE-229J) (AFOSR-65-2095) (AF 49(638)1207) AD 629021 Unclassified

Presented at AIAA Second Aerospace Sci. Meeting, New York, Jan. 25-27, 1965.

Also published in AIAA Jour., v. 3: 1439-1444, Aug. 1965.

This paper derives a set of necessary conditions for singular arcs. In this case, the classical Weierstrass and Legendre tests as well as the maximum principle fail to determine the nature of the extremal path. In the present analysis the second variation of the function to be minimized is evaluated for explicitly defined control variations. The dominant term of a power series in τ, a parameter of the control variation which is allowed to approach zero in the limit, is calculated and examined for semidefiniteness. Should this term be zero for a particular problem, a new control variation is chosen and the procedure repeated. These control variations all belong to a special class of functions that were constructed with the satisfaction of terminal boundary conditions in mind. These boundary conditions are satisfied by applying secondary control variations that contribute terms to the second variation that are at least one degree higher in τ. The results of the analysis are applied to the specific problem of rocket flight in an inverse square law field. It is shown that, for the time open case, the singular arc (Lawden's spiral) is nonoptimal.

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Grumman Aircraft Engineering Corp, Bethpage, N. Y.

GODDARD PROBLEM WITH BOUNDED THRUST, by H. Munick. [1965] [3]p. incl. diagrs. (AFOSR-65-2331) (AF 49(638)1207) AD 629261 Unclassified

Also published in AIAA Jour., v. 3: 1283-1285, July 1965.

The problem considered is that of finding the thrust program, or control, as a piecewise continuous function of time, so that, with a fixed fuel supply, the summit altitude of a rocket in vertical flight is maximized. Under the assumptions that an optimal control exists and that the upper bound of thrust is at a sufficiently high magnitude, it is proved that the optimal control contains at most 3 subarcs. The analysis extends the previous results of Miele, Leitmann, and others to a larger class of drag functions. One of the drag functions, belonging to the class considered in the present analysis, is shown to correspond to a drag coefficient witnessing a sharp increase in the neighborhood of the speed of sound. (Contractor's abstract)

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Grumman Aircraft Engineering Corp., Bethpage, N. Y.

CONCERNING ADJOINTS OF DISCRETE-TIME SYSTEMS, by P. E. Sarachik and E. Kreindler. [1965] [2]p. (AFOSR-65-2354) (In cooperation with New York U. AF AFOSR-65-747) (AF 49(638)1207) AD 629814 Unclassified

Also published in IEEE Trans. Automatic Control, AC-10: 350-352, July 1965.

It is shown that an adjoint to a discrete-time system having all the properties of the adjoint to a continuous-time system cannot be found. (Contractor's abstract)

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Grumman Aircraft Engineering Corp., Bethpage, N. Y.

OPTIMAL CONTROL, INEQUALITY STATE CONSTRAINT AND THE GENERALIZED NEWTON-RAPHSON ALGORITHM, by R. McGill. [1965] [8]p. incl. diagrs. refs. (AFOSR-66-1192) (AF 49(638)1207)
AD 640781 Unclassified

Also published in SIAM Jour. Control, Ser. A, v. 3: 291-298, 1965.

The generalized Newton-Raphson algorithm has been developed as a tool for efficiently extracting solutions to nonlinear problems of optimal control by means of the modern high speed digital computer. This paper presents the extension of the algorithm to the important class of problems characterized by inequality constraints on the state space. The efficacy of the procedure is demonstrated by a numerical example. The problem solved is nonlinear, but admits of a closed form solution. This makes possible a direct comparison between the solution obtained by the algorithm and the analytic solution.

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Grumman Aircraft Engineering Corp. Research Dept., Bethpage, N. Y.

DISTRIBUTION THEORY AS THE BASIS OF GENERALIZED PASSIVE-NETWORK ANALYSIS, by M. R. Wohlers and E. J. Beltrami. [1965] [7]p. (AFOSR-65-2094) (AF 49(638)1512) AD 629339 Unclassified

Also published in IEEE Trans. on Circuit Theory, v. CT-12: 164-170, June 1965.

The properties of linear time-invariant passive systems are described in the context of generalized function (distribution) theory. The postulatory description of these systems is phrased in both the scattering or wave formulation, and the impedance or voltage-current basis. One conclusion of this paper is that a specific definition of passivity (attributed to G. Raisbeck) leads to a complete description of the system only when the postulate of causality is separately invoked; i.e., this definition of passivity does not imply causality and it is therefore a more fundamental assumption. Another conclusion is that the 2 seemingly different sets of postulates (scattering and impedance) are in many instances identical, the differences arise solely in the assumptions made concerning the domains of the 2 operators. Distribution theory is also used in an essential way to obtain new existence theorems, for both formulations, which are stated entirely on the real-frequency axis ($p = j\omega$). The language herein is deliberately that of generalized function theory, so that the class of admissible systems and the inputs to these systems are broadened. In particular, the results can be applied directly to systems which are described in terms of elementary functions.

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Grumman Aircraft Engineering Corp. Research Dept., Bethpage, N. Y.

A DISTRIBUTIONAL STUDY OF THE REAL FREQUENCY BEHAVIOR OF PASSIVE SYSTEMS, by M. R. Wohlers. Sept. 1965, 6p. (Research Dept. memo. no. RM-294J) (AFOSR-65-2306) (AF 49(638)1512)
AD 624771 Unclassified

Presented at Allerton Conf. on Circuit and System Theory, Illinois U., Urbana, Oct. 20-22, 1965.

The purpose of this paper is to present two theorems that constitute a realizability theory for passive n-ports in which all statements are given directly on the real frequency axis. To achieve the generality desired, i.e., to consider more general systems than rational ones, the theory of distributions has been used as the vehicle for the analysis. (Contractor's abstract)

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Grumman Aircraft Engineering Corp. Research Dept., Bethpage, N. Y.

COMPUTATIONAL TECHNIQUES FOR THE SYNTHESIS OF OPTIMUM NONUNIFORM TRANSMISSION LINES BASED ON VARIATIONAL PRINCIPLES, by M. R. Wohlers, R. E. Kopp, and H. G. Moyer. [1965] [7]p. incl. diagrs. (AFOSR-65-2338) (AF 49(638)1512)
AD 625948 Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill., Oct. 25-27, 1965.

Also published in Proc. Nat'l. Electronics Conf., v. 21: 135-141, 1965.

Synthesis procedures for the design of nonuniform transmission lines are described which employ techniques developed in the theory of optimal systems. The computational procedures, intended for computer use, are based on analytic algorithms derived using variational techniques (calculus of variations, Pontryagin Maximum Principle). Both lossless (L, C) lines and lossy (G, L, C) lines are discussed with application to the design of broadband matching networks, and absorbers. The advantages of this approach include the circumvention of the classic approximation-realization cycle, and the implicit use of max-min type constraints on the values of the line parameters.

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[Gustavus-Adolphus Coll., St. Peter, Minn.]

ATTITUDE CHANGE AND COMMUNICATION-ATTITUDE

DISCREPANCY, by J. O. Whittaker [1965] [7]p. incl. table, refs. (AFOSR-65-0710) (AF AFOSR-62-188) AD 615357 Unclassified

Also published in Jour. Social Psychol., v. 65, 141-147, 1965.

The results of the experiment indicate that there is a curvilinear relationship between attitude change and communication-attitude discrepancy. Communications presenting stands relatively close to the subject's position result in less change than do those further removed. A point is reached, however, beyond which greater discrepancies result in diminished change These data suggest that there is an optimal discrepancy between the stand of the communication and the position or attitude of the subject which results in maximum change To insure the maximum effect from persuasive communications, assessment of the distribution of attitudes held by the target audience must be made, and the deviation or discrepancy of the position of the communication must be determined on the basis of this distribution

1030

[Gustavus-Adolphus Coll., St. Peter, Minn.]

CONSISTENCY OF INDIVIDUAL DIFFERENCES IN PERSUASIBILITY, by J. O. Whittaker. [1965] [8]p. incl. refs. (AFOSR-66-1161) (AF AFOSR-62-188) AD 640698 Unclassified

Also published in Jour. Commun., v. 15, 28-38, Mar. 1965

Previous research has demonstrated the existence of a generalized trait of persuasibility. Some individuals are found to be highly susceptible to persuasive influences, regardless of the issues involved, while others are found to be highly resistant. Unfortunately, however, within most of the studies demonstrating this trait, only one medium of communication has been employed. Some investigators, for example, have used only mass communications, while others have investigated persuasibility solely in direct interpersonal communication situations. On the basis of this previous work, it has been clearly demonstrated that persuasibility as a generalized trait is "medium-free." In other words, we do not know whether those individuals found to be generally susceptible to mass communication influences are also generally susceptible to interpersonal influecnes, or vice versa In this study, susceptibility to autokinetic situation, and the results showed a significant relationship This study is an attempt to extend this work through a comparison of persuasibility in an interpersonal situation

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[Gustavus-Adolphus Coll., St. Peter, Minn.]

SEX DIFFERENCES AND SUSCEPTIBILITY TO INTERPERSONAL PERSUASION, by J. O. Whittaker [1965] [4]p. incl. tables. (AFOSR-66-1162) (AF AFOSR-62-188) AD 640699 Unclassified

Also published in Jour. Social Psychol., v. 66 91-94, 1965.

Previous studies have found female subjects to be significantly more persuasible than males in mass communication situations. In addition, the present investigation has observed that female subjects in the autokinetic situation appear to be more susceptible to the influence of a confederate's judgments than do male subjects. In that study, however, another hypothesis was under investigation, and conditions were such that no definite conclusions in this regard could be reached. This investigation was conducted to determine if there are sex differences to susceptibility to interpersonal persuasive influences. The hypothesis was that female subjects will show greater susceptibility to the influence of a confederate's judgments in the autokinetic situation than will male subjects Also under investigation in this study is the effect of the sex of the confederate as a variable in persuasion. In this connection it was hypothesized that a male confederate will exert greater persuasive influence over both male and female subjects than will a female confederate.

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Hamline U. (Dept. of Mathematics) St. Paul, Minn.

ON ABSOLUTELY CONTINUOUS FUNCTIONS, by D. E. Varberg. (1965) (11p.) (AFOSR-66-0219) (AF AFOSR-65-35) AD 631385 Unclassified

Also published in Amer. Math. Monthly, v. 72, 831-841, Oct. 1965.

The concept of absolute continuity for functions of a real variable is discussed. This topic has been well explored so most of the results are not new. What is new is the approach, which begins with an elegant inequality discovered lying buried as an innocent problem in Natanson's book (Theory of Functions of a Real Variable). From this inequality many well-known and some new results follow in an almost trivial fashion.

1033

Harvard U. Cruft Lab., Cambridge, Mass.

IDENTIFICATION OF LINEAR DYNAMIC SYSTEMS, by Y.-C. Ho and R. C. K. Lee. May 25, 1964, 29p. incl. diagrs. (Technical rept. no. 446) (AFOSR-64-1349) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) AD 601844 Unclassified

Also published in Inform. and Control, v. 8, 93-110, Feb. 1965.

This report presents a real time computational scheme for the identification of linear dynamic system parameters. The method is shown to be convergent under stochastic environment for arbitrary initial estimates of the system parameters. Experiments with second- and fourth-order systems further verify the practicality of the method. Applications of the approach to adaptive prediction and filter design are direct and obvious. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

PARAMAGNETIC RELAXATION OF SOME RARE-EARTH IONS IN DIAMAGNETIC CRYSTALS, by C.-Y. Huang. Aug. 4, 1964, 1v. incl. diagrs. tables, refs. (Technical rept. no. 452) (AFOSR-65-0026) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) AD 608278 Unclassified

Also published in Phys. Rev., v. 139, A241-A254, July 5, 1965.

The pulsed-saturation method at 8.9 kmc/sec was used to measure the spin-lattice relaxation rate T_1^{-1} for Eu^{2+}, Ho^{2+}, and Tm^{2+} in CaF_2 for Yb^{3+} in yttrium gallium garnet, yttrium aluminum garnet, and lutetium gallium garnet; for Nd^{3+} in yttrium gallium garnet and yttrium aluminum garnet; and for Sm^{3+} in lanthanum ethyl sulphate at low temperatures. The experimental data in most cases are in satisfactory agreement with the theoretical predictions based on the combined Van Vleck-Orbach theory. Besides the expected conventional processes, a process $T_1^{-1} \propto T^5$ was observed for Eu^{2+} in CaF_2 in the temperature range $15°K < 30°K$. Furthermore, a pronounced anisotropy in T_1 (a factor ~ 6) for Sm^{3+} in lanthanum ethyl sulphate was found both experimentally and theoretically. (Contractor's abstract)

1035

Harvard U. Cruft Lab., Cambridge, Mass.

AN ESTIMATION THEORY APPROACH TO PULSE AMPLITUDE MODULATION THEORY, by T. Berger. Jan. 5, 1965, 27p. incl. diagrs. (Technical rept. no. 438) (AFOSR-65-1323) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) AD 463887 Unclassified

By generalizing a trivial problem in estimation theory, some interesting results have been obtained for a class of pulse amplitude modulation (PAM) communication channels. In particular, we consider a linear channel with memory perturbed by additive noise which is uncorrelated with the signal statistics. It is shown that, for specified second-order statistics and a mean square error criterion, the Bayes estimation rule for the specific case of zero-mean Gaussian signal and noise statistics is also both the best linear estimation rule and the minimax estimation rule. This fact is used in the theoretical design of sampled-data and continuous time receivers for such PAM systems. In the continuous time case with an infinite observation interval and stationary noise statistics, the receiver thus designed agrees with the optimum linear receiver previously derived for this case by Tufts using a very different approach; the present analysis shows that Tufts's linear receiver is, therefore, also the best nonlinear receiver in the minimax sense.

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Harvard U. Cruft Lab., Cambridge, Mass.

STABILITY OF A CLASS OF DIFFERENTIAL EQUATIONS WITH A SINGLE NONLINEARITY, by K. S. Narendra and C. P. Neuman. Apr. 28, 1965, 23p. (Technical rept. no. 468) (AFOSR-65-2274) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) Unclassified

In this report, the absolute stability of a class of dynamical systems with a single nonlinearity which satisfy neither the Popov nor the extended Popov theorem is investigated in great detail. Specifically, by reexamining the new Lyapunov function introduced recently by the authors and utilizing the Kalman lemma, frequency

domain stability criteria are obtained for the linear plant G(s) in the case of both monotone increasing and odd monotone increasing nonlinearities. For infinite sector problems these criteria are applicable to linear plants whose numerator dynamics have some real non-zero zeros; for finite sector problems these criteria are applicable to systems whose characteristic equation evaluated at the maximum stable feedback gain has some real non-zero zeros or real non-zero poles. The results presented here demonstrate that the stability criteria on the linear plant are even weaker in the case of odd monotone increasing nonlinearities than in the case of monotone increasing nonlinearities. Some examples are presented in order to illustrate the ideas developed

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Harvard U. [Cruft Lab.] Cambridge, Mass

ADAPTIVE DESIGN OF FEEDBACK CONTROLLERS FOR STOCHASTIC SYSTEMS, by Y.-C. Ho. [1965] [2]p. incl diagr. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under Nonr-186616) Unclassified

Published in IEEE Trans. Automatic Control, v AC-10: 367-368, July 1965.

A design procedure is presented for a controller which offers the advantage that there is no approximation whatsoever in the training data. The u(t) used is always the optimal control for the observations given by construction. The approximation comes in only as a result of the finite size of the pattern samples and the form of the controller function assumed. The procedure monotonically improves the approximation One can always increase the number of samples used, the complexity of the function used for approximation; and the dimension of the pattern vector (the number of z's).

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Harvard U. [Cruft Lab.] Cambridge, Mass.

AN ALGORITHM FOR LINEAR INEQUALITIES AND ITS APPLICATIONS, by Y.-C. Ho and R. L. Kashyap. [1965] [6]p. incl. refs (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under Nonr-186616) Unclassified

Published in IEEE Trans. Electron Comput., v EC-14: 683-688, Oct. 1965.

An exponentially convergent and finite algorithm is presented for the determination of the solution α of the linear inequalities $A\alpha > 0$ for a given matrix A, or for determining the nonexistence of solution for $A\alpha > 0$. This result is useful in threshold-switching theory and in pattern classification problems Experiments indicate extremely rapid convergence of the method.

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Harvard U. Cruft Lab., Cambridge, Mass.

A CLASS OF ITERATIVE PROCEDURES FOR LINEAR INEQUALITIES, by Y.-C Ho and R L Kashyap. Jan 14, 1965, 8p. (Technical rept no 461) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) AD 459050 Unclassified

A class of exponentially convergent and finite procedures for determining α such that $A\alpha > 0$ is presented (Contractor's abstract)

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Harvard U [Cruft Lab] Cambridge, Mass

DIFFERENTIAL GAMES AND OPTIMAL PURSUIT-EVASION STRATEGIES, by Y -C. Ho, A. E Bryson, Jr., and S. Baron [1965] [5]p incl diagr refs (Technical rept. no. 457) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under Nonr-186616) Unclassified

Published in IEEE Trans. Automatic Control, v. 10 385-389, Oct. 1965.

It is shown that variational techniques can be applied to solve differential games. Conditions for capture and for optimality are derived for a class of optimal pursuit-evasion problems. Results are used to demonstrate that the well known proportional navigation law is actually an optimal intercept strategy. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

DISPERSION OF NONLINEAR SUSCEPTIBILITY, by R. K. Chang. Nov. 1965 [75]p. incl. diagrs. table, refs. (Technical rept. no. 491) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under Nonr-186616) AD 479875

The dispersion of the optical nonlinear susceptibility of semiconductors with 43m symmetry is discussed. The nonlinear susceptibility measures properties which are peculiar to mixed parity of band wavefunctions and which should contain information about the electronic structure that is complementary to that obtained from the dispersion of linear susceptibility. The magnitude of the nonlinear susceptibility for second-harmonic production has been measured, relative to KDP, in single crystal mirrors of GaAs, InAs, InSb, and ZnTe at 9 different wavelengths. Pronounced maxima in the nonlinear susceptibility as a function of frequency is observed and can be correlated with the structure of the linear dielectric constants. These maxima in the nonlinear susceptibility are connected with critical points in the joint density of states of the band structure The nonlinear susceptibility is complex when the medium is

absorbing at either or both of the fundamental and harmonic wavelengths. In order to know the real and imaginary parts of the nonlinear susceptibility, one must know its phase as well as its magnitude. An experiment is described which determines the phase of the nonlinear susceptibility. This phase has been measured for GaAs, InAs, and ZnTe with the ruby laser. Another part of the talk deals with the verification of several postulates of nonlinear optics, in particular, the nonlinear counterpart of laws for optical reflection and the analog of Brewster's angle for second-harmonic polarization. (Contractor's abstract)

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Harvard U. [Cruft Lab.] Cambridge, Mass.

DISPERSION OF THE OPTICAL NONLINEARITY IN SEMICONDUCTORS, by R. K. Chang, J. Ducuing, and N. Bloembergen. [1965] [4]p. incl. diagrs. refs. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under Nonr-186616) Unclassified

Published in Phys. Rev. Ltrs., v. 15 415-418, Aug. 1965.

The dispersion of the modulus of the nonlinear susceptibility $\chi_4^{NL}(2\omega)$ responsible for second-harmonic generation has been directly measured for the first time. The crystals investigated were several semiconductors having zincblende (43m) symmetry. The frequency range not only includes the absorption-edge region but also extends well inside this region. The experimental arrangement is shown. The intensity of the reflected harmonic beam from the semiconductor is measured f and compared to that produced in transmission through a KDP crystal by the same source. The dispersion results clearly show the influence of the critical points in the density of states The dispersion of the real and imaginary part of $\chi^{NL}(2\omega)$ should provide some information not available from the study of linear properties alone.

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Harvard U. Cruft Lab., Cambridge, Mass.

A FUNCTIONAL EQUATION METHOD FOR ESTIMATING CONVERGENCE INTERVALS AND TRUNCATION ERRORS IN SMALL PARAMETER NONLINEAR OSCILLATIONS, by R. J. McLaughlin. Dec. 1965, 47p. incl. diagrs. refs. (Technical rept. no. 486) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) AD 627646 Unclassified

Most current methods of constructing periodic solutions of quasi-linear differential equations with periodic right-hand sides suffer from 2 important practical defects. Although under appropriate conditions the theory of such equations guarantees the existence of a periodic solution for 'sufficiently small' values of the perturbing parameter, there is usually no indication of how small the parameter must be, and hence no indication whether any particular calculated solution really applies. Secondly, although in principle an exact solution may usually be constructed by infinite iteration of some computation algorithm (assuming the parameter to be sufficiently small), there is usually no indication of the error remaining after only a finite number of iterations, and hence no indication of the accuracy of the approximate solution with which one must be satisfied in practice. The present report describes a method of constructing, from the majorized right-hand side of the original differential equation, a certain functional algebraic equation whose solution is a majorant for the periodic solution of the differential equation. This majorant has the property that its power series expansion majorizes the formal power series expansion of the periodic solution term by term.

1044

Harvard U. [Cruft Lab.] Cambridge, Mass.

LINEAR ELECTRIC SHIFTS IN ENDOR SPECTRUM OF F CENTERS (Abstract), by J. Reichert. [1965] [1]p. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 489, Apr. 26, 1965.

A linear electric-field shift has been observed in the ENDOR spectrum of F centers in KCl. An ENDOR spectrometer has been constructed in which a uniform dc electric field could be applied to a sample (with fields to about 30 kv/cm) without seriously degrading the sensitivity of the spectrometer. A TE_{102} mode rectangular cavity was modified to permit nuclear radio-frequency fields and dc electric fields to be simultaneously incident on the sample F centers were created by x-ray bombardment (50 kv at 20 ma for 15 h) of KCl crystals at room temperature. All ENDOR spectra with and without electric fields were observed at 2°K. A splitting in the ENDOR lines due to the electric field for the nearest-neighbor atoms (6 sites at [100]) was observed. The angular dependence of the electric-field effect was also measured.

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Harvard U. [Cruft Lab.] Cambridge, Mass.

LINEAR FEEDBACK SOLUTIONS FOR MINIMUM EFFORT INTERCEPTION, RENDEZVOUS, AND SOFT LANDING, by A. E. Bryson, Jr. [1965] [3]p. incl. diagr. [Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616] Unclassified

Published in AIAA Jour., v. 3· 1542-1544, Aug. 1965.

Consideration is given of an equation which can be

interpreted as a sampled-data guidance law or a continuous feedback guidance law in application to the following cases: terminal velocity control, interception of a target in free fall, rendezvous with a target in free fall, and soft landing.

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Harvard U. Cruft Lab., Cambridge, Mass.

NONLINEAR FEEDBACK SOLUTION TO A BOUNDED BRACHISTOCHRONE PROBLEM IN A REDUCED STATE SPACE, by J. L. Speyer. Dec. 1965 [21]p. incl. diagrs. (Technical rept. no. 492) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under Nonr-186616) AD 627647 Unclassified

The optimal nonlinear feedback law for both an unbounded and bounded Brachistochrone problem is given. These control laws describe the Brachistochrone problem in a very simple manner. They are derived by using a dimensionless set of state variables which are of lower dimension than the original state space. Also using this reduced state space a 2 dimensional instead of 3 dimensional field of extremals is constructed for the bounded Brachistochrone problem. This illustrates that the state space may be reduced so that the storage of a field of extremal trajectories will not exceed the storage capacity of a practical on board computer. In this way, optimal feedback control may become a practical technique for a larger class of nonlinear systems.

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Harvard U. Cruft Lab., Cambridge, Mass

NUCLEAR MAGNETIC RELAXATION IN LIQUID METALS, ALLOYS, AND SALTS, by M. Hanabusa. May 14, 1965 [145]p. incl. diagrs. tables, refs. (Technical rept. no. 470) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) AD 474515 Unclassified

Nuclear relaxation phenomena have been studied in systems in which extremely fast modulations of the perturbing interactions by internal motions exist. A comparison of the spin-lattice relaxation time T_1 and the spin-spin relaxation time T_2 has been of particular interest, as well as an investigation of the various possible relaxation mechanisms, including the well-known Fermi contact hyperfine interaction. Comprehensive calculations of relaxation times for all important perturbing interactions have been made on the basis of the Redfield theory. Experiments measured both T_1 and T_2, and examined the dependence of the relaxation times on temperature, isotopic abundance, solute concentration, impurity content, and so on. Whenever necessary, Knight shifts were measured, and the results were used in combination with the relaxation time data. All measurements were made with a coherent pulsed nuclear resonance apparatus, and the sample temperature was controlled by means of a hot air oven. The conclusion is that a strong electric quadrupole relaxation mechanism exists in molten sodium metal and sodium alloys. The data can be explained, if a temperature-dependent molecular association is assumed.

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Harvard U. Cruft Lab., Cambridge, Mass

ON THE ABSTRACTION PROBLEM IN PATTERN CLASSIFICATION, by Y.-C. Ho and C. Blaydon Aug 1965 [16]p. incl. refs. (Technical rept. no. 476) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) AD 623778 Unclassified

An algorithm is presented which, utilizing the given samples of the 2 class A and B, converges to the expression p (A x), the probability that the given sample x belongs to class A.

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Harvard U. [Cruft Lab.] Cambridge, Mass.

OPTICALLY INDUCED MAGNETIZATION IN RUBY, by J. P. van der Ziel and N. Bloembergen [1965] [6]p incl. diagrs table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) Unclassified

Published in Phys. Rev., v. 138· A1287-A1292, May 17, 1965

The magnetization of ruby in a magnetic field at 300 K is changed when the ruby is optically pumped with linearly polarized radiation from a Q-switched ruby laser. With a magnetic field parallel to the trigonal axis, laser light polarized parallel to this axis induces transitions from the spin ± 1 2 levels of the $^4A_2$ ground state to the levels of the $\bar{E}(^2E)$ excited state. The change in M_z is linearly proportional to H except near the anticrossing points of the $^4A_2$ spin levels at 2.07 and 4.14 kG. At these field strengths, there is an enhancement of the magnetization caused by state mixing of the $^4A_2$ wave functions. When H has a small component perpendicular to the z axis, a magnetization is detected parallel to this component in the vicinity of 4.14 kG. The effect requires a long ground-state relaxation time. In a separate experiment, the relaxation of M_z was found to vary from 0.13 μsec in zero magnetic field to a constant value of 0 57 μsec for fields above 60 G. (Contractor's abstract)

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Harvard U. [Cruft Lab.] Cambridge, Mass

OPTICALLY-INDUCED MAGNETIZATION RESULTING FROM THE INVERSE FARADAY EFFECT, by J. P. van der Ziel, P. S. Pershan, and L. D. Malmstrom.

[1965] [4]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham), and Office of Naval Research] under Nonr-186616) Unclassified

Published in Phys. Rev. Ltrs., v. 15: 190-193, Aug. 1965.

The first observation of optically (laser) induced magnetization in a nonabsorbing material is described, and the relationship between this effect which is called the inverse Faraday effect (IFE), and the Faraday effect in the same material is demonstrated.

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Harvard U., [Cruft Lab.] Cambridge, Mass.

PARAMAGNETOELECTRIC EFFECTS IN $NiSO_4 \cdot 6H_2O$, by S. L. Hou and N. Bloembergen. [1965] [9]p. incl. illus. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [Nonr-186616]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 22-25, 1964.

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Also published in Phys. Rev., v. 138: A1218-A1226, May 17, 1965.

Piezoelectric paramagnetic crystals can show a linear dependence of the paramagnetic susceptibility on an applied electric field. This effect has been detected in $NiSO_4 \cdot 6H_2O$ at low temperatures. The thermodynamic inverse effect, the creation of an electric polarization by applied magnetic fields, has also been observed. Both effects are derived from a free energy which for the tetragonal 422 symmetry takes the form $\xi(H_a E_b - H_b E_a) H_c$, where c denotes the tetragonal axis. The quantity ξ has been measured as a function of temperature. It has a pronounced maximum at 3°K, where $\xi = 2.6 \times 10^{-9}$ esu. It passes through zero at 1.38°K. Between 10 and 70°K it decreases approximately as T^{-2}. These features are explained by a microscopic theory which considers the linear variation in an applied electric field of all parameters in the spin Hamiltonian of the four Ni^{++} ions in the unit cell. The dominant contribution comes from the change in the crystal-field splitting D. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

REINFORCED PREFIXED COMMA FREE CODES, by C. V. Ramamoorthy and D. W. Tufts. Aug. 1965, 26p. incl. diagrs. tables. (Technical rept. no 480) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under Nonr-186616) AD 474482 Unclassified

A new class of prefixed comma free codes is considered in which the distance between the prefix of length A and other A-tuple is allowed to vary with the position of the A-tuple. This is particularly useful for systems in which the receiver can predict the position of the synchronizing prefix within a number of digits that is small compared to the work length. This work extends the work of Gilbert, who has considered uniform, distance one, prefixed comma free codes. Our generalization of the constraints on comma free codes leads us to modifications of Gilbert's method of enumerating the number of allowable code words. By treating the state diagram of a code word generator as a signal flow graph the enumeration can be performed by using the flowgraph loop rule developed by Shannon, Mason, and Lorens.

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Harvard U. Cruft Lab., Cambridge, Mass.

STABILITY OF A CLASS OF DISCRETE TIME SYSTEMS WITH A SINGLE FEEDBACK NONLINEARITY, by K. S. Narendra and C. P. Neuman. June 1, 1965, 33p. incl. diagrs. refs. (Technical rept. no. 473) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616) AD 473590 Unclassified

In this report, the new Lyapunov function introduced recently by the authors is used in order to derive sufficient conditions for the absolute stability of the sampled-data control system which is composed of a linear time-invariant plant characterized by the transfer function in the forward path and a nonlinear feedback element whose argument is a linear combination of the system state variables. The main contribution of this report is the derivation of frequency domain stability criteria for the linear plant in the case of continuous monotone increasing and odd monotone increasing nonlinear feedback functions which have a continuous and bounded derivative and satisfy certain inequality statements. The frequency domain stability criteria provide a direct, systematic method for the generation of explicit Lyapunov functions. In addition, for the case of certain nonlinear time-varying feedback elements, the Lyapunov function is employed to derive a geometrical method, completely analogous to the Circle Criterion of continuous-time dynamical systems, for determining the range of absolute stability of the sampled-data control system through the examination of the frequency response of the time-invariant plant.

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Harvard U. Cruft Lab., Cambridge, Mass.

A SUCCESSIVE SWEEP METHOD FOR SOLVING OPTIMAL PROGRAMMING PROBLEMS, by S. R. McReynolds and A. E. Bryson, Jr. Mar. 2, 1965, 5p. (Technical rept. no. 463) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under Nonr-186616) AD 459518 Unclassified

An automatic, finite-step numerical procedure is

described for finding exact solutions on nonlinear optimal programming problems. The procedure represents a unification and extension of the steepest-descent, and second variation techniques. The procedure requires the backward integration of the usual adjoint-vector differential equations plus certain matrix differential equations. These integrations correspond, in the ordinary calculus, to finding the first and second derivatives of the performance index respectively. The matrix equations arise from an inhomogeneous Ricatti transformation, which generates a linear 'feedback control law' that preserves the gradient histories on the next step or permits changing them by controlled amounts, while also changing terminal conditions by controlled amounts. Thus, in a finite number of steps, the gradient histories can be made identically zero, as required for optimality, and the terminal conditions satisfied exactly. One forward plus one backward sweep, correspond to one step in the Newton-Raphson technique for finding maxima and minima in the ordinary calculus. As by-products, the procedure produces (a) the functions needed to show that the program is, or is not, a local maximum (the generalized Jacobi test) and (b) the feedback gain programs for neighboring optimal paths to the same, or a slightly different, set of terminal conditions.

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Harvard U. [Cruft Lab.] Cambridge, Mass.

TEMPERATURE-DEPENDENT CRYSTAL FIELD AND HYPERFINE INTERACTIONS, by W. M. Walsh, Jr., J. Jeener, and N. Bloembergen. [1965] [13]p. incl. illus. diagrs. tables, refs. (In cooperation with Bell Telephone Laboratories, Murray Hill, N. J.) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186616]) Unclassified

Published in Phys. Rev., v. 139: A1338-A1350, Aug. 16, 1965.

The effects of temperature variation on the spin-Hamiltonian parameters of several paramagnetic ions bound in simple crystals have been measured by magnetic resonance techniques. In MgO the g shifts of two F-state ions, V^{2+} and Cr^{3+}, increase and the cubic-field splittings of two S-state ions, Mn^{2+} and Fe^{3+}, decrease with increasing temperature almost exactly as would be expected from thermal expansion alone. The axial crystalline-field splitting of locally compensated Cr^{3+} ions also increases with temperature at a rate attributable primarily to thermal expansion. The absence of appreciable explicit temperature dependence of crystalline-field parameters in MgO is consistent with an effective point-charge model for the source of the lattice potential and cubically symmetric lattice vibrations. In zinc blende, however, the cubic-field splitting of Mn^{2+} decreases more rapidly with rising temperature than may be accounted for by thermal expansion alone, presumably because of failure of the point-charge approximation. The hyperfine couplings of $(V^{51})^{2+}$ and $(Mn^{55})^{2+}$ in MgO decrease with increasing temperature, whereas a much smaller increase would be expected due to thermal expansion. Similar explicit variations of the $(Mn^{55})^{2+}$ hyperfine interaction are found in ZnS, ZnO, CdTe, and $KMgF_3$. The effect may be approximately represented by a power law of the form $A(T) = A(0)(1-CT^n)$ where $n \cdot 3/2$. The significance of this result for nuclear-magnetic-resonance studies of concentrated magnetic materials is indicated. The general nature of the explicit temperature dependence is discussed but no detailed theoretical analysis is possible at this time. (Contractor's abstract modified)

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Harvard U Cruft Lab., Cambridge, Mass.

RADIATION FROM A UNIFORMLY MOVING DISTRIBUTION OF ELECTRIC CHARGE IN AN ANISOTROPIC, COMPRESSIBLE PLASMA, by H. S. Tuan and S. R. Seshadri. May 2, 1963 [26]p. incl. diagrs. refs. (Technical rept. no. 410) (AFOSR-64-0615) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186632, and National Science Foundation) AD 411849 Unclassified

Also published in IEEE Trans. Antennas and Propagation, v. AP-13: 71-78, Jan. 1965.

The radiation characteristics of a linear distribution of electric charge moving with a uniform velocity in a homogeneous electron plasma of infinite extend are investigated for the case in which a uniform static magnetic field is impressed externally throughout the medium. The linear distribution of charge and its direction of motion are assumed to be parallel and perpendicular, respectively, to the direction of the external magnetic field. Of the two possible modes of waves of small amplitude, namely, the modified electromagnetic mode and the modified plasma mode, the uniformly moving charge distribution excites the modified plasma mode. The emitted radiation has no frequencies less than the plasma frequency. For a particular value of the ratio of the gyrotropic to the plasma frequency of the electrons, the frequency and the angular spectrum of the emitted radiation are determined for 2 values of the velocity of the charge. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

THE CYLINDRICAL ANTENNA WITH ARBITRARY DRIVING POINT, by R. W. P. King and T. T. Wu. Oct. 1964 [40]p. incl. diagrs. (Technical rept. no. 455) (AFOSR-64-2454) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186632) AD 608283 Unclassified

Also published in IEEE Trans. Antennas and Propagation, v. AP-13: 710-718, Sept. 1965.

A new reasonably accurate approximate solution is obtained in trigonometric form of the distribution of current and the admittance of a cylindrical antenna when driven off center. The symmetrical problem (sleeve dipole) with 2 equal generators at the same distances from the center is solved first, then the antisymmetrical

case with equal and opposite generators. A suitable superposition of the 2 results provides the solution for the dipole antenna when driven at an arbitrary point along its length. The results are sufficiently simple to be useful in the study of antennas with active or passive elements located along their length. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

THE LONG YAGI-UDA ARRAY, by R. J. Mailloux Mar. 30, 1965 [68]p. incl. illus. diagrs. tables, refs. (Technical rept. no. 464) (AFOSR-65-1324) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186632 and National Science Foundation) AD 615803 Unclassified

The King-Sandler array theory is used to analyze the excitation of a surface wave along a semi-infinite Yagi array, as well as the scattering of such a wave at the end of the array. A method for approximately analyzing the behavior of finite Yagi arrays is presented which involves the matching of 2 terminal-zone problems for semi-infinite arrays. Before attempting to correlate the new theory with the more rigorous array theory, an experimental study of a 2-element Yagi array was undertaken, and all results are shown to be accurately predicted by the King-Sandler theory. An extensive set of numerical data is presented to compare wave theory with array theory, and once again the agreement is excellent. Finally, the new theory is shown to predict a certain critical point in the data at which the wave solution ceases to exist. This point is also observed to enter dramatically into the King-Sandler solution, thus providing a final contribution to the evidence which links the wave theory to the accepted King-Sandler theory.

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Harvard U. [Cruft Lab.] Cambridge, Mass.

ANTENNA AND WAVE THEORIES OF INFINITE YAGI-UDA ARRAYS, by R. J. Mailloux. [1965] [8]p. incl. diagrs. refs. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under Nonr-186632, and National Science Foundation) Unclassified

Published in IEEE Trans. Antennas and Propagation, v. AP-13: 499-506, July 1965.

An integral equation for the propagation constant along an infinitely long Yagi structure is derived by expanding the vector potential function for such an array in terms of the spatial harmonic solutions of wave theory. This equation is shown to be identical with the integral equation derived on the basis of array theory and transformed by the Poisson summation formula. With the identity of array theory and this new wave theory formation established, the wave theory is used to discuss allowed wave solutions and the physical characteristics required of dipoles in order that they support a wave solution. The fundamental integral equation is solved by means of the array theory of King and Sandler; the numerical results are found to agree quite well with previously published data. Finally, the problem of two parallel nonstaggered Yagi arrays is considered, and it is shown that the propagation constant of the composite structure either decreases or increases over that of the isolated array depending upon whether the symmetric or the antisymmetric mode is excited. Some peculiar effects are noted with respect to this antisymmetric solution, and these lead to the existence of conditions under which no unattenuated wave solution is possible. This is referred to as the "cutoff condition." Numerical results are achieved which agree very well with experimental data obtained as part of this research. (Contractor's abstract)

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Harvard U. [Cruft Lab.] Cambridge, Mass.

THE BICONICAL ANTENNA IN A RADIALLY STRATIFIED MEDIUM, by J. G. Fikioris. [1965] [14]p. incl. diagrs. refs. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under Nonr-186632, and National Science Foundation) Unclassified

Published in IEEE Trans. Antennas and Propagation, v. AP-13: 289-302, Mar. 1965.

The theory of a tranamitting biconical antenna in a radially and continuously stratified medium is developed; its input impedance is computed and plotted vs its length for various media and cone angles. The medium extends to infinity and is characterized by a complex dielectric factor $\xi = \epsilon - i\sigma/\omega = \epsilon_0 f(r)$, where r is the radial distance from the center of the antenna. For the "stratification function" the form $f(r) = (kr + a)/(kr + b)$ is considered, where a and b are constant parameters, in general complex. The plots clearly exhibit all effects of dissipation and stratification expected on physical grounds and observed experimentally for dipole antennas. (Contractor's abstract)

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Harvard U. [Cruft Lab.] Cambridge, Mass.

THE CIRCULAR LOOP ANTENNA MULTILOADED WITH POSITIVE AND NEGATIVE RESISTORS, by K. Iizuka. [1965] [14]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186632) Unclassified

Published in IEEE Trans. Antennas and Propagation, v. AP-13. 7-20, Jan. 1965.

Studies are made of both the driving-point impedance and the amplitude and phase distributions of the current in a circular loop which is driven by an arbitrary number of delta-function generators and loaded with an arbitrary number of lumped impedances. The only restriction imposed in the present treatment is that the elements (either generator or load) are spaced at equal intervals of $2\pi b \cdot m$ along the circumference where m is

the total number of elements and b is the radius of the loop. The numerical calculations include loads with negative resistance in order to take account of loops loaded with an element like an Esaki tunnel diode, with proper precautions against both self-oscillation and switching effects. A study of such precautions is to be considered separately.

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Harvard U. Cruft Lab., Cambridge, Mass.

COUPLED DIPOLES IN A DISSIPATIVE MEDIUM. PART I: THEORY. PART II. MEASUREMENTS, by R. W. P. King, S. S. Sandler, and K. Iizuka. July 20, 1965 [35]p. incl. diagrs. tables, refs. (Technical rept. no. 479) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186632 and National Science Foundation) AD 623779 Unclassified

The admittance and impedance of a 2-element array when immersed in an arbitrary dissipative medium are determined from a generalization of the King-Sandler theory of arrays. Numerical results are given for half-wave and quarter-wave dipoles with 2 different thicknesses. The distance between the element is the independent variable. Experiments carried out in a tank filled with a conducting solution to determine the self and mutual admittances of coupled dipoles are described. The agreement between the measured values and the theory is quite good.

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Harvard U. [Cruft Lab.] Cambridge, Mass.

THE CURRENT IN BARE CIRCULAR LOOP ANTENNAS IN A DISSIPATIVE MEDIUM, by R. W. P. King, C. W. Harrison, Jr., and D. G. Tingley. [1965] [3]p. incl. diagr. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under Nonr-186632) Unclassified

Published in IEEE Trans. Antennas and Propagation, v. AP-13: 529-531, July 1965.

The distribution of current in bare circular loop antennas has been evaluated from the theory of T. T. Wu. Computations have been made for loops in air and in an infinite homogeneous isotropic dissipative medium. Currents are shown graphically for loops with circumferences up to two wavelengths in media, with α/β ranging from zero to one, where $\kappa = \beta - j\alpha$ is the complex wave number. (Contractor's abstract)

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Harvard U. [Cruft Lab.] Cambridge, Mass.

AN EXPERIMENTAL INVESTIGATION OF A TWO-SLOT TRANSMISSION LINE ON NONPLANAR SURFACES, by R. W. Burton and R. W. P. King. [1965] [4]p. incl. illus. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham), and Office of Naval Research] under Nonr-186632) Unclassified

Published in IEEE Trans. Microwave Theory and Tech., v. MTT-13: 303-306, May 1965.

The 2-slot transmission line, which is the dual of a 2-strip line when both lines lie in a plane, is studied experimentally when the metal sheet into which it is cut is bent through angles up to 90°. It is found that the bent 2-slot line is substantially the dual of a similarly bent 2-strip line including a complementary reactive junction network at the bend. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

RADIATION FROM A CURRENT LOOP IN A COMPRESSIBLE PLASMA, by H. S. Tuan. June 25, 1965 [16]p. incl. diagrs. (Technical rept. no. 475) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186632) AD 624154 Unclassified

The technique of treating radiation problems in 2 component, warm isotropic plasmas in terms of 3 orthogonal modes is applied to investigate the radiation characteristics of a circular filamentary current loop with a prescribed current distribution. The cases of a circular loop excited with dipole-mode current at frequencies below the ion plasma frequency is emphasized. Numerical values for the radiated power are obtained for certain interesting ranges of the parameters.

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Harvard U. [Cruft Lab.] Cambridge, Mass.

RADIATION FROM A PHASED LINE SOURCE IN A MAGNETOIONIC MEDIUM, by H. S. Tuan and S. R. Seshadri. [1965] [12]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham), and Office of Naval Research] under Nonr-186632) Unclassified

Published in Canad. Jour. Phys., v. 43: 1636-1648, Sept. 1965.

The radiation resistance of a circular filament of electric current immersed in an unbounded magneto-ionic medium has been evaluated for the case in which the axis of the loop is parallel to the direction of the external static magnetic field. Numerical values of the radiation resistance have been obtained for two different sizes of the loop and for some typical values of the plasma parameters, for the special case of the dominant mode excitation for which the current is a constant around the loop. Radiation from a prescribed electric current on a filamentary loop in a warm, unbounded plasma has been investigated. The formula for

radiation resistance is obtained in the general case. A numerical example is obtained specifically for the case of radiation from the distribution of a dipole mode of the current on the loop.

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Harvard U. Cruft Lab., Cambridge, Mass.

SCATTERING FROM A DIPOLE ANTENNA EMBEDDED IN A DISSIPATIVE HALF-SPACE. PART 1. CURRENT DISTRIBUTION, by H. S. Tuan and R. W. P. King. Oct. 1965, 19p. incl. diagrs. refs. (Technical rept. no. 487) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-186632) AD 475454 Unclassified

The current distribution on a half-wave dipole antenna embedded in a conducting half-space is investigated in this report. The dipole antenna is parallel to the plane of the interface between the 2 media. It is illuminated by a diffracted inhomogeneous plane wave with perpendicular magnetic field vector. The current distribution is found mainly consinusoidal with a shifted cosine correction term. A numerical analysis is given for the case where the dissipative medium has average earth constants. Variations of the current due to different angles of incidence are also investigated.

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Harvard U. Dept. of Mathematics, Cambridge, Mass.

ON FINITE DESARGUESIAN PLANES. I, by R. Brauer. [1965] [7]p. (AFOSR-66-1381) (AF 49(638)1381) AD 640774 Unclassified

Also published in Math. Zeitschr., v. 90: 117-123, Aug. 1965.

A Desarguesian projective plane Π determines its group G of projectivities. Conversely, given the group G, the plane Π may be reconstructed. In principle, any axiomatic description of Π yields a characterization of the projective group G. Of course, these characterizations may appear somewhat artificial from a group theoretical point of view, and other characterizations which are more closely related to group theoretical principles may be sought. This paper concerns the case of finite planes Π. The question then is of interest in connection with the problem of characterizing the simple or nearly simple finite groups. If Π belongs to the Galois field GS(q) with q elements, G is the group G = PGL(q). The final aim is that of giving a characterization of G by means of properties of the centralizer of an involution. This introductory paper deals with a set of postulates for a group G which permit a projective plane Π in terms of G, such that G has a natural representation by collineations of Π. These results are still close to a direct translation of projective geometry into group theory. A later paper will examine the characterizations of G by means of centralizers of involutions. The number q is odd.

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Harvard U. [Dept. of Mathematics] Cambridge, Mass.

HYPERBOLIC CAPACITY AND INTERPOLATING RATIONAL FUNCTION, by J. L. Walsh. [1965] [11]p. (AFOSR-66-1512) (AF 49(638)1591) Unclassified

Also published in Duke Math. Jour., v. 32: 369-380, Sept. 1965.

The object of this note is twofold: (1) to establish some results concerning hyperbolic (non-euclidean) capacity of plane point sets, extending theorems due to Tsuji and Pommerenke and (2) to apply these results in the study of interpolation and approximation by rational functions, including in particular the concept of maximal (greatest geometric degree of) convergence. The sequence of theorems developed in the present note is largely the hyperbolic analog of the discussion previously developed by Walsh, Feketi et al.

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Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON THE DEGREE OF CONVERGENCE OF EXTREMAL POLYNOMIALS AND OTHER EXTREMAL FUNCTIONS, by J. L. Walsh and A. Sinclair. [1965] [15]p. incl. refs. (AFOSR-66-1513) [AF 49(638)1591] AD 638712 Unclassified

Also published in Trans. Amer. Math. Soc., v. 115: 145-160, Mar. 1965.

Let a given function F(z) be of class L^p, $p > 1$, on an analytic Jordan curve γ in the plane of the complex variable z, and let $p_n(Z)$ be the unique sequence of polynomials in z of respective degree n of best approximation to F(z) on γ in the sense of minimizing $\int_\gamma |F(z) - p_n(z)|^p |dz|$; these minimizing $p_n(z)$ may also be subjected to certain auxiliary conditions of interpolation $p_n(W_k) = u_k$, $k = 1, 2, \ldots, m$, which are independent of n and are not necessarily related to F(z). The object is to study convergence and degree of convergence of the sequence $p_n(z)$ to a possible limit minimizing function and to study various properties of this limit function. This problem is attacked first by studying a general situation in L^p space, and then by specializing to the problem already mentioned. Likewise the analogous problem is treated where best approximation is measured by a surface integral over the interior C of γ.

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Harvard U. [Dept. of Mathematics] Cambridge, Mass.

THE CONVERGENCE OF SEQUENCES OF RATIONAL FUNCTIONS OF BEST APPROXIMATION. II, by J. L. Walsh. [1965] [10]p. (AFOSR-66-1514) (AF 49(638)-1591) Unclassified

Also published in Trans. Amer. Math. Soc., v. 116: 227-237, Apr. 1965.

Unless the poles of a rational function of best approximation are prescribed in advance, the determination of those poles even approximately may be difficult, yet be necessary for a complete study of approximation or convergence. The object of this note is to enlarge the category of those cases where this determination is possible, especially to study approximation on a set having no interior points, and on a set with several components. Here methods are based on the use of geometric degree of convergence, in various forms, including methods developed in the theory of approximating polynomials.

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Harvard U. [Dept. of Mathematics] Cambridge, Mass.

THE CONVERGENCE OF SEQUENCES OF RATIONAL FUNCTIONS OF BEST APPROXIMATION WITH SOME FREE POLES, by J. L. Walsh. [1965] [16]p. incl. refs. (AFOSR-66-1517) (AF 49(638)1591) AD 639884 Unclassified

Also published in Approximation of Functions; Proc. of the [Eighth] Symposium, General Motors Research Laboratories, Warren, Mich., (Aug. 31-Sept. 2, 1964) ed. by H. L. Garabedian. Amsterdam, Elsevier, 1965. p. 1-16.

In this paper various results concerning the convergence of sequences of rational functions of best approximation with some free poles prescribed and others free, with reference both to degree of approximation and regions of convergence, are brought together and unified, new ones are added, and open problems are particularly emphasized. In particular the paper discusses degrees of convergence, regions of convergence, the degree of convergence of poles, norms involving p^{th} powers, and properties of the Pade functions.

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Harvard U. [Dept. of Mathematics] Cambridge, Mass.

CONVOLUTION TRANSFORMS WHOSE INVERSION FUNCTIONS HAVE COMPLEX ROOTS, by J. Dauns and D. V. Widder. [1964] [16]p. (AFOSR-66-0672) (AF AFOSR-63-393) AD 641526 Unclassified

Also published in Pacific Jour. Math., v. 15: 427-442, June 1965.

The convolution transform is defined by the equation (1.1) $f(x) = G(x-t)\,(t)dt = (G_*)(x)$. If the kernel G(t) has a bilateral Laplace transform which is the reciprocal of an entire function E(s), the E(s) is called the inversion function of the transform. This terminology is appropriate in view of the fact that the transform (1.1) is inverted, in some sense, by the operation E(D), where D stands for differentiation with respect to x: (1.2) $E(D)f(x) = (x)$. It is the purpose of the present paper to prove (1.2) when the roots of E(s) are allowed to be genuinely remote from the real axis.

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Harvard U. [Dept. of Mathematics] Cambridge, Mass.

FOURIER COSINE TRANSFORMS WHOSE REAL PARTS ARE NON-NEGATIVE IN A STRIP, by D. V. Widder. [1966] [6]p. (AFOSR-66-2194) (AF AFOSR-63-393) AD 642968 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 1246-1252, Dec. 1965.

The note makes use of results that the Poisson integral representation of every function u (s, y) which is positive and harmonic in a strip, $-1 < y < 1$ to characterize those Fourier cosine transforms whose real parts are positive and integrable on $-\infty < x < \infty$ for each y in $-1 < y < 1$. The characterizing condition on $\varphi(t)$ is that $\varphi(t) \cosh t$ (defined for $t < 0$ so as to be even) should be real and positive definite.

1075

Harvard U. [East Asian Research Center] Cambridge, Mass.

FROM FRIENDSHIP TO COMRADESHIP: THE CHANGE IN PERSONAL RELATIONS IN COMMUNIST CHINA, by E. F. Vogel. [1965] [15]p. (AFOSR-66-0977) (AF 49(638)1399) AD 619353 Unclassified

Also published in China Quart., No. 21: 46-60, Jan.-Mar. 1965.

In Communist China, personal friendship has been replaced by comradeship, a universalistic ethic which regards all persons as equal under the state. This ethic is necessary to this modernizing society, because it reduces the threat to political control and because it provides a basis of personal relations which makes it possible for persons from different social backgrounds, different geographical areas, and different likes and dislikes to have relationships with each other. The people conform to comradeship largely from fear of being accused or exposed as a threat to national goals by friends or acquaintances.

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Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

SPIN DIFFUSION IN THE HEISENBERG PARAMAGNET, by H. S. Bennett and P. C. Martin. [1965] [10]p. (AFOSR-65-1346) (AF 49(638)589) AD 620364 Unclassified

Also published in Phys. Rev., v. 138: A608-A617, Apr. 19, 1965.

Two methods are presented for calculating the spin diffusion coefficient, the long-wavelength low-frequency limit of the spin pair correlation function. These methods are used to evaluate this coefficient in the isotropic Heisenberg paramagnet. In the first method, successively higher correlations are neglected, and eventually an approximate nonlinear integral equation is obtained.

In the second, a dispersion relation and sum-rule moment relations are utilized. Expressions are obtained for the diffusion coefficient both at high temperatures and near the Curie temperature. The two evaluations of the diffusion constant at high temperatures agree with each other extremely well, and are in qualitative agreement with two previous determinations.

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Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

NON LOCAL TRANSPORT COEFFICIENTS CORRELATION FUNCTIONS, by P. C. Martin. [1965] [26]p. incl. diagrs. tables, refs. (AFOSR-65-1829) (AF 49(638)-589) AD 625979 Unclassified

Also published in Statistical Mechanics of Equilibrium and Non-Equilibrium, Proc. Internat'l. Symposium on Statistical Mechanics and Thermodynamics, Aachen (Germany) (June 15-20, 1964), ed. by J. Meixner. (Amsterdam) North-Holland Publishing Co., 1965, p. 100-125.

Postulated expressions for transport coefficients are considered as limiting values of correlation functions, with special emphasis on their physical significance. The correlation functions of the densities of conserved variables in steady states manifest all the linearized hydrodynamic properties of these steady states. Thus they contain both the damping of the hydrodynamic modes, their velocity, and their strength. This information appears in the Fourier transform of slowly varying space-time correlation functions in a natural manner. One limit of these functions yields the familiar expressions for transport coefficients when there are no long range forces. This point is presented by generalizing the simple example of a one component substance at very low temperature.

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Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

TROUBLE WITH RELATIVISTIC SU(6), by S. Coleman. [1965] [6]p. incl. refs. (AFOSR-65-1830) (AF 49(638)-1380) AD 625989 Unclassified

Also published in Phys. Rev., v. 138: B1262-B1267, June 7, 1965.

A relativistic generalization has been proposed of the SU(6) group, based on the product of U(6) and U(6). The smallest group containing this group and the Poincare group is found. This group has the catastrophic feature that all of its faithful unitary representations contain an infinite number of states for fixed 4-momentum: thus there are an infinite number of particles in every supermultiplet. It is conjectured that similar difficulties afflict every group that contains an internal symmetry group and the Poincare group in such a way that these groups do not commute. The conjecture is proved for a large class of Lie groups (semidirect products of semisimple groups and Abelian groups), under the restrictive assumption that the translations are contained in the Abelian group. (Contractor's abstract)

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Harvard U. [Lyman Lab. of Physics] Cambridge, Mass.

THEORY OF ULTRASONIC ATTENUATION AND SECOND SOUND IN INSULATORS, by P. C. Kwok, P. C. Martin, and P. B. Miller. [1965] [4]p. incl. refs. (AFOSR-65-2790) (AF 49(638)1380) AD 627783 Unclassified

Also published in Solid State Commun., v. 3: 181-184, July 1965.

The properties of interacting phonons are determined in a unified fashion through a study of the displacement correlation function. Expressions for the attenuation are obtained at all frequencies and for different anharmonic mechanisms in insulators and helium. Second sound is shown to be an additional phonon mode at long wavelength.

1080

Harvard U. [Lyman Lab. of Physics] Cambridge, Mass.

REGGE POLES IN QUANTUM ELECTRODYNAMICS WITH MASSIVE PHOTONS, by H. Cheng and T. T. Wu. [1965] [6]p. incl. diagrs. (AFOSR-65-2792) (AF 49-(638)1380) AD 628288 Unclassified

Also published in Phys. Rev., v. 140: B465-B469, Oct. 25, 1965.

Starting from the Lagrangian theory of quantum electrodynamics with massive photons, it is found that the lowest order radiative corrections to the fourth order 'box' diagram of the Compton scattering amplitude contribute terms proportional to (lnt)-sq for large t, violating the Regge behavior if uncancelled. The sixth-order ladder diagram and two others obtained from it by interchanging one of the external photon vertices with a virtual photon vertex are re-evaluated. It is found that the unwanted terms contributed by all these diagrams exactly cancel, proving that in this theory, the fermion lies on a Regge trajector, up to the sixth-order perturbation. (Contractor's abstract)

1081

Harvard U. [Lyman Lab. of Physics] Cambridge, Mass.

MICROSCOPE THEORY OF SUPERFLUID HELIUM, by P. C. Hohenberg and P. C. Martin. [1965] [69]p. incl. diagrs. tables, refs. (AFOSR-65-2801) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1380 and National Science Foundation) AD 628293 Unclassified

Also published in Ann. Phys., v. 34: 291-359, Sept. 1965.

The paper discusses the properties of an interacting condensed Bose system, emphasizing those aspects which do not depend on the weakness of the potential, and which therefore apply to superfluid helium. A physical and mathematical characterization of Bose condensation

is presented in terms of an additional macroscopic quantity, the wave function of the condensed mode, which is defined in terms of microscopic quantities. The hydrodynamic generalization applicable to slowly varying disturbances from equilibrium is then discussed and rigorous microscopic expressions are derived for the parameters of this theory (including dissipative coefficients). The elementary excitation spectrum in this collision dominated regime is exhibited. The Landau quasi-particle theory is examined, as well as the relation of condensation and the excitation spectrum, to the property of superfluidity. Under certain regularity assumptions the form of the long-wavelength excitation spectrum at vanishing temperature is deduced. Finally, techniques are discussed for evaluating properties of the Bose system starting from the interaction potential. (Contractor's abstract)

1082

Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

CORRELATION FUNCTIONS FOR COHERENT FIELDS, by U. M. Titulaer and R. J. Glauber. [1965] [7]p. (AFOSR-66-0018) (AF 49(638)1380) AD 630079
Unclassified

Also published in Phys. Rev., v. 140: B676-B682, Nov. 8, 1965.

A factorization condition which must be satisfied by the first n correlation functions for the electromagnetic field operators has been used to define nth-order coherence. The first-order coherence condition has been shown to imply maximum fringe contrast in interference patterns. In the present paper the authors investigate the mathematical consequences of assuming the condition for maximum fringe contrast. By considering the correlation functions as scalar products and formulating rigorous inequalities for them they are able to show that the assumed condition in turn implies factorization of the first-order correlation function. By extending the same methods they are able to show that all of the higher order correlation functions factorize into forms similar to those required for full coherence, but differing from them through the inclusion of a sequence of constant numerical factors. These coefficients are shown to furnish a convenient description of the higher-order coherence properties of the field. Their values are presented for some typical examples. They derive a number of inequalities satisfied by the coefficients for the case of fields which possess positive-definite weight functions in the P representation. Some inequalities obeyed by the correlation functions for such fields are derived as well.

1083

Harvard U. [Lyman Lab. of Physics] Cambridge, Mass.

RENORMALIZATION EFFECTS AND THE CABIBBO ANGLE, by H. T. Nieh. [1965] [4]p. incl. refs. (AFOSR-66-0438) (AF 49(638)1380) AD 630102
Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 902-905, Dec. 6, 1965.

A report is made of calculations of the renormalization of the semileptonic weak coupling constants by the U(3) symmetry-breaking interactions. The consideration is based on a phenomenological field-theoretical model of U(3) symmetry breakdown, which is an extension of the idea that the symmetry breakdown is dominated by the nonvanishing expectation value of the scalar field S33. The conclusions depend essentially on meson-pole dominance approximations.

1084

Harvard U. [Lyman Lab. of Physics] Cambridge, Mass.

STRONG AND ELECTROMAGNETIC DECAY OF MESONS, by L.-H. Chan. [1965] [4]p. incl. diagr. table, refs. (AFOSR-66-0476) (AF 49(638)1380) AD 630080
Unclassified

Also published in Phys. Rev., v. 140: B1324-B1327, Dec. 6, 1965.

Partial widths of strong and electromagnetic decays of mesons are calculated within the framework of Schwinger's field theory of matter. Results are consistent with present experimental data. The model requires a two-photon-pseudoscalar-meson interaction and a direct four-pseudoscalar-meson interaction. The former is shown to be consistent with the $\pi \to \gamma e^+e^-$ form factor. The latter explains the $\delta \to \eta\pi\pi$ and $\eta \to \pi^+\pi^0\pi^-$ decays, and the coupling constant also agrees with the $\pi\pi$ S-wave coupling constant. Some justification in terms of the heavy scalar-meson nonet is given for the four-meson interaction.

1085

Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

T INVARIANCE AND THE NEUTRON ELECTRIC DIPOLE MOMENT, by D. G. Boulware. [1965] [4]p. incl. refs. (AFOSR-66-0794) (AF 49(638)1380) AD 638824
Unclassified

Also published in Nuovo Cimento, Ser. X, v. 40: 1041-1044, Dec. 1965.

The results of calculations of the neutron electric dipole moments predicted by various models of CP violation are given. It is concluded that Ramsey's proposed measurement of the electric dipole moment should provide a test for the existence of strangeness conserving CP violating interactions.

1086

Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

FIELD THEORY OF MATTER. IV, by J. Schwinger. [1965] [6]p. (AFOSR-66-1315) (AF 49(638)1380) AD 639976
Unclassified

Also published in Phys. Rev., v. 140: B158-B163, Oct. 11, 1965.

The relativistic dynamics of 0^- and 1^- mesons in the idealization of U_3 symmetry is derived from the hypothesis that a compact group of transformations on fundamental fields induces a predominantly local and linear transformation of the phenomenological fields that are associated with particles. The physical picture of phenomenological fields as highly localized functions of fundamental fields implies that the interaction term of the phenomenological Lagrange function can have symmetry properties, expressed by invariance under the compact transformation group, that have no significance for the remainder of the Lagrange function, which describes the propagation of the physical excitations. It is verified that the meson interaction term derived by considering fundamental fermion fields is invariant under the parity-conserving group U(6)XU(6). The implied connection between the $\rho\pi\pi$ and $\omega\rho\pi$ coupling constants is well satisfied. There is a brief discussion of the dynamics of fermion-particle triplets, from which it is shown that the invariance of the similarly derived interaction term implies the mass degeneracy of the singlet and octuplet of 1^- mesons, without relation to 0^- masses. The triplets are also used to illustrate the derivation of gauge - and relativistically invariant electromagnetic properties. The mass degeneracy of the nine 1^- mesons, and of nine 2^+ mesons, can be inferred from the commutation properties of bilinear combinations of the fundamental field.

1087

Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

ON THE METHOD OF DASHEN AND GELL-MANN, by S. Coleman. [1965] [3]p. (AFOSR-67-1381) (AF 49-(638)1380) AD 653809 Unclassified

Also published in Phys. Ltrs., v. 11: 144-146, Oct. 1, 1965.

Dashen and Gell-Mann have proposed (Phys. Ltrs., v. 17: 142, 145, 1965) an ingenious method for obtaining many of the desirable consequences of SU(6) invariance while avoiding the notorious difficulties of a fully relativistic SU(6) invariant theory. They assume that a group called the hybrid collinear group turns one-particle states with the appropriate direction of motion into one-particle states. They phrase this by saying that the other elements of the original group 'leak' while the elements of the collinear group do not. The purpose of this note is to prove that if the hybrid collinear group does not leak, it commutes with the Hamiltonian. Thus the Dashen-Gell-Mann theory contains an internal contradiction which persists if small leakage is allowed.

1088

Harvard U. [Lyman Lab. of Physics] Cambridge, Mass.

PHOTON-PHOTON SCATTERING IN TRANSPARENT CRYSTALS (Abstract), by D. Forster and H. Haken. [1965] [1]p. [AF 49(638)1380] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 113, Jan. 27, 1965.

A theoretical investigation of this process is presented, in analogy photon-photon scattering in vacuum. In a crystal, the roler of intermediate virtual electron-positron pairs is taken over by virtual electron-hole pairs. Because of the considerably smaller threshold energy for creation of the latter pairs, the scattering probability is many orders of magnitude larger than in vacuum. We restrict consideration to insulating cubic crystals with an inversion center. By applying the methods of quantum field theory, we carry out the calculation in the fourth order of perturbation theory. In evaluating the scattering diagrams, we assume the energy bands parabolic in wave-vector space and calculate the electronic transition elements in dipole approximation by means of a k·p-expansion. The differential cross section that results is stated in terms of known crystal parameters. Assuming the intensity of both incoming light rays to be 10^7 W/cm^2, we find the intensity of scattered light to be about 10^{-5} W/cm^3 of irradiated crystal volume. Finally, the present quantum-field theoretical treatment of the problem is compared to the semiclassical method, and the nonlinear dielectric susceptibility that couples different lightwaves is calculated

1089

Harvard U. [Medical School] Boston, Mass.

[CODING AND TRANSMISSION IN THE VISUAL SYSTEM], by D. H. Hubel. Final scientific rept. Mar. 1, 1965 [7]p. (AFOSR-65-0458) (AF AFOSR-63-410) AD 614486 Unclassified

The research performed was mainly in the field of single-cell recordings from cat and monkey visual areas. The chief areas explored were (1) monkey lateral geniculate recordings using stimuli of various shapes and colors, and (2) a continuation of work on visual deprivation in immature kittens. Summaries of 3 papers which treat the extension of this work into problems of binocular deprivation, strabismus, and recovery are included. A summary is also included for studies of visual areas II and III in cats (Talbot and Marshall, 1941). The following conclusions are given: (1) Damage produced at the cortical level by monocular closure is not caused by disuse, but appears to depend on the interaction of the 2 pathways; (2) lack of synergy in the input from the 2 eyes is sufficient to cause a profound disruption in the connections that subserve binocular interaction; and (3) capacity of an animal to recover from the effects of early monocular or binocular visual deprivation is severely limited, even for recovery periods of over a year.

1090

Harvard U. Medical School. Dept. of Pharmacology, Cambridge, Mass.

BINOCULAR INTERACTION IN STRIATE CORTEX OF KITTENS REARED WITH ARTIFICIAL SQUINT, by D. H. Hubel and T. N. Wiesel. [1965] [19]p. incl. illus. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1443 and Public Health Service) Unclassified

Published in Jour. Neurophysiol., v. 28: 1041-1059, Nov. 1965.

In 4 kittens the right medial rectus was severed at about the time of normal eye opening, producing an obvious divergent squint. The animals were raised under normal conditions for periods of 3 months to 1 yr. When the 2 eyes were then tested separately no behavioral visual defects were seen. Recordings from the striate cortex were normal, except for a marked decrease in the proportion of binocularly driven cells: instead of about 80%, only 20% could be influenced from the 2 eyes. The cortex appeared normal microscopically. In a given penetration there was a marked tendency for cells driven from a particular eye to occur in long uninterrupted sequences. These results suggest that the strabismus caused cells to shift in their ocular dominance, a given cell coming to favor more and more the eye that dominated it at birth, ultimately losing all connections with the nondominant eye. It was concluded, that a lack of synergy in the input from the 2 eyes is sufficient to cause a profound disruption in the connections that subserve binocular interaction. In 2 kittens an opaque contact occluder was placed over one eye one day and the other eye the next, alternating eyes each day from shortly after birth to an age of 10 weeks. This kept the eyes from working together without introducing the possibility of antagonistic interaction between them. Vision in either eye seemed normal. Penetrations in the striate cortex gave results similar to those obtained in squint animals.

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Harvard U. Medical School. Dept. of Pharmacology, Cambridge, Mass.

COMPARISON OF THE EFFECTS OF UNILATERAL AND BILATERAL EYE CLOSURE ON CORTICAL UNIT RESPONSES IN KITTENS, by T. N. Wiesel and D. H. Hubel. [1965] [12]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1443 and National Institutes of Health) Unclassified

Published in Jour. Neurophysiol., v. 28: 1029-1040, Nov. 1965.

In 3 kittens the lids of both eyes were sutured together shortly after the time of normal eye opening, and the animals were raised in normal surroundings to an age of 3 months. In 2 of the animals the responses to visual stimulation were observed in the striate cortex. In marked contrast to what had been predicted from experiments with monocular eye closure, 2/3 of cells responded actively; half of these reacted normally, and half lacked the normal preference for specific stimulus orientations, some showing no preference at all. The remaining 1/3 of the cells were unresponsive. In the third kitten an eye was opened and vision tested. The pupillary response was normal, but behaviorally the animal appeared blind. Histologically the lateral geniculate body showed changes similar to those found after monocular deprivation, but they occurred throughout all layers bilaterally: the Nissl-stained cells appeared pale, cross-sectional areas of cell bodies were reduced by about 40%, and the pale substance between cell nests was greatly reduced in volume. There were no obvious changes in retinas or cortex. It is concluded that at the cortical level the extent of the ill effects of closing one eye depend to a large extent on whether the other eye is also closed. The damage produced by monocular closure is not, therefore, caused simply by disuse but seems to depend on interaction of the 2 pathways.

1092

Harvard U. Medical School. Dept. of Pharmacology, Cambridge, Mass.

EXTENT OF RECOVERY FROM THE EFFECTS OF VISUAL DEPRIVATION IN KITTENS, by T. N. Wiesel and D. H. Hubel. [1965] [13]p. incl. illus. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1443 and Public Health Service) Unclassified

Published in Jour. Neurophysiol., v. 28: 1060-1072, Nov. 1965.

In kittens, monocular or binocular deprivation by lid suture for the first 3 months of life leads to virtual blindness, marked morphological changes in the lateral geniculate body, and a severe deterioration of innate cortical connections. In 7 kittens whose eyes had been sutured at birth for 3 months, 6 unilaterally and one bilaterally, an attempt was made to assess the extent of recovery by reopening an eye and allowing the animals to live for another 3-15 months. In 2 of the monocular closures the deprived eye was opened and the normal eye closed. In all kittens there was some slight behavioral recovery during the first 3 months, but the animals remained severely handicapped and never learned to move freely using visual cues. There was no morphological improvement in the lateral geniculate body. The impression that atrophy can develop with deprivation beginning at 3 months was confirmed. In monocularly deprived animals a few cells in the striate cortex may have recovered responses to stimulation to the originally deprived eye, but in many of these cells the responses were abnormal. In the binocularly deprived kitten there was a marked increase in the proportion of cells responding abnormally to the eye that was reopened, without any obvious increase in the total number of cells responding to that eye. It is concluded that the animals' capacity to recover from the effects of early monocular or binocular visual deprivation, whether measured behaviorally, morphologically, or in terms of single-cell cortical physiology, is severely limited, even for recovery periods of over a year.

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[Harvard U.] School of Dental Medicine [Boston, Mass.]

HYPOTHALAMIC SECRETORY FACTOR FOR ADRENOCORTICOTROPIC HORMONE SF/ACTH, by P. L. Munson. Final rept. Aug. 15, 1963-Aug. 14, 1964, Jan. 15, 1965, 4p. (AFOSR-65-0286) (AF AFOSR-63-405) AD 611179 Unclassified

The purpose of this research is to purify the hypothalamic hormone responsible for the increased biosynthesis and secretion of ACTH in stress. This hormone, originally named 'corticotropin releasing factor (CRF)' by Dr. Murray Saffran of McGill University, is now referred to as 'hypothalamic secretory factor for ACTH (HSF-ACTH)'. Because the only feasible guide to yield and specific activity of HSF-ACTH is a rather complicated biological assay system, the studies have included ways to improve and simplify the biological assay for the hypothalamic secretory factor for ACTH are based on a discovery that in the rat anesthetized with pentobarbital, morphine inhibits ACTH secretion to nonspecific stimuli without interfering with the action of HSF-ACTH on the anterior pituitary gland.

1094

Hawaii U. Dept. of Sociology, Honolulu.

A MODEL OF THE NEGOTIATION PROCESS, by O. J. Bartos. Jan. 1965, 41p. incl. table, refs. (AFOSR-65-0076) (AF AFOSR-62-314) AD 617887 Unclassified

A mathematical model of negotiation is described. The basic assumption is that each negotiator always prefers the proposal that has the highest utility for him, the utility being given by the product between payoff and belief in 'acceptability' of the proposal. The belief in acceptability (subjective probability) is, in turn, assumed to change with each speech delivered during the session. it increases whenever a colleague endorses the proposal decreases whenever a colleague fails to join others in endorsing the proposal. It is shown that the model has some desirable properties; it implies that the most frequently endorsed proposal is always believed to be the most acceptable proposal, that a negotiator who is alone in endorsing a proposal ultimately stops endorsing it, that the negotiator who speaks last has the greatest influence, that the very first speaker always endorses the proposal that has the highest payoff for him, that concession always occurs towards the proposal that has the 'next highest' payoff', and that a majority can assure that the acceptance of any proposal that has non-negative payoff to everybody is achieved.

1095

Hawaii U. [Dept. of Sociology] Honolulu.

CONCESSION-MAKING IN EXPERIMENTAL CONDITIONS, by O. J. Bartos. [1965] [12]p. incl. diagrs. tables, refs. (SSRI reprint no. 6) (AFOSR-66-1145) (AF AFOSR-62-314) AD 640173 Unclassified

Also published in Gen. Systems, v. 10: 145-156, 1965.

Perhaps due to the prominence that negotiation has gained as a means for settling international and labor-management conflicts, an interest in negotiation has been growing within several disciplines. Numbers of models of bargaining and arbitration have been formulated by authors trained in economics and mathematics; case studies of the actual negotiation process have been made by sociologists, psychologists, and political scientists; and experiments in bargaining and negotiation are being conducted by behavioral scientists of various backgrounds. The accomplishments of these efforts have been many and our understanding of the negotiation process has increased considerably. Yet, curiously enough, a question that is of considerable practical importance and which has been a subject of some theoretical speculation has not been approached in a systematic fashion until recently; namely, is making concessions a good negotiation strategy, or is it better to make few if any concessions?

1096

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

GENERALIZED POLYNOMIAL IDENTITIES AND PIVOTAL MONOMIALS, by S. A. Amitsur. [1965] [17]p. (AFOSR-65-1402) (AF EOAR-63-70) AD 622913 Unclassified

Also published in Proc. Amer. Math. Soc., v. 114: 210-226, Jan. 1965.

The classical approach to the theory of polynomial identities of a ring R is extended to a more generalized polynomial relation of the form $P(x) = \Sigma a_{i_1} \pi_{j_1} a_{j_2} \ldots a_{i_k} \pi_{j_k} a_{i_{k+1}} = 0$, where π_j are monomials of a set of noncommutative indeterminates and the elements $a_{i_\lambda} \in R$ appear both as coefficients and between the monomials π_j. The main theorem states that a primitive ring R satisfies a polynomial identity if and only if it is isomorphic with a dense ring of linear transformations over a division ring D which is finite over its center, and R contains a linear transformation of finite rank.

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Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON KERNELS, EIGENVALUES, AND EIGENFUNCTIONS OF OPERATORS RELATED TO ELLIPTIC PROBLEMS, by S. Agmon. [1965] [37]p. incl. refs. (AFOSR-66-1211) (AF EOAR-66-18) AD 639175 Unclassified

Published in Commun. Pure and Appl. Math., v. 18: 627-663, Nov. 1965.

An indirect method of estimating Green's kernels is described. It yields pointwise estimates which hold uniformly in all space variables. Moreover this method uses very little of the properties of elliptic differential

operators and applies to a general class of integral operators which need not be connected with differential problems. Further, the formula of the asymptotic distribution of positive (and of negative) eigenvalues for very general selfadjoint elliptic problems whose spectrum may extend to infinity on both sides of the real line is established using the derived estimates. The corresponding asymptotic results for the eigenfunctions (spectral function) are also established.

1098

Hebrew U. Dept. of Mathematics, Jerusalem (Israel).

ON SPECTRALITY CRITERION FOR OPERATORS ON A DIRECT SUM OF HILBERT SPACES, by S. R. Foguel. [1965] [3]p. (AFOSR-66-2859) (AF EOAR-66-18)
AD 644718 Unclassified

Also published in Israel Jour. Math., v. 3: 248-250, Dec. 1965.

In a "Spectral Theory for Certain Operators on a Direct Sum for Hilbert Spaces", Math. Annalen, v. 162: 294-330, 1966, N. Dunford gave a necessary and sufficient condition for an operator U^p to be spectral. The purpose of this note is to furnish a direct proof for his criterion.

1099

Hebrew U. Dept. of Physics, Jerusalem (Israel).

ELECTRON DENSITY AND IONIZATION PHENOMENA IN SHOCK WAVES, by W. Low. Annual summary rept. Nov. 23, 1965 [17]p. (AFOSR-66-0634) (AF 61(052)846)
AD 631006 Unclassified

A new shock-tube suitable for microwave and optical measurements was designed and manufactured. It was established that the Mach speed behind a taper section ending in an area change is close to that predicted by the steady state theory, provided measurements are made far enough downstreams, and provided viscous corrections are being made. However, near the transition section, large deviations from the values predicted either by the steady state or linear theory are found. Within 20-50 nozzle lengths there are fluctuations in the Mach speed which are only damped out far enough downstreams. For the inverse problem of a shock flow into an expanding constriction yielding a larger area, one also finds that the Mach speed far enough downstreams approximates the steady state theory. However, near the transition section the fluctuations are not as violent. The optical data show a peculiar intensity dependence on the position behind the shock front.

1100

Hebrew U. Dept. of Physics, Jerusalem (Israel).

IDENTIFICATIONS OF SOLAR ULTRAVIOLET LINES RESULTING FROM A STUDY OF THE Ar_I AND K_I ISOELECTRONIC SEQUENCES, by U. Feldman, B. S. Fraenkel, and S. Hoory. [1965] [6]p. incl. illus. diagr. tables. (AFOSR-66-1738) (AF EOAR-63-62)
AD 641444 Unclassified

Also published in Astrophys. Jour., v. 142: 719-723, Aug. 15, 1965.

The classification of the $3p^5 3d$ level in Ar_I isoelectronic spectra and the interaction between configurations $3p^6 3d^{r-1} nl$ and $3p^5 3d^{r+1}$ are discussed. Solar lines of transitions $3p^6$-$3p^5 nl$, $3p^6 3d$-$3p^6 nl$ and $3p^6 3d$-$3p^5 3d^2$ are identified. (Contractor's abstract)

1101

Hebrew U. Dept. of Physics, Jerusalem (Israel).

A METHOD FOR E. P. R. MEASUREMENTS OF ORTHORHOMBIC SITES IN A CRYSTAL OF TETRAGONAL SYMMETRY, by J. Bronstein and V. Volterra. [1965] [2]p. (AFOSR-65-2545) (AF EOAR-63-64) AD 628362
Unclassified

Also published in Phys. Ltrs., v. 16: 211-212, June 1, 1965.

A method is described by which the g-tensor of an orthorhombic site can be measured in case of a crystal of tetragonal symmetry. The method is applicable only for ions with Kramers doublets and with a small or no hyperfine interaction. The method can also be applied to crystal systems of other symmetries.

1102

Hebrew U. Dept. of Physics, Jerusalem (Israel).

ELECTRON PARAMAGNETIC RESONANCE OF Eu^{2+} IN $CaWO_4$, by J. Bronstein and V. Volterra. [1965] [4]p. incl. tables, refs. (AFOSR-65-2565) (AF EOAR-63-64) AD 629232 Unclassified

Also published in Phys. Rev., v. 157: A1201-A1204, Feb. 15, 1965.

Single crystals of $CaWO_4$ doped with Eu^{2+} were investigated by electron paramagnetic resonance at 300, 77, 20, and 4°K. A spectrum of tetragonal symmetry was observed and fitted to the spin Hamiltonian for tetragonal symmetry. The values of the parameters are given for 300, 77, and 20°K. The absolute sign of the parameters was determined from observations at 4°K. The hyperfine splitting constants are $A^{151} = -34.4 \pm 0.5$, $B^{151} = -35.0 \pm 0.5$; $A^{153} = -15.5 \pm 0.3$, $B^{153} = -16.0 \pm 0.3$; all in 10^{-4} cm^{-1}.

1103

Hebrew U. Dept. of Physics, Jerusalem (Israel).

PARAMAGNETIC RESONANCE OF RARE EARTH IONS

IN CERIUM OXIDE, by Y. Komet, W. Low, and R. C. Linares. [1965] [2]p. incl. table, refs. (AFOSR-66-2734) (AF EOAR-63-64) AD 644133 Unclassified

Also published in Phys. Ltrs., v. 19: 473-474, Dec. 1, 1965.

An investigation was made of the electron spin resonance spectra of Er^{3+}, Yb^{3+} and Gd^{3+} which were present as small impurities (less than 0.01%) in single crystals of CeO^2. The electron spin resonance spectra were all measured at 2°K and 290°K at 3 cm wavelength. The most striking effect is the great similarities in the spectra of the same rare earth ions in ThO^2 and CeO^2 despite the fact that crystal lattice spacings differ by about 4%.

1104

[Hebrew U. Dept. of Physics, Jerusalem (Israel).

QUANTUM OSCILLATIONS IN THE ULTRASONIC ATTENUATION AND MAGNETIC SUSCEPTIBILITY OF ARSENIC, by Y. Shapira and S. J. Williamson. [1965] [2]p. incl. diagrs. (AFOSR-65-0759) (In cooperation with Massachusetts Inst. of Tech., Cambridge) (AF EOAR-64-24) AD 617812 Unclassified

Also published in Phys. Ltrs., v. 14: 73-74, Jan. 15, 1965.

In this investigation an additional major portion of the Fermi surface of arsenic was discovered. The attenuation of 10 - 50 - mc/s longitudinal and shear ultrasonic waves propagated along the trigonal axis of arsenic was measured in a magnetic field up to 110 kg, and the differential magnetic susceptibility was observed by the audio frequency field modulation technique with synchronous detection in a magnetic field up to 80 kg. In both types of experiments, De Haas-Van Alphen type oscillations were observed from which were noticeable 3 sets of periods—a long period of the order of 10^{-5} gauss^{-1} and 2 short periods of the order of 10^{-7} gauss^{-1}. One of the short periods which corresponds to a new major portion of the Fermi surface, has not been observed in former experiments. The 3 periods are further discussed.

1105

Hebrew U. Dept. of Physics, Jerusalem (Israel).

HYPERFINE INTERACTIONS IN THE GROUND STATE AND 22-KEV STATE OF Sm^{149} IN FERRIMAGNETIC COMPOUNDS OF SAMARIUM, by S. Ofer, E. Segal and others. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR-65 0760) (In cooperation with Massachusetts Inst. of Tech., Cambridge) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under AF EOAR-64-24, and [Air Force Office of Scientific Research], Atomic Energy Commission and [Office of Naval Research] under AT(30-1)2098) AD 618352 Unclassified

Also published in Phys. Rev., v. 137: A627-A638, Jan. 18, 1965.

Hyperfine interactions in $SmFe_2$, $SmFeO_3$, Sm metal, and particularly in samarium iron garnet, SmIG, have been studied at various temperatures using the Mössbauer effect in Sm^{149}. Large magnetic hyperfine interactions are observed in SmIG even at room temperature, in contrast with the observed Sm sublattice magnetization. The values or upper limits for the magnetic hyperfine field acting on Sm nuclei in SmIG, $SmFe_2$, and $SmFeO_3$ are given. Experimental results support an assignment of a spin 5/2 for the 22-kev level of Sm^{149}. The origin of the temperature dependence of the hyperfine fields acting on Sm nuclei in SmIG is discussed, including the effects of the molecular exchange field and the electrostatic crystalline field. Comparison is also made with the theory of magnetization of Sm sublattices. Exchange effects are found to be strong and dominant at high temperatures, whereas at low temperatures, crystalline-field effects are found to predominate. These results are in fair agreement with theoretical predictions.

1106

Hebrew U. Dept. of Physics, Jerusalem (Israel).

ANOMALOUS ISOMER SHIFT RATIOS IN Eu^{151} AND Eu^{153}, by U. Atzmony and S. Ofer. [1965] [2]p. incl. diagr. table. (AFOSR-65-1177) (AF EOAR-64-24) AD 622772 Unclassified

Also published in Phys. Ltrs., v. 14: 284-285, Feb. 15, 1965.

Recoilless absorption measurements were made with Eu_2O_3, $EuSO_4$, and Eu metal absorbers at 20°K using the 97-kev and 103-kev transitions of Eu^{153} and the 21.7-kev transition of Eu^{151}. Results show that the isomer shift ratio is different for the various transitions. Two possible explanations for the results are given.

1107

Hebrew U. Dept. of Physics, Jerusalem (Israel).

A STUDY OF CONDUCTION ELECTRON POLARIZATION IN FERROMAGNETIC RARE EARTH METALS USING PERTURBATION OF γ-γ CORRELATIONS, by S. G. Cohen, N. Kaplan, and S. Ofer. [1965] [5]p. incl. diagrs. refs. (AFOSR-65-1764) (AF EOAR-64-24) AD 626350 Unclassified

Also published in Proc. Internat'l. Conf. on Magnetism, Nottingham (Gt. Brit.) (Sept. 7-11, 1964), p. 432-436.

The effective magnetic fields H_{eff} at ^{175}Lu and ^{177}Hf nuclei within diamagnetic ions, situated as dilute impurities in ferromagnetic rare earth metals, are determined using the technique of measuring the perturbation of the integral angular correlation of γ-γ cascades

emitted from these nuclei as a function of temperature, both in the presence of an external magnetic field and without an external field. From these results it can be concluded that the effective field in all cases is negative, i.e. opposite to the magnetization, that the magnitude of H_{eff} is proportional to the magnetization, at least in the case of Gd host metal, and that for ^{177}Hf the magnitude of H_{eff} follows very roughly the magnitude of the spin S of the magnetic host. If it is assumed that the main contribution to H_{eff} is due to polarized conduction electrons, it can be shown that within the Kasuya-Yosida model, the effective s-f exchange interaction, J_{s-f}, is negative and of the order of -0.1 ev.

1108

Hebrew U. Dept. of Physics, Jerusalem (Israel).

MÖSSBAUER EFFECT IN Dy^{161} IN METALLIC DYSPROSIUM, $DyFe_2$, AND $DyAl_2$, by S. Ofer, M. Rakavy and others. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-2562) (AF EOAR-64-24) AD 629236 Unclassified

Also published in Phys. Rev., v. 138: A241-A246, Apr. 5, 1965.

The recoilless absorption spectra of the 26-kev γ rays from Dy^{161m} in Dy^{161} situated in Dy metal, $DyFe_2$, and $DyAl_2$ were measured at various temperatures. A value of (-825 ± 30) mc/sec was found for the magnetic hyperfine constant ($g_0\mu_n H_{eff}$) of the ground state of Dy^{161} in Dy metal at 20°K. This value is in very good agreement with the "free-ion" value calculated for the Dy^{3+} ions in the fully magnetized state ($J_z = J$) from data on electron spin resonance in dilute salts. The internal magnetic field acting on the Dy nucleus in $DyFe_2$ at magnetic saturation is (14 ± 2)% higher than in Dy metal. The magnetic field acting in $DyAl_2$ at magnetic saturation is the same, within the experimental errors, as in Dy metal. The ratio of the magnetic moments of the 26-kev level and the ground state of Dy^{161} was found to be -1.19 ± 0.05. An isomeric shift of (2.5 ± 0.4) mm/sec was found between Dy metal and Dy_2O_3 absorbers. The isomeric shifts of $DyAl_2$ and $DyFe_2$ absorbers relative to a Dy_2O_3 absorber were found to be (0.4 ± 0.4) mm/sec. (Contractor's abstract)

1109

Hebrew U. Dept. of Physics, Jerusalem (Israel).

PARAMAGNETIC-RESONANCE SPECTRUM OF COBALT ONE PLUS IN SINGLE CRYSTALS OF CALCIUM OXIDE, by W. Low, and J. T. Suss. [1965] [3]p. incl. tables, refs. (AFOSR-66-1623) (AF EOAR-64-24) AD 639531 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 519-521, Sept. 1965.

The paramagnetic-resonance spectrum of Co^{1+} in single crystals of CaO is reported. Details of this spectrum are discussed. Effective care polarization for Co^{1+} in MgO and CaO and for Ni^{2+} in MgO are compared. The care polarization for Co^{1+} is found to be nearly independent of the crystal lost.

1110

Hebrew U. Dept. of Physics, Jerusalem (Israel).

DEGREE OF IONISATION OF Fe LINES IN THE SOLAR SPECTRUM IN THE RANGE 170-220 A, by E. Alexander, U. Feldman, and B. S. Fraenkel. [1965] [2]p. incl. tables, refs. (AFOSR-65-0761) (AF EOAR-64-70) AD 617450 Unclassified

Also published in Phys. Ltrs., v. 14: 40-41, Jan. 1, 1965.

This note gives a preliminary determination of degrees of ionization of Fe lines in the spectral range between 170A and 220A, based on 3 methods of excitation. A comparison is made between the intensity of Fe spectra on 3 pairs of exposures to determine the degree of ionization of Fe lines in this region. It is concluded that it is highly probable that a high percentage of Fe lines appearing in the 170 - 220A range of the solar spectrum originate from degrees of ionization corresponding to Fe IX or less.

1111

Hebrew U. Dept. of Physics, Jerusalem (Israel).

NEW LINES IN ISOELECTRONIC SEQUENCES OF ARGON I FROM V VI TO Ni XI AND IN ISOELECTRONIC SEQUENCES OF POTASSIUM I FROM Cr VI TO Cu XI, by E. Alexander, U. Feldman, and B. S. Fraenkel. [1965] [4]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2553) (AF EOAR-64-70) AD 627756 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 55: 650-653, June 1965.

A method of differentiation between highly ionized spectra has enabled extension of the argon I isoelectronic sequences of the $3p^5 4s$ and $3p^5 5s$ levels. A sequence of $3p^5(^2P_{3/2})4d$ and $3p^5(^2P_{1/2})4d$ levels is established. The potassium I isoelectronic sequences of $3p^6 3d$-$3p^6 nf$ transitions are also extended. Lines of the following ions are reported: V VI, Cr VI and VII, Mn VIII, Fe VIII and IX, Co IX and X, Ni X and XI, Cu XI.

1112

Hebrew U. Dept. of Physics, Jerusalem (Israel).

$3p^6$-$3p^5 3d$ TRANSITIONS OF Fe IX AND Ni XI IN THE SOLAR SPECTRUM, by E. Alexander, U. Feldman and others. [1965] [1]p. incl. table. (AFOSR-65-2596) (AF EOAR-64-70) AD 629233 Unclassified

Also published in Nature, v. 206: 176, Apr. 1965.

The strong solar lines at 171.1 and 148.5A were classified as the $3p^6\ ^1S_0$ - $3p^5 3d\ ^1P_1$ transition of Fe IX and Ni XI; the classification was obtained by use of the technique of classification between different degrees of ionization.

1113

Hebrew U. Dept. of Psychology, Jerusalem (Israel).

CORRELATES OF AMBIVALENCE, RISK-TAKING AND RIGIDITY, by A. Minkowich. Aug. 1, 1965, 90p. incl. tables, refs. (Scientific rept. no. 11) (AFOSR-65-1700) (AF EOAR-64-21) AD 624035 Unclassified

Problems of assessing ambivalence and risk-taking tendencies, and the exploration of their interrelations within a theoretical framework of decision-making behavior were investigated. An attempt was made to interpret within this framework the demonstrated relationships between ambivalence and risk-taking tendencies and the following variables: perceptual rigidity, intolerance of ambiguity, field dependence, dogmatism, anxiety and socialization experiences during childhood. Ambivalence was demonstrated as a generalized trait and was correlated with punitive parental socialization, with anxiety, field dependence, intolerance of ambiguity and low risk of prestige. Experimentally induced guilt resulted in a decrease of ambivalence. Marked sex differences were found for the relationships of ambivalence with financial risk and with styles and content sensitivity in binocular resolutions.

1114

Hebrew U. Dept. of Sociology, Jerusalem (Israel).

ROLE BEHAVIOR AND SOCIAL STRUCTURE, by S. N. Eisenstadt, D. Weintraub, and N. Toren. Sept. 1965, 69p. (AFOSR-65-2292) (AF EOAR-63-78) AD 628236 Unclassified

The major conclusions of the studies on role behaviour and social structure refer to the possibility of differential crystallization of different role-components and the conditions under which successful role-innovation may be found.

1115

[Hebrew U. Dept. of Sociology, Jerusalem (Israel).

PROCESSES OF MODERNIZATION AND OF URBAN AND INDUSTRIAL TRANSFORMATION UNDER CONDITIONS OF STRUCTURAL DUALITY, by S. N. Eisenstadt. [1965] [11]p. incl refs. (AFOSR-65-2670) (AF EOAR-64-23) AD 629235 Unclassified

Presented at Seventh Latin Amer. Cong. of Sociology, Summer 1964.

Also published in Internat'l. Social Science Council, v. 4. 40-50, Mar. 1965.

In the cases analyzed, there tended to develop, in almost all the institutional spheres, a situation of growing interaction between different groups and strata, of their being drawn together into new common frameworks, of growing differentiation and at the same time lack of adequate mechanism to deal with the problems attendant on such internal differentiation and on the growing interaction between the various groups. This coming together of different groups into common social frameworks may have been intermittent and unequally distributed between different groups and strata of the population. But from all these points of view it is extremely doubtful whether it differed greatly from developments in other modernizing or modern societies at similar levels of modernization which were more successful in establishing relatively stable institutional frameworks. The crucial problem of these societies has been not a relatively small extent of modernization but rather the lack of development of new institutional settings, regulative mechanism and normative injunctions upheld within strategic areas of the social structure and capable of dealing with the various problems, which arose in all these spheres.

1116

Henri-Rousselle Hospital. Neurophysiological Lab., Paris (France).

VISCERAL AFFERENT ACTIVITY EFFECTS ON BRAIN STEM RETICULAR FORMATION, by P. C. Dell. Final technical rept. July 1, 1964-June 30, 1965. July 1, 1965, 14p. (AFOSR-66-0180) (AF EOAR-64-51) AD 628298 Unclassified

This report presents the results obtained from the following investigations: (1) Sleep-inducing effects mediated by visceral vago-aortic afferents. Determination of the electrical parameters necessary to stimulate selectively large size fibers of the vago-aortic trunks to provoke at will signs of sleep. Diameter and nature of the responsible afferent fibers. Behavior of the Nucleus Tractus Solitarius during the phase of falling asleep. Evolution of mono- and poly-synaptic reflexes during the stimulation of these visceral afferent pathways, and (2) Differe characteristics of the immediate and delayed comp ent of reticular responses. The different sites of origin at the brain stem level of these two components. Significance of tonic and phasic reticular activation. Differential organization of the ponto-mesencephalic reticular formation. (Contractor's abstract, modified)

1117

Herner and Co., Washington, D. C.

"USE AND MENTION" IN THE INFORMATION SCIENCES, by R. A. Fairthorne. [1965] [4]p. (AFOSR-65-2289) (AF 49(638)1427) AD 629367 Unclassified

Also published in Proc. Symposium on Education for Information Science, Warrenton, Va. (Sept. 7-10, 1965), Washington, Spartan Books, 1965, p. 9-12.

The information sciences study certain aspects of the use of language for certain ends. They do not themselves use language for these ends; they only mention such use. Many current confusions and absurdities concerning the proper, and possible, scope and aims of "informational" devices, processes, and studies could be resolved by distinguishing between tools, their users, and their uses. Slovenly use of the word "information" to denote, without definition, anything from pieces to par 'o increase of knowledge gravely aggravates these confusions. The word is not only confusing, but unnecessary, for before people can be informed about anything they must be told or notified about it. Thus the first task of information systems is "Notification," an activity that includes both "dissemination" and "information retrieval".

1118

Herner and Co., Washington, D. C.

SOME BASIC COMMENTS ON RETRIEVAL TESTING, by R. A. Fairthorne. [1965] [4]p. (AFOSR-66-0414) (AF 49(638)1427) AD 632181 Unclassified

Also published in Jour. Doc., v. 21: 267-270, Dec. 1965.

One should test only such performance as is necessary to the aim of the system. To define the aim is difficult, because we deal with essentially social systems. Necessary, but not sufficient, conditions can be established for performance. As knowledge grows, so will the conditions known to be necessary. To separate aim and achievement from the values of the aims and achievements, one must consider them in terms of documentation, not of the external applications or intentions. What matter are: what sort of documentary entities are asked for; how they are asked for; how well the system supplies what is asked for when it is asked for in these terms. A documentary system cannot substitute for an author or reader completely. Some ignorance is inevitable. The indexer cannot predict all the ways an item may legitimately interest a user, while the user cannot know his interests beforehand so precisely that he can state exactly what he wants and what he does not want. There are also the inevitable ambiguities of the indexing and request languages themselves.

1119

Hong Kong U. Dept. of Pathology.

CHINESE LIVER FLUKE-CLONORCHIS SINENSIS, ITS OCCURRENCE IN HONG KONG, by J. B. Gibson, M. C. Path, and T. Sun. [1965] [5]p. incl. illus. diagrs. refs. (AFOSR-66-0843) (AF AFOSR-64-683) AD 641882 Unclassified

Also published in Internat'l. Pathol., v. 6. 94-98, Oct. 1965.

The life cycle of Clonorchis sinensis is reviewed and related to mechanisms by which man becomes infected. The prevalence of clonorchiasis is discussed, also changes in incidence since World War II. The pathological characteristics of clonorchiasis and its important complications are presented, together with pathogenesis.

1120

Howard U., Washington, D. C.

[INVESTIGATION OF YOUTH MOTIVATION], by J. R. Fishman. Final rept. Feb. 12, 1965, 3p. (AFOSR-65-0358) (AF AFOSR-63-115) Unclassified

The research performed under this grant has been concerned with the organization and operation of a conference on youth and social action in the U. S. and abroad. At this conference the discussion topics included social and political involvement of contemporary American youth, cross-cultural perspectives of the social and historical factors influencing the actions of youth, implications of social action for problems of social pathology (e.g. delinquency), Civil Rights Movement, social change and personality development; and future research directions and strategies. Thirteen papers were submitted by people of the different disciplines of sociology, history and culture, seven of which an introductory summary are being prepared for publication as an edition of the Journal of Social Issues, Winter-Spring 1965.

1121

Howard U. Dept. of Economics, Washington, D. C.

EXTERNAL MILITARY TECHNOLOGICAL TRANSFER AND STRUCTURAL CHANGE, by D. L. Spencer. Feb. 1965, 30p. incl. tables, refs. (AFOSR-65-0168) (AF AFOSR-64-533) AD 612169 Unclassified

The rapidity of technological change within a country is functionally related to a nation's propensity to borrow technology. Japan, with a celebrated propensity to borrow Western technology, has, in the post-World War II period, again made impressive gains, based in large part on borrowed technology. The United States' military presence in Japan has been an important transmission belt making possible much of this technological transfer, and consequent structural change. This research points to basic conclusions that the impact of an external military is far from the negative image popularly conceived. A military presence endowed with a higher technical civilization can initiate a fillip to a recipient country's structural evolution. Moreover, military aid, contrary to the often made negative contrast with economic aid, has long-term dynamic effects in the transfer of higher level technology which can shift production functions significantly over time. Implications of the United States military presence also can obtain for other countries as well, but with varying levels of intensity depending on the country's national propensity to borrow technology, and other strategic factors.

1122

Hughes Research Labs., Malibu, Calif.

TRANSIENT PHOTODECARBOXYLATION INTERMEDIATES, by J. D. Margerum. [1965] [2]p. incl. diagrs. table. (AFOSR-65-2371) (AF 49(638)1264) AD 626351 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 3772-3773, Aug. 20, 1965.

A new type of excited state acid-base reaction is described in which 6 different carboxylate ions in aqueous solutions are photolyzed with near ultraviolet light and dissociate efficiently into carbon dioxide and a carbanion. The starting compounds all had nitrophenylacetate structures. The transient intermediates were nitrophenylcarbanions, 5 of which were identified by their absorption spectra and rate of decay following flash photolysis. Acid-anion structures are believed to stabilize these reactive intermediates, which have typical lifetimes of between one and sixty seconds. Photolysis products were identified and corresponded either to the addition of a proton to the carbanion or to the formation of a bibenzyl type structure. 4,4'-Dinitrobibenzyl was formed in high yield from the photolysis of 4-nitrophenylacetic acid in aqueous base.

1123

Hughes Research Labs., Malibu, Calif.

ON THE ASYMPTOTIC BEHAVIOR OF ELECTROMAGNETIC FIELDS SCATTERED FROM CONVEX CYLINDERS NEAR GRAZING INCIDENCE, by W. P. Brown, Jr. [1965] [49]p. incl. diagrs. refs. (AFOSR-65-2104) (Bound with its AFOSR-65-2211; AD 623849) (AF 49-(638)1439) AD 627713 Unclassified

Also published in Jour. Math. Anal. and Appl., v. 15: 355-385, Aug. 1966.

The work reported in this paper concerns the determination of an asymptotic expansion of the electromagnetic field scattered from a convex cylinder near grazing incidence. A systematic procedure for the generation of such an expansion is formulated from the concepts of boundary layer theory. The general form of mth term in the expansion is derived for all points within a domain that includes the immediate vicinity of the point of grazing incidence and the penumbral region in the neighborhood of the shadow boundary. Boundary and matching conditions for the determination of the unspecified coefficients in the expansion are formulated. Finally, explicit representations for the initial term in the expansion are given for all points within the transition domain.

1124

Hughes Research Labs., Malibu, Calif.

DISPERSION EFFECTS IN LASER AMPLITUDES, by G. F. Smith, W. P. Brown, Jr., and C. R. Giuliano. Final scientific rept. Oct. 1, 1964-Sept. 30, 1965 [105]p. incl. illus. diagrs. refs. (AFOSR-65-2211) (AF 49-(638)1439) AD 623849 Unclassified

It has been shown that the rytov approximation is severely limited in its applicability to long distance optical propagation in the atmosphere. A new and powerful boundary layer calculational technique has been developed and applied to the problem of scattering of electromagnetic waves from convex cylinders near grazing incidence. Multigigacyle acoustic waves were generated in crystalline solids by giant pulse ruby laser radiation; several unsuccessful attempts were made to probe these waves with bragg-scattered gas laser radiation. However, multiple wavelength shifts in stimulated Brillouin scattering from quartz were observed; it was established, by time resolved interferometry, that these shifts result from an iterative process.

1125

Hughes Research Labs., Malibu, Calif.

TIME-RESOLVED INTERFEROMETRY IN STIMULATED BRILLOUIN SCATTERING, by C. R. Giuliano. [1965] [3]p. incl. illus. diagrs. (AFOSR-66-0544) (Bound with its AFOSR-65-2211; AD 623849) (AF 49(638)1439) AD 639885 Unclassified

Also published in Appl. Phys. Ltrs., v. 7: 279-281, Nov. 15, 1965.

Multiple wavelength shifts in stimulated Brillouin scattering from quartz was observed and it was demonstrated with time-resolved interferometry that the multiple shifts are due to an iterative process. Application of the streaking technique combined with accurate pulse shape measurements for the pump light shows promise for exact thresholds determination for stimulated Brillouin scattering and other nonlinear optical effects.

1126

Hughes Research Labs., Malibu, Calif.

ON THE VALIDITY OF THE RYTOV APPROXIMATION IN OPTICAL PROPAGATION CALCULATIONS, by W. P. Brown, Jr. [1965] 23p. incl. diagrs. refs. (Bound with its AFOSR-65-2211; AD 623849) (AF 49(638)1439) Unclassified

The applicability of the Rytov approximation to the calculation of the characteristics of optical propagation in a weakly inhomogeneous random medium is investigated. The condition that the mean square value of the second term in the associated perturbation expansion be smaller than that of the first is adopted as a criterion for the validity of the Rytov approximation. It is shown that there is a very severe range limitation on the validity of the Rytov approximation for optical propagation in the lower portions of the earth's atmosphere. The equivalence of the validity conditions for the Rytov and Born approximations contradicts the statements of Tatarksi and Chernov who contend that the Rytov approximation is superior to the Born approximation.

It is conjectured that the Rytov and Born approximations have the same domain of validity for all γ.

1127

[Hull U. Dept. of Chemistry (Gt. Brit.).

KINETICS OF HYDROGEN-OXYGEN AND HYDROCARBON-OXYGEN REACTIONS, by R. R. Baldwin and R. W. Walker. Final rept. Oct. 1962-June 1965, 14p. incl. table, refs. (AFOSR-65-1909) (AF EOAR-63-31) AD 626059 Unclassified

The research program is reviewed and some results presented. Main aspects of the study include: (1) the development of computer programs to interpret the various aspects of the H_2-O_2 reaction; (2) the effect of CO on the H_2-O_2 reactions; (3) the oxidation of CH_4 when small amounts are added slowly to H_2-O_2 mixtures; (4) the effect of tetramethyl and tetraethyl silane on the second limit of the H_2-O_2 reaction; and (5) the decomposition of H_2O_2 in the presence of H_2 and CO.

1128

Hull. U. Dept. of Chemistry (Gt. Brit.).

THE USE OF THE HYDROGEN-OXYGEN REACTION IN EVALUATING VELOCITY CONSTANTS, by R. R. Baldwin, D. Jackson and others. [1965] [11]p. incl. diagrs. tables, refs. [AF EOAR-63-31] Unclassified

Published in Tenth Symposium (Internat'l.) on Combustion, Cambridge (Gt. Brit.) (Aug. 17-21, 1964), Pittsburgh, Combustion Inst., 1965, p. 423-433.

Studies of the H_2/O_2 reaction have given information on some of the reactions of the radicals H, O, OH, and HO_2 with hydrocarbons, CO, and H_2O_2 in the region of 500°C. The inhibiting action of hydrocarbons on the second limit has given Arrhenius parameters for H + RH in the case of ethane, propane, n- and i-butane. More restricted information on the reaction of O and OH with these hydrocarbons is also obtained. Studies of the yields of CO_2 and H_2O in slowly reacting $H_2/CO/O_2$ mixtures enables the ratios k_{OH+CO}/k_{OH+H_2} and $k_{HO_2+CO}/k_{HO_2+H_2}$ to be evaluated. Studies of the decomposition of H_2O_2 sensitized by H_2 give the relative rates of $OH + H_2$ and $OH + H_2O_2$, as well as the ratio of the rates of $H + H_2O_2 = H_2O + OH$ and $H + H_2O_2 = H_2 + HO_2$. Study of the reduction of this sensitizing effect by traces of added O_2 enables the ratio of the rates $H + H_2O_2 = H_2$ and $H + O_2 + M = HO_2 + M$ to be determined. (Contractor's abstract)

1129

Idaho U. Dept. of Physical Sciences. Moscow.

REACTIVE INTERMEDIATES IN THE BICYCLO[3.1.0]HEXYL AND BICYCLO[3.1.0]HEXYLIDENE SYSTEMS. I. THE ACID-CATALYZED ADDITION OF METHANOL AND ACETIC ACID TO BICYCLO[3.1.0]HEXENE-2, by P. K. Freeman, M. F. Grostic, and F. A. Raymond. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-1653) (AF AFOSR-63-34) AD 624369 Unclassified

Presented at meeting of the Amer. Chem. Soc., Chicago, Ill., Aug. 1964.

Abstract published in 148th Nat'l. meeting of the Amer. Chem. Soc. Abstracts of Papers, 1964, p. 59-S.

Also published in Jour. Org. Chem., v. 30: 771-777, Mar. 1965.

Thermodynamically controlled acid-catalyzed addition of acetic acid or methanol to bicyclo[3.1.0]hexene-2 results in 4-acetoxycyclohexene or 4-methoxycyclohexene, respectively. Kinetically controlled addition of methanol results in predominantly cis- and trans-2-methoxybicyclo[3.1.0]hexane, with formation of small amounts of 4-methoxycyclohexene. Acid-catalyzed addition of methanol-d to bicyclo[3.1.0]hexene-2 proceeds stereospecifically cis to yield trans-3-deuterio-trans-2-methoxybicyclo[3.1.0]hexane. (Contractor's abstract)

1130

Idaho U. Dept. of Physical Sciences, Moscow.

REACTIVE INTERMEDIATES IN THE BICYCLO[3.1.0]HEXYL AND BICYCLO[3.1.0]HEXYLIDENE SYSTEMS. II. THE CARBENOID DECOMPOSITION OF THE p-TOLUENESULFONYLHYDRAZONES OF 3-BICYCLO[3.1.0]HEXANONE AND 2-BICYCLO[3.1.0]HEXANONE, by P. K. Freeman and D. G. Kuper. [1965] [3]p. incl. tables, refs. (AFOSR-65-1654) (AF AFOSR-63-34) AD 624177 Unclassified

Also published in Jour. Org. Chem., v. 30: 1047-1049, Apr. 1965

Sodium methoxide induced decomposition of the p-toluenesulfonylhydrazone of 3-bicyclo[3.1.0]hexanone produces bicyclo[3.1.0]hexene-2, while sodium methoxide induced decomposition of the p-toluenesulfonylhydrazone of 2-bicyclo[3.1.0]hexanone results in bicyclo[3.1.0]hexene-2, 1, 3-cyclohexadiene, 1-hexen-5-yne, 1, 2, 5-hexatriene, and trans-1, 3, 5-hexatriene. (Contractor's abstract)

1131

Idaho U. Dept. of Physical Sciences, Moscow.

SYNTHESIS OF BICYCLO[3.2.1]OCTA-3, 6-DIEN-2-ONE: AN UNUSUAL VALENCE ISOMERISATION, by P. K. Freeman and D. G. Kuper. [1965] [1]p. (AFOSR-65-1655) (AF AFOSR-63-34) AD 624169 Unclassified

Also published in Chem. and Indus. (London), No. 10: 424-425, Mar. 1965.

Bicyclo[3.1.0]hex-3-ene-6-endo-carboxylic acid chloride was treated with CH_2N_2. The crude endo-6-diazomethylcarbonyl-bicyclo[3.1.0]hex-3-ene formed was photolyzed in tetrahydrofuran (THF) until 90% of the N was evolved. After THF was removed, chromatographic separation gave bicyclo[3.2.1]octa-3, 6-dien-2-one and tetracyclo[3.3.0.0^{4}, $6^{0}2,8$]octan-3-one. The reaction mechanism is shown.

1132

Idaho U. [Dept. of Physical Sciences] Moscow.

CRYSTAL GROWTH AND THE REFRACTIVE INDEX OF STRONTIUM OXIDE (Abstract), by E. F. Steckmann and G. E. Pynchon. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-634] and Research Corporation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 109, Jan. 27, 1965.

Single crystals of optical quality were prepared by controlled cooling of molten strontium oxide contained inside a cylinder of sintered material prepared from commercially available strontium oxide powder. The heat necessary to melt the interior of the cylinder was obtained by passing electrical current through it. The refractive index of three single crystals was measured at several different wavelengths in the visible spectrum by the method of minimum deviation. The absolute refractive index of these crystals varied from $1.86245 \pm 3 \times 10^{-5}$ at the wavelength 6562.82A to $1.92585 \pm 3 \times 10^{-5}$ at the wavelength 4046.56A

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Idaho U. [Dept. of Physical Sciences] Moscow.

F-CENTER ENERGY LEVELS AND WAVEFUNCTIONS FOR A POINT-CHARGE CESIUM CHLORIDE STRUCTURE (Abstract), by L. F. Oden and E. F. Steckmann. [1965] [1]p. [AF AFOSR-64-634] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10. 76, Jan. 27, 1965.

The ground-state and first excited-state energies and wavefunctions have been calculated for an electron bound to a negative-ion vacancy in a rigid cesium chloride structure consisting of point charges for 7 different values

of the lattice constant. The potential energy of the electron was expanded in a series of Kubic harmonics, and Schrödinger's equation was separated by an expansion of the wavefunction in a series of Kubic harmonics of the appropriate symmetry type. The resulting simultaneous second-order radial differential equations were integrated numerically by a power-series expansion. The energy difference between the ground state and the first excited state was obtained as a function of the lattice constant, and the results were found to be consistent with an Ivey-type formula. A comparison of results is made with other methods of approximation and with experimental data.

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Idaho U. Dept. of Physical Sciences, Moscow.

PHOTOISOMERIZATION OF ENDO- AND EXO-TRICYCLO[3.2.1.$0^{2,4}$]OCTENE-6, by P. K. Freeman, D. G. Kuper, and V. N. Mallikarjuna Rao. [1965] [4]p. (AFOSR-65-2042) (AF AFOSR-65-34) AD 627490 Unclassified

Also published in Tetrahedron Ltrs., No. 37: 3301-3304, Sept. 1965.

Irradiation of an ether solution of exo-bicyclo[3.2.1.$0^{2,4}$]octene-6 using unfiltered light from a 450 watt Hanovia high pressure mercury lamp resulted in a 29% yield of tetracyclo[3.3.0.$0^{2,8}0^{4,6}$]octane. The structure of this hydrocarbon is identical to the hydrocarbon produced by Wolff-Kishner reduction of tetracyclo[3.3.0.$0^{2,8}0^{4,6}$]octan-3-one as demonstrated by nmr and IR spectral comparison. Irradiation of the endo-isomer under the same conditions produced a 15% yield of the tetracyclic compound.

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Idaho U. Dept. of Physical Sciences, Moscow.

TWO NOVEL TETRACYCLO-OCTANES, by P. K. Freeman, V. N. Mallikarjuna Rao, and G. E. Bigam. [1965] [2]p. incl. diagrs. (AFOSR-66-0299) (AF AFOSR-65-34) AD 628852 Unclassified

Also published in Chem. Commun., No. 21: 511-512, Nov. 10, 1965.

A method is described for the generation of tetracyclooctanes by way of appropriate tricyclic carbene intermediates. The carbenoid decomposition of the p-toluenesulfonylhydrazone of tricyclo[3.2.1.$0^{3,6}$]octan-2-one generates, tetracyclo[3.3.0.0.$^{2,8}0^{3,7}$]octane(IV) and tetracyclo[3.3.0.0.$^{2,8}0^{3,6}$]octane(VI). Catalytic hydrogenation of IV produces tricyclo[3.3.0.$0^{3,7}$]octane; similar treatment of VI yields tricyclo[3.3.0.$0^{2,7}$]-octane.

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IIT Research Inst. Technology Center, Chicago, Ill.

THE SURFACE AREA OF LIQUIDS IN CIRCULAR TUBES, by T. A. Erickson. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-65-2259) (AF 49(638)1121) AD 625994 Unclassified

Also published in Jour. Phys. Chem., v. 69: 1809-1813, June 1965.

The surface area of a liquid in a circular tube approximates to about 2% the area represented by an oblate spheroid that has the tube radius and the meniscus height as its major and minor semiaxes, respectively. Over much of their range, the tables of Bashforth and Adams appear to represent coordinates of an ellipse within about 4%. (Contractor's abstract)

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IIT Research Inst. Technology Center, Chicago, Ill.

FORCED VAPORIZATION OF WATER, by T. A. Erickson. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-2260) (AF 49(638)1121) AD 625363 Unclassified

Also published in Humidity and Mixture, Internat'l. Symposium on Humidity and Moisture, Washington, D. C. (May 20-23, 1963), ed. by A. Wexler, New York, Rheinhold Publishing Corp., v. 3: 351-354, 1965.

The usual Hertz-Knudsen relation derived for the rate of evaporation of pure liquids is given by $n = (2\pi MRT_s)^{-1/2}(P_s - P)$. The rate of evaporation is shown to be represented as well, if not better, by a relation derived from a classical thermodynamic treatment of the forced vaporization of water as a steady-rate process. On the basis of this derivation, the mass flow is described by the equation $n = N_A^{-1} \ln(P^0/P)$. (Contractor's abstract)

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IIT Research Inst. Technology Center, Chicago, Ill.

THEOREM-PROVING BY COMPUTERS, by B. Kallick. Final rept. Jan. 1, 1964-Dec. 31, 1964. Jan. 31, 1965, 63p. incl. refs. (Rept. no. IITRI H6008-5) (AFOSR-65-0338) (AF 49(638)1349) AD 611815 Unclassified

The subject is the development of efficient theorem-proving algorithms, amenable to computer implementation, through the application of the theory of mathematical logic. The approach taken is via the Herbrand theorem and consists in expressing the theorem as the negation of a prefix formula of predicate calculus and of finding an inconsistent set of instances of this formula. The following problem is dealt with: in searching for an inconsistent set of instances and having already generated certain instances of a formula, how can the information in the matrix of the formula be utilized to determine the most appropriate way of generating the next instance. In this regard, the idea of expressing the matrix in disjunctive normal form and generating instances so as to construct inconsistent sub-paths is considered to be a useful technique and worthy of continued study. A partial solution to the following problem is also obtained: how can the information that a given disjunctive term of the matrix

has figured in an inconsistent sub-path be utilized to avoid the repetition of identical computation the next time that term is encountered. A proof procedure is described which is capable of deciding certain known solvable subcases of the decision problem. It is conjectured that the procedure yield a new solvable subcase.

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Illinois U. [Charged Particle Research Lab.] Urbana.

INVESTIGATION OF THE CHARGE-TO-MASS RATIO OF ELECTRICALLY SPRAYED LIQUID PARTICLES, by J. J. Hogan and C. D. Hendricks. [1965] [6]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1428) (Sponsored jointly by the Air Force Office of Scientific Research under AF AFOSR-64-107 and National Science Foundation) AD 621466 Unclassified

Also published in AIAA Jour., v. 3: 296-301, Feb. 1965.

An analysis of the charge-to-mass ratios (specific charges) of particles generated by the electrical atomization process is presented. The study involves the surface energy of the dispersed system of particles, the effects of space charge on the source, and the effects of conductivity on the atomization process. Experimental data are presented in support of these theories. It appears that a dynamic equilibrium is established by which the space charge evaporation rate, voltage drop across the liquid meniscus, and surface energy extremum of the dispersed system of particles act simultaneously to establish the radius and specific charge of the emitted particles. A colloidal suspension in glycerine is experimentally shown to produce particles of high specific charge (400 coul/kg) when electrically dispersed under appropriate conditions. (Contractor's abstract)

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Illinois U. Charged Particle Research Lab., Urbana.

PRODUCTION OF UNIFORM-SIZED LIQUID DROPLETS, by N. R. Lindblad and J. M. Schneider. [1965] [4]p. incl. illus. diagrs. (AFOSR-65-2496) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-107 and National Science Foundation) AD 626521 Unclassified

Also published in Jour. Scient. Instr., v. 42: 635-638, Aug. 1965.

A method for producing a stream of uniform-sized liquid droplets and individual droplets is discussed in detail. The method is based on the principle that a cylinder of liquid (jet) is dynamically unstable under the action of surface tension. When a capillary wave of a prescribed wavelength is applied to the jet, the jet will disintegrate into a stream of uniform-sized droplets. Since the droplet size depends on the capillary tube through which the liquid flows, the size can be easily varied. A piezoelectric transducer is used to produce the capillary wave on the jet. The apparatus will produce droplets in a range between 25 and 350 μ m in radius. The method is unique in that the droplet size can be precisely controlled and individual droplets can be produced at will. (Contractor's abstract)

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Illinois U. Charged Particle Research Lab., Urbana.

AN APPARATUS TO STUDY THE COLLISION AND COALESCENCE OF LIQUID AEROSOLS, by J. M. Schneider, N. R. Lindblad, and C. D. Hendricks. [1965] [7]p. incl. illus. diagrs. (AFOSR-65-2498) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-107 and National Science Foundation) AD 628451 Unclassified

Also published in Jour. Colloid Sci., v. 20: 610-616, Aug. 1965.

An apparatus used to study collision and coalescence of liquid aerosols and some of the physical quantities enhancing or hindering these processes is described. The relative trajectories, collision, and coalescence of 2 oppositely charged water droplets are shown for the droplets approaching at right angles. The droplets were 96 μ and 79 μ in radius and had velocities at impact of 330 cm/sec and 110 cm/sec, respectively. It was found extremely difficult to make the 2 droplets collide when both were highly charged with the same sign of charge. However, droplets highly charged with the opposite sign of charge had a high collision rate. (Contractor's abstract)

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Illinois U. [Charged Particle Research Lab.] Urbana.

CHARGED COLLOIDAL SIZED PARTICLES FOR PROPULSION (Abstract), by C. D. Hendricks. [1965] [1]p. (Bound with its AFOSR-65-1266; AD 622527) (AF AFOSR-64-107) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

A statement of the general worth and competitive state of colloid propulsion is presented. A short summary of the various methods of producing colloids for propulsion is given. The conclusions reached are: (1) colloid propulsion has a useful part to play in the overall electric propulsion field if beams of particles can be produced; (2) the most promising beam production technique appears to be electrical spraying through capillaries. Experimentally obtained curves of specific charge as a function of various parameters in a capillary spraying system are presented. The parameters of interest are field strength at the capillary tip, liquid density, conductivity, surface tension, and mass flow rate. The results of a study of electrokinetic pumping of insulating liquids are also presented. Pumps of this type contain no mechanical impellers or moving parts other than the pumped liquid. Aerospace applications of such pumps are discussed and some limitations are pointed out.

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Illinois U. [Charged Particle Research Lab.] Urbana.

STIMULATED CATHODO-LUMINESCENCE IN n-TYPE GaAs AT 77°K, by P. D. Coleman and G. E. Bennett. [1965] [1]p. incl. illus. (AFOSR-65-2059) (Sponsored jointly by [Air Force Office of Scientific Research under AF AFOSR-65-272] and Wright Patterson Air Force Base) AD 627726 Unclassified

Also published in Proc. IEEE, v. 53: 419-420, Apr. 1965.

Lasing behavior was observed in Te doped (3×10^{18} dopants/cc) GaAs under electron beam excitation. A 0-50 kv space-charge limited electron gun supplied the electron beam in the form of one μsec pulses. Below threshold the peak of fluorescence remained at 8260A and exhibited a 2.3 power dependence on the peak electron beam power. At threshold an increment in the beam power caused a 50-ns pulse of light to grow to 10 times the previous fluorescent light level.

1144

Illinois U. Coordinated Science Lab., Urbana.

GENERATION OF TREES WITHOUT DUPLICATIONS, by W. Mayeda and S. Seshu. [1965] [5]p. incl. diagrs. (AFOSR-65-1970) (AF 49(638)1383) AD 626300 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 181-185, June 1965.

Recent emphasis on the use of electronic digital computers has focused attention on a number of practical problems which were hitherto treated on an 'existence' basis. One problem which arises in computer analysis of electrical networks is the listing of all trees in the network. Any practically useful scheme must find all the trees of the network without generating duplicates (for practical networks the number of trees exceeds the fast memory of any computer and, hence, slows down search for duplicates). Also, the trees must be generated by replacement of one branch at a time in order to keep track of signs (for active network analysis). A practical procedure satisfying these conditions is presented. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

ON CERTAIN RELAXATION OSCILLATIONS: ASYMPTOTIC SOLUTIONS, by P. J. Ponzo and N. Wax. [1965] [27]p. incl. diagrs. (AFOSR-66-0038) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-931 and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 640924 Unclassified

Also published in Jour. Soc. Indus. and Appl. Math., v. 13: 740-766, Sept. 1965.

Various geometrical and analytical methods have been used to determine the existence of a stable periodic solution of the generalized Liénard equation. Work was done in both the scaled phase and Liénard planes.

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Illinois U. Coordinated Science Lab., Urbana.

PROPERTIES OF LOSSY COMMUNICATION NETS, by W. Mayeda and M. E. Van Valkenburg. [1965] 6p. incl. diagrs. (AFOSR-66-0245) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-931 [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 640930 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 334-338, Sept. 1965.

A communication net is considered in which the edges are lossy in the sense that flow through the edge is attenuated. Such a model describes many power or information transmission systems. The classical problem for such a net is that of maximizing the flow from a source to a sink. The solution to the problem for the lossless case is well known; the lossy case has been considered only recently by Fujisawa. In determining properties of the lossy communication nets, a saturated edge is defined as one in which the edge flow is equal to the capacity of that edge. The concept of the saturated cut set is introduced to obtain relationships that must be satisfied by the terminal capacities. If $\underline{\tau}_{pq}$ is the source terminal capacity (maximum flow at the source vertex to receive maximum flow at q) and $\underline{t}_{pq}$ is the sink terminal capacity (maximum flow that can be received at q when the maximum flow is sent from p to q) then $\underline{\tau}_{ij} \geq \underline{t}_{kj}$ or $\tau_{ij} \geq \tau_{ik}$, for any vertices i, j, and k. The property analogous to the S-submatrix property in the lossless case is also obtained. All results given reduce to known results when the loss of every edge becomes zero. This includes the maximum flow-minimum cut theory of Ford and Fulkerson, which is applicable only in the lossless case. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

SYNTHESIS OF INTERCONNECTED LINEAR TIME-VARYING SYSTEMS, by W. R. Perkins. [1965] [3]p. incl. refs. (AFOSR-66-0391) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-931 and Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under DA 28-043-AMC-00073(E)) AD 640927 Unclassified

Also published in Proc. Nat'l. Electronics Conf., v. 21: 694-696, 1935.

The development of general analysis and synthesis methods for linear, time-varying systems has proved to be very challenging. The major difficulty is that most

time-varying differential equations cannot be solved in closed form analytically. Recently an approach based on an operator algebra has been introduced by Stubberud. This method does not require differential equation solution, and permits synthesis of a class of control systems. The main difficulty is the considerable labor involved in manipulating the time-varying operators. The purpose of this paper is to develop a simple state-variable method that is useful in the synthesis of time-varying systems, and that requires neither the solution of differential equations nor the manipulation of time-varying operators. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

GENERATION OF DIRECTED TREES, 2-TREES AND PATHS WITHOUT DUPLICATION, by A. Paul, Jr. Jan. 1965, 44p. incl. diagrs. refs. (Rept. no. R-241) (AFOSR-65-0259) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under DA 28-043-AMC-00073(E)) AD 610149 Unclassified

The increasing number of applications of graph theory to the solution of problems in many fields make it desirable to have available complete knowledge of the properties of these graphs. Since many problems in electrical networks, switching circuits, and communication nets can be formulated in terms of directed graphs, it is appropriate to study their properties. In this paper, procedures are developed for generating the directed trees, 2-trees and paths of a directed graph. Unlike other methods for generating these subgraphs, the procedures developed here avoid generating duplicate elements thus they eliminate the necessity of repeated search to select a complete set of elements. Proofs are given to verify that all elements of the set of directed trees, 2-trees or paths are generated and that no duplicate elements occur. Examples are given to illustrate the procedures in detail. The procedures are amenable to digital computer application. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

ON MINIMAL-VARIANCE CONTROL OF LINEAR SYSTEMS WITH QUADRATIC LOSS, by M. K. Sain. Jan. 1965, 45p. incl. diagrs. refs. (Rept. no. R-240) (AFOSR-65-0541) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00073(E)) AD 610776 Unclassified

The problem of minimizing the variance of a quadratic performance index, in the presence of control noise whose properties are known a priori, has been studied for linear, constant systems with open-loop control. The expected value of the performance index is constrained to be a positive number, which cannot be less than the optimal mean index when variance is free. Solution is by means of the calculus of variations, which is applied to an equivalent noise-free problem. The necessary (Euler) equations are integro-differential and have a kernel matrix derived from output correlation functions. In general, these equations contain a forcing vector which depends upon the third-moment properties of the noise process. For systems in which the state vector can be chosen as the output, the existence of an inverse for the kernel matrix can be related to the total state controllability of an equivalent linear, noise-free plant which incorporates statistical data from the disturbance process. A maximum estimate for the number of eigenvalues is given, and is refined for the special case of single-input, state-output control. Necessary and sufficient conditions for a unique solution can be found in specific examples. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

OPTIMUM CONTROL OF LINEAR SYSTEMS WITH TIME LAGS, by G. S. Tahim. Jan. 1965, 39p. incl. diagrs. refs. (Rept. no. R-242) (AFOSR-65-0542) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1383, Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00073 (E)) AD 610777 Unclassified

The problem of optimal control of a system governed by linear differential-difference equations with constant coefficients is studied. The performance index is the integrated square error plus weighted control and the final time is infinite. An important question that arises in the study of the optimization problem is the existence of the optimal solution. In the case of dynamic systems governed by ordinary linear differential equations it is known that the existence of the optimal solution is related to the concept of controllability. The controllability conditions for such systems are also known. In this thesis the necessary and sufficient conditions for complete controllability of a system of linear differential-difference equations with constant coefficients are established. For single input systems, with the help of these conditions, the optimal control problem is related to classical frequency domain problem of improving the sensitivity of the overall system with respect to parameter variations. In order to extend the relation between the optimization problem and the sensitivity improvement for multiple input systems, a sensitivity matrix is defined and its relationship with optimization is established. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

AN ALGEBRAIC STUDY OF SHOCK STRUCTURE, by B. L. Hicks and S. M. Yen. Feb. 1965, 23p. incl. diagrs. table. (Rept. no. R-244) (AFOSR-65-0543) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 457806 Unclassified

Far up- and downstream of a shock front the structure of a shock must conform to the Navier-Stokes equations. At these boundaries, therefore, the viscosity

coefficient $\tilde{\mu}$ and Prandtl number $\tilde{Pr}$ must have values appropriate to the medium and the conditions there. For a monatomic gas, $\tilde{Pr}$ must equal 8/9, and the derivatives of $t_\perp$ (the lateral temperature) and of dn/dx (the density gradient) are calculable. We can use these conditions to test the accuracy of various theoretical shock structures proposed and to find approximate macroscopic properties of shock structures for any monatomic gas without solving the Boltzmann equation. We have developed the corresponding first order theory in algebraic form by modifying the Mott-Smith expressions for $t_\perp$ and dn/dx in a simple way such that the modified functions will satisfy the auxiliary conditions and will thus agree with the known transport characteristics of monatomic gases. By using the number density n as the independent variable, we are able to find the macroscopic shock structure on the basis of given asymptotic values of $\tilde{Pr}$ alone, while the spatial distribution of properties depends on both $\tilde{Pr}$ and $\tilde{\mu}$. Comparisons are presented of the shock structures for monatomic gases calculated according to the first order algebraic theory, Mott-Smith, and Navier-Stokes. The first order theory reproduces the Navier-Stokes results in the low Mach number range and supplies a simple representation of the Navier-Stokes model. At high Mach number, the correction of the properties to the Mott-Smith model amount to at most less than 20% of stress τ/p_1 or of the heat flux q. The shock thickness is much smaller than Camac's experimental value for argon. A second order calculation may be made by including as an additional condition the matching of any experimentally determined shock thickness. As an example calculations are given for argon. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

TRANSIENT RESPONSES OF BUTTERWORTH AND CHEBYSHEV FILTER NETWORKS, by G. Kishi. Feb. 1965, 39p. incl. diagrs. (Rept. no. R-194) (AFOSR-65-0891) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1383, [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 458645 Unclassified

Transient responses of the Butterworth and the Chebyshev filter networks are calculated for both suddenly impressed and suddenly removed sinusoidal input signals with angular frequency ω_c. The transient responses of these networks are treated in terms of the in-phase and the quadrature components, and these functions together with envelope functions are presented under the assumption of narrow bandwidth for the following cases: (1) For the n-th degree Butterworth filter networks with mid-band angular frequency ω_0 and half-power (or 3db) transmission band $\omega_0 \pm \omega_b$, the cases of n = 3 to 7, $\omega_c = \omega_0$ and the cases of n = 3 to 5, $(\omega_c - \omega_0)/\omega_b$ = 0.2, 0.4, 0.6, 0.8, 1.0, and half-gain points. (2) For the n-th degree Chebyshev filter networks with mid-band angular frequency ω_0 and $A_p$db transmission band $\omega_0 \pm \omega_b$, the cases of n = 3 to 7, $\omega_c = \omega_0$, and A_p = 0.01, 0.03, 0.1, 0.3, 1db, and the cases of n = 3 to 5, A_p = 0.03db and $(\omega_c - \omega_0)/\omega_b$ = 0.2, 0.4, 0.6, 0.8, 1.0.

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Illinois U. Coordinated Science Lab., Urbana.

ANALYSIS AND SYNTHESIS OF LOSSY COMMUNICATION NETS, by K. Onaga. Mar. 1965, 59p. incl. diagrs. refs. (Rept. no. R-245) (AFOSR-65-0892) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1383 and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 467234 Unclassified

The property of optimum maximum flows in lossy communication nets is investigated. A lossy communication net is a weighted linear graph in which an edge capacity, C, and an efficiency factor, ρ, are associated with each edge. The flow through an edge is limited by its edge capacity, and the flow, ψ, entering an edge capacity, and the flow, ψ, entering an edge suffers a loss of $(1-\rho)\psi$ in passing through the edge so that only the amount $\rho\psi$ emerges from the other end of the edge. A basic saturated cut set (BSC) of an optimum maximum flow (most economical maximum flow) is characterized in terms of a transfer inclusion relation. Based on this characterization, a method of locating the BSC's of the optimum maximum flows is developed. Decomposition of an optimum maximum flow into optimum semi-flows with respect to a basic saturated cut set reduces the task of flow assignment. The properties of sending terminal capacity matrices, $\overline{T}$, and receiving terminal capacity matrices, $\underline{T}$, of a lossy net are studied in terms of principal partitioning. Synthesis procedures for lossy bi-tree nets from given $\overline{T}$ or $\underline{T}$ matrices are developed. The success of these methods is due to the fact that a bi-tree net has a single path between any pair of nodes. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

RUBIDIUM SPIN RELAXATION IN THE RARE GASES: A STUDY UNDER ULTRACLEAN CONDITIONS, by F. A. Franz. Feb. 1965, 34p. incl. diagrs. tables, refs. (Rept. no. R-246) (AFOSR-65-0893) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 458872 Unclassified

Also published in Phys. Rev., v. 139: A603-A611, Aug. 1965.

The spin relaxation of an optically pumped rubidium vapor induced by rubidium-rare gas atomic collisions has been investigated in an ultraclean environment. The experiment was performed under conditions such that the partial pressure of non-rare gas impurities was less than 1×10^{-8} Torr, and that the time between Rb-Rb spin exchange collisions was short compared to the spin relaxation time. The cross sections for disorientation of rubidium were found to be considerably smaller than previously reported values. This fact is attributed primarily to the low degree of impurity contamination in the present work. When compared to already existing values for cesium and sodium, it is seen that the

disorientation cross sections of these 3 alkali metals have a remarkably similar dependence on buffer gas atomic number. The new experimental values are also compared to recent theoretical calculations.

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Illinois U. Coordinated Science Lab., Urbana.

A DYNAMIC PROGRAMMING OF OPTIMUM FLOWS IN LOSSY COMMUNICATION NETS, by K. Onaga. Mar. 1965 [19]p. incl. diagrs. table. (Rept. no. R-247) (AFOSR-65-0894) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1383, and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 459639 Unclassified

A flow $\bar{t}$ with the sending flow value $\bar{T}$ at the source and the receiving flow value $\bar{t}$ at the sink is said to be optimum if there is no flow which has less sending flow value than $\bar{T}$ while having the same receiving value $\bar{t}$. A necessary and sufficient condition of optimality is obtained. Based on this characterization a dynamic programming of optimum flows in a lossy communication net is devised and demonstrated by an example.

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Illinois U. Coordinated Science Lab., Urbana.

RESEARCH IN NETWORK, LINEAR GRAPH AND COMMUNICATION NET THEORIES IN JAPAN, by W. Mayeda. Mar. 1965, 10p. (Rept. no. R-248) (AFOSR-65-0895) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1383, and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 460353 Unclassified

This report introduces some research groups in Japan that are in the fields of network, linear graph and communication net theories. In the Hokkaido and the Tohoku Universities, the groups are researching the synthesis of networks consisting of n-wire lines. In the Yamagata University, analysis of electrical networks by linear graphs is studied. In the Tokyo Institute of Technology, network synthesis is very active. Communication nets are studied in the Electrical Communication Laboratory and the Electrotechnical Laboratory. The filter design group is active in the Nippon Electric Co. Network theory is a very popular research subject in the Osaka University and the Kyushu University. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

PHOTO CURRENT SUPPRESSOR GAUGE DEVELOPMENT, by W. L. Schuemann. Final rept. Mar. 1965 [21]p. incl. diagrs. (Rept. no. R-249) (AFOSR-65-0896) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 460535 Unclassified

A type of ionization gauge called the photo current suppressor gauge has been developed at the Coordinated Science Laboratory of the University of Illinois during the past 3 yr. This gauge is capable of effectively suppressing the photoelectric current (x-ray current) from the ion collector, thereby considerably extending the range of ionization-type gauges. Simple suppressor gauges have a limitation similar to the x-ray limit of the Bayard-Alpert gauge ($\sim 1 \times 10^{-13}$ Torr. Slightly more complicated suppressor gauges probably would not be limited by an x-ray effect above 1×10^{-16} Torr, though this has not been experimentally verified. These gauges have a higher sensitivity than typical inverted gauges, are only slightly more complicated, and can use the same power supplies and electrometers.

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Illinois U. Coordinated Science Lab., Urbana.

DIELECTRIC PROPERTIES OF A WEAKLY TURBULENT PLASMA, by Y. H. Ichikawa. Apr. 1965, 23p. incl. diagrs. (Rept. no. R-251) (AFOSR-65-1142) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 462330 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 523, Apr. 26, 1965.

Generalization of the Herring-Yoshikawa theory has been developed to take into account the dynamical effect of turbulent fluctuation on the dielectric properties of weakly turbulent plasma. According to the hydrodynamic description of electron plasma, the turbulent fluctuation gives rise to appreciable modification of the dielectric properties in the low frequency region and at the frequency of twice of the electron plasma frequency. An expression of the static dielectric constant shows that the characteristic correlation distance of the weakly turbulent plasma becomes longer than the Debye distance of corresponding homogeneous plasma in thermal equilibrium state. Contrary to the hydrodynamic scheme, the integral equation has been derived for the induced fluctuation in the kinetic description of the plasma. This integral equation suggests that the turbulent fluctuation may modify the dielectric properties of the turbulent plasma also at the electron plasma frequency. (Contractor's abstract)

1159

Illinois U. Coordinated Science Lab., Urbana.

OPTIMAL MATCHING OF LINEAR TIME-VARYING NETWORKS, by R. J. Tracy. Apr. 1965, 26p. incl. diagr. (Rept. no. R-252) (AFOSR-65-1143) (Sponsored

jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E))
AD 614800 Unclassified

The calculus of variations is used to obtain the optimal load network for a linear time-varying n-port network excited at each port by arbitrary signals. The given network is represented using a state variable description; use of a matrix of Lagrange multipliers in the variational process then leads directly to the state variable description of the adjoint matching network. The choice of anticipative or non-anticipative load networks is considered. The general result is then specialized to obtain the usual condition required for matching time-invariant networks in the periodic steady state. Conditions which guarantee the existence of an optimal match are obtained from the second variation. Finally, the entire matching process is interpreted in terms of the lossy and lossless parts of the network response. (Contractor's abstract)

1160

Illinois U. Coordinated Science Lab., Urbana.

A PROCEDURE FOR SYNTHESIS OF SWITCHING NETWORKS, by A. C. McKellar. May 1965, 42p. incl. diagrs. tables. (Rept. no. R-253) (AFOSR-65-1456) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E); and National Science Foundation) AD 618333 Unclassified

A procedure is described which yields a realization of a sequential machine as any asynchronous switching network. The basic idea is to perform an operation on the flow table which corresponds to opening a feedback loop of some realization. Repetition of such operations leads to the specification of a combinational network which is considered to be a solution to the problem. In addition to being iterative, the procedure is capable to being implemented on a digital computer. Necessary and sufficient conditions for the existence of asynchronous cascade and parallel realizations are given and methods of obtaining such realizations are explored. It is shown that the steady state behavior of a sequential machine is useful in this regard. (Contractor's abstract)

1161

Illinois U. Coordinated Science Lab., Urbana.

OPTIMAL CONTROL OF LINEAR SYSTEMS WITH TIME LAG, by T. E. Mueller. June 1965, 42p. incl. diagrs. refs. (Rept. no. R-254) (AFOSR-65-1457) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E))
AD 618332 Unclassified

New results are given which permit a numerical solution of the optimal regulator problem for systems governed by linear differential-difference equations in which the optimization interval is finite. An iterative algorithm which assures convergence to the optimum is derived from the necessary and sufficient conditions for optimality. This algorithm requires neither the choice of an initial control nor the choice of a convergence parameter. The conditions for optimality are derived in 2 forms: an integral equation and a coupled set of differential-difference equations. Numerical examples for this are presented. (Contractor's abstract)

1162

Illinois U. Coordinated Science Lab., Urbana.

OPTIMIZATION OF SYSTEMS WITH PULSE-WIDTH-MODULATED CONTROL, by D. E. Kirk. June 1965, 66p. incl. diagrs. tables, refs. (Rept. no. R-255) (AFOSR-65-1458) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) Unclassified

A new procedure for optimizing the performance of pulse-width-modulated systems is given for plants which may be nonlinear and time-varying. A modified Bolza performance index is employed. The optimization is formulated as a multiple-arc problem of the calculus of variations. Necessary conditions for optimal control are given in the form of a nonlinear two-point boundary value problem. The method of steepest descent is applied to obtain numerical solutions. A computational procedure is found which is especially suited to this type of problem. Special features of the procedure are automatic step size adjustment, and the generation of a sequence of performance indices which is monotonic. Examples which illustrate the range of application are given. (Contractor's abstract)

1163

Illinois U. Coordinated Science Lab., Urbana.

SELF-DIAGNOSIS OF ELECTRONIC COMPUTERS: AN EXPERIMENTAL STUDY, by E. G. Manning. July 1965, 72p. incl. diagrs. tables, refs. (Rept. no. R-259) (AFOSR-65-1703) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00072(E); and National Science Foundation)
AD 620248 Unclassified

The problem considered is the development of design principles which will permit the design of self-diagnosing computers. A self-diagnosing computer is one for which there exists a self-diagnosis procedure, defined as an experiment having one of two outcomes: (a) all transistor-diode logic is entirely failure-free; or (b) card or module x has a failure of type y. Also, the procedure must be sufficiently fast to permit execution every few hr, using non-technical personnel. So little is known about the problems involved in making a computer self-diagnosing, that it is appropriate to first attack a more restrictive, experimental problem. Consequently, an attempt was made to derive a self-diagnosis procedure for the execution-phase hardware (main control, arithmetic unit, and decoders) of an existing machine (the CSX-1). The principal experimental tool was the sequential analyzer

system which allows digital simulation of the class of sequential machines generated under failure from a given machine.

1164

Illinois U. Coordinated Science Lab., Urbana.

MODIFIED UNISTOR GRAPHS AND SIGNAL FLOW GRAPHS, by J. Numata. July 1965 [36]p. incl. diagrs. refs. (Rept. no. R-261) (AFOSR-65-1704) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-931, and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 619723 Unclassified

After giving a definition of a modified unistor graph, its fundamental properties are listed. Topological formulas are given for the graph and for a short circuit function. A proof of Mason's formula for signal flow graphs by modified unistor graphs is included.

1165

Illinois U. Coordinated Science Lab., Urbana.

NETWORK SYNTHESIS TO MINIMIZE MULTIPARAMETER SENSITIVITY, by S. C.-h. Lee. Aug. 1965 [173]p. incl. diagrs. refs. (Rept. no. R-262) (AFOSR-65-1705) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 619726 Unclassified

The concept of sensitivity group is introduced in giving a new definition of multiparameter sensitivity which is more general than that of Goldstein and Kuo. Some theorems on the multiparameter sensitivity for RLC network are given. From these theorems, the sensitivity groups of any RLC network can be directly determined from the network. The multiparameter sensitivity of any RLC network can thus be easily obtained. The new definition makes it possible to compare 3 RLC networks of different topology realizing the same network functions with respect to multiparameter sensitivity. In particular, RC ladder networks are compared with non-seriesparallel structures which are synthesized by an extension of a procedure due to H. B. Lee. It is shown that the new networks always have smaller values of multiparameter sensitivity than 2 classes of equivalent ladder networks. Numerical examples computed on CDC 1604 and IBM 7094 are given to illustrate the method. (Contractor's abstract)

1166

Illinois U. Coordinated Science Lab., Urbana.

A CURRENT MODE DA CONVERTER, by J. Stifle. Aug. 1965, 25p. incl. diagrs. tables. (Rept. no. R-263) (AFOSR-65-1706) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 619778 Unclassified

The design of a digital to analog converter using a current driven ladder instead of the more conventional voltage driven technique is described. The constant current source is a standard Darlington configuration which is easily temperature compensated. The converter specifications include a maximum worst case absolute error of less than .01%, long term stability better than .008%, 0 offset voltage, and a setting time of less than 1.8 usec. No trimming components are used. (Contractor's abstract)

1167

Illinois U. Coordinated Science Lab., Urbana.

COMPUTER COMPILER. PART I - PRELIMINARY REPORT, by G. Metze and S. Seshu. Aug. 1965, 36p. incl. diagrs. (Rept. no. R-264) (AFOSR-65-1707) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00073(E); and National Science Foundation) AD 619738 Unclassified

A technique is proposed for the automatic system design of a digital computer. The desired computer is described in a FORTRAN-like language. This information is read by a (system) compiler which produces a microinstruction flow-chart optimized according to the given criterion. This output is given to another (logic) compiler which produces the logic circuit diagram of the desired machine. The basic concepts and the proposed input language are discussed in this preliminary report and an example of the input for a full-fledged computer is given.

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Illinois U. Coordinated Science Lab., Urbana.

GROUND STATE OCCUPATION PROBABILITIES FOR OPTICALLY PUMPED ALKALI METAL ATOMS, by F. A. Franz. Aug. 1965 [63]p. incl. diagrs. tables, refs. (Rept. no. R-265) (AFOSR-65-1708) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 620249 Unclassified

Calculations of the relative populations of the ground state Zeeman sublevels of an optically pumped alkali atom are presented. Two modes of optical pumping-zero mixing and complete mixing in the excited state-and 3 modes of alkali relaxation-uniform, Zeeman, and electron randomization-are considered. Calculations of the sublevel relative populations for an alkali atom of nuclear spin 3/2 are then made in terms of experimentally measurable parameters for all 6 combinations of pumping and relaxation modes. The numerical results are summarized in tables as functions of pumping and relaxation rates. (Contractor's abstract)

1169

Illinois U. Coordinated Science Lab., Urbana.

A CLASS OF FLAT DELAY FILTER NETWORKS AND THEIR TRANSIENT RESPONSES, by G. Kishi. Aug. 1965, 39p. incl. diagrs. (Rept. no. R-256) (AFOSR-65-1709) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 619727 Unclassified

The transfer functions of the network studied are rational functions of the frequency variable whose denominators are Bessel polynomials and whose numerators have real frequency roots. Amplitude and group delay characteristics are shown in a set of curves. Transient responses of the networks are investigated for suddenly impressed and removed sinusoidal input signals. The set of curves shows excellent transient behavior compared with that of conventional filters.

1170

Illinois U. Coordinated Science Lab., Urbana.

A TOPOLOGICAL TECHNIQUE FOR ANALYSIS OF ACTIVE NETWORKS, by J. T. Barrows, Jr. Aug. 1965, 32p. incl. diagrs. refs. (Rept. no. R-266) (AFOSR-65-2218) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 621925 Unclassified

This paper presents a generalization of Fuessner's method for the analysis of active networks. This method makes it possible to determine system functions of any network in a simple and straightforward manner. In the usual topological analysis of networks it is necessary to list all possible trees or co-trees and the signs of their tree admittance products as well as determining the set of 2-tree products and their signs for the network function in question. Usually 2 graphs, a current and a voltage graph, are used to implement this process when dependent sources are present in the network. The method presented here utilizes solely the original topology and the assigned branch current directions to determine these terms and their sign. Justification of the technique is given for the case of 1 and 2 dependent sources present in a network with the summary of the method for each case. The analysis of a network with an arbitrary number of dependent sources is seen to follow directly. Finally an example of a network with 2 dependent sources is given which illustrates the method. (Contractor's abstract)

1171

Illinois U. Coordinated Science Lab., Urbana.

THE USES OF PLATO: A COMPUTER-CONTROLLED TEACHING SYSTEM, by D. L. Bitzer, E. R. Lyman, and J. A. Easley, Jr. Oct. 1965 [29]p. incl. illus. diagrs. refs. (Rept. no. R-268) (AFOSR-65-2286) (Sponsored jointly by Advanced Research Projects Agency, and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 623526 Unclassified

The use of a high-speed digital computer as a central control element provides great flexibility in an automatic teaching system. Using a computer-based system permits versatility in teaching logics since changing the type of teacher merely requires changing the computer program, not the hardware. In addition, having access to the decision-making capacity of a large computer located as one unit permits complicated decisions to be made for each student. Such capacity would be prohibitively expensive to provide by means of decision-making equipment located at each student station. The results of exploratory queuing studies show that the system could teach as many as a thousand students simultaneously without incurring a noticeable delay for any student's request. The educational results thus far have been extremely encouraging. However, reliable conclusions on educational achievement must await the results of more thorough experiments now in progress which include larger numbers of students learning under a variety of conditions. The adaptability and usability of the system for a variety of purposes in education and the behavioral and physical sciences have been clearly demonstrated. (Contractor's abstract)

1172

Illinois U. Coordinated Science Lab., Urbana.

A DECODING METHOD FOR BOSE-CHAUDHURI BINARY CODES USING AN ERROR COUNTING TECHNIQUE, by W. J. Bouknight. Oct. 1965, 29p. incl. diagrs. tables. (Rept. no. R-267) (AFOSR-65-2287) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E); and National Science Foundation) AD 623525 Unclassified

The implementation of a decoding scheme for Bose-Chaudhuri (n, K) cyclic codes is discussed. A method of error counting is formulated and a trial-and-error correction operation is developed based on error count reduction by successful trial corrections.

1173

Illinois U. Coordinated Science Lab., Urbana.

THE PSEUDO-SHOCK: A NON-LINEAR PROBLEM OF TRANSLATIONAL RELAXATION, by B. L. Hicks. June 1965, 32p. incl. diagrs. tables, refs. (Rept. no. R-236) (AFOSR-65-2297) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 618328 Unclassified

The Boltzmann equation was solved by Nordsieck's Monte Carlo method for the case of translational relaxation of a gas of elastic spheres whose initial velocity distribution function is given. The Mach number describes the

relative separation of the 2 peaks of the bimodal distribution function and therefore controls the degree of initial departure from equilibrium. Calculations were made for M = 0.5, 1, 2, 4, and 6, which includes a range of initial conditions from very close to very far from thermal equilibrium. It was also shown that in a Krook model of our relaxation process, the ratio of the 2 collision numbers is somewhat smaller than 2 late in the relaxation and approaches 2 asymptotically.

1174

Illinois U. Coordinated Science Lab., Urbana.

ON THE GENERALITY OF SWITCHING NETWORKS WITH RESTRICTED NON-LINEARITY, by A. C. McKellar. July 1965, 13p. (Rept. no. R-258) (AFOSR-65-2298) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E); and National Science Foundation) AD 618331 Unclassified

The generality of special types of asynchronous realizations of sequential machines is considered and compared with the synchronous case. It is shown that linear asynchronous networks are essentially combinational. On the other hand, every sequential machine can be realized as a network whose output and feedback functions are linear in the feedback inputs. It is proven that more feedback loops are required to do this than are required by known synchronous realizations. A relationship is established between asynchronous networks which are quadratic in their feedback inputs and synchronous networks which are linear in their feedback inputs. (Contractor's abstract)

1175

Illinois U. Coordinated Science Lab., Urbana.

STOCHASTIC FLOW OF MESSAGES AND ITS EFFICIENT TRANSMISSION THROUGH COMMUNICATION NETS, by K. Onaga. Nov. 1965, 13p. (Rept. no. R-269) (AFOSR-65-2757) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)1383 and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E))
AD 624255 Unclassified

Efficient transmission of stochastic flow of messages through store-and-forward type communication nets is discussed in this paper. In order to express quality or performance of flow ψ quantitatively, the penality index P (ψ) is defined as the sum of total time delay D (ψ), total transmission cost K (ψ), and total transmission redundancy R (ψ) with certain proportions of penalty. A necessary and sufficient condition of minimum penalty flow for the fixed flow value is obtained and is demonstrated by a simple example. (Contractor's abstract)

1176

Illinois U. Coordinated Science Lab., Urbana.

ION OSCILLATIONS IN A WEAKLY TURBULENT PLASMA, by Y. N. Ichikawa. Nov. 1965 [34]p. incl. diagrs. refs. (Rept. no. R-271) (AFOSR-66-0112) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E))
AD 624604 Unclassified

Ion oscillations in a high temperature electron-ion plasma with high frequency turbulent fluctuations are investigated by generalizing the quasi-linear theory to a spatially inhomogeneous sytem. It is found that the feedback effect of the high frequency fluctuation on the low frequency oscillation in the system gives rise to a parametric growth of the ion acoustic mode even if the system has a stable velocity distribution with respect to the ion acoustic mode. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

ELEMENTARY COMPLETE TREE TRANSFORMATION, by W. Mayeda. Dec. 1965, 19p. incl. diagrs. (Rept. no. R-272) (AFOSR-66-0496) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-931 and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E))
AD 625201 Unclassified

It is known that a passive electrical network without mutual couplings can be analyzed by knowing all possible trees of a linear graph corresponding to the network. Since there exists a reasonably simple method of generating all possible trees of a linear graph without duplications, analysis of such a network by a computer becomes simple. When a pair of linear graphs is used, an active network can be analyzed by knowing all possible complete trees each of which is a tree of both linear graphs. At present there is no simple method of generating all possible complete trees without duplications. Hence, in order to obtain all possible complete trees by a computer, one of the best available methods at present is to generate all possible trees of each linear graph to obtain 2 collections of trees, then intersecting the 2 collections. It is not difficult to design an active network such that there are more than 1000 trees in each of a pair of linear graphs corresponding to the net, but there are less than 100 complete trees. Hence to obtain a simple method of generating all possible complete trees is undoubtedly important for anlaysis of active networks by a computer.

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Illinois U. Coordinated Science Lab., Urbana.

SET OF CUT SETS AND OPTIMUM FLOW, by W. Mayeda and M. E. Van Valkenburg. Nov. 1965, 14p. incl. diagrs. (Rept. no. R-270) (AFOSR-66-0498) (Sponsored jointly by Air Force Office of Scientific

Research under AF AFOSR-65-931, and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 625200 Unclassified

An important unsolved problem in the theory of communication nets is the enumeration of the properties of a set of edge flows necesaary to give a required terminal flow from one vertex to another. For example, there is no simple method for obtaining a set of edge flows to give maximum terminal flow. The relationship of these flows and the conditions necessary to obtain maximum flow are important practical problems in systems in which edge flow is limited; in the telephone system for example. Clearly an improvement would result if it were possible to reduce some edge flows and still maintain the same terminal flow. The method presented stems from the work of Ford and Fulkerson which relates maximum terminal flow to the cut set separating the terminals. A new set of cut sets called a 'set of M-cut sets' is introduced from which it is possible to improve edge flows while maintaining maximum terminal flow.

1179

Illinois U. Coordinated Science Lab., Urbana.

REPLAB—A LESSON IN SCIENTIFIC INQUIRY USING THE PLATO SYSTEM, by D. L. Bitzer, E. R. Lyman, and J. R. Suchman. Dec. 1965 [34]p. incl. illus. diagr., tables, refs. (Rept. no. R-260) (AFOSR-66-0507) (Sponsored jointly by Advanced Research Projects Agency; and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E)) AD 627076 Unclassified

One of the teaching techniques employed in the Illinois Studies in Inquiry Training project was a lesson, REPLAB, (Responsive Environment Programmed Laboratory), written for use with the PLATO computer-controlled teaching system. The lesson was designed to develop inquiry skills and to study inquiry styles of individual students. A film, showing an event involving a bimetallic strip was presented to the students by means of a computer-activated projector. The students answered questions about the event posed them via the PLATO 'electronic book.' Answers to some of the questions could be found by careful observation of the film, others by obtaining further information from results displayed on their 'electronic blackboards' by the computer in response to their inquiries in the PLATO experiment laboratory, property laboratory or condition laboratory. One set of questions in the question sequence tested the students' ability to go beyond the data they had obtained from the computer and formulate theories. The detailed record of the REPLAB student responses provided by the PLATO system gave data for a correlation of variables in the REPLAB lesson with those from pre-tests and post-tests given the students. (Contractor's abstract)

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Illinois U. Coordinated Science Lab., Urbana.

HIGH RESOLUTION RADIO FREQUENCY MEASUREMENTS OF FARADAY ROTATION AND DIFFERENTIAL ABSORPTION WITH ROCKET PROBES, by H. Knoebel, D. Skaperdas and others. Dec. 1965 [131]p. incl. illus. diagrs. tables, refs. (Rept. no. R-273) (AFOSR-66-0508) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 28-043-AMC-00073(E); and National Aeronautics and Space Administration) AD 627903 Unclassified

A highly essential system for lower ionosphere radio propagation measurements, using probe rockets, developed by the Coordinated Science Laboratory, is described in detail. Unique features include: (1) feedback around a closed loop consisting of the rocket and ground stations employed in a null-seeking technique, which increases absorption measurement accuracy and (2) artificial rotation of the ground gased antenna which extends the range over which Faraday rotation can be resolved from layer reflection phenomena. The rocket borne and ground station equipment has been shown to work reliably during a series of 14 rocket measurements made from both land-based facilities and the NASA seagoing mobile launch platform during the International Quiet Sun Years. Complete engineering information is given in the hope that other investigators may easily duplicate the measurements. Data processing techniques for smoothing and improving the accuracy as well as some typical data are described.

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Illinois U. Coordinated Science Lab., Urbana.

OSCILLATIONS IN A ONE-DIMENSIONAL INHOMOGENOUS PLASMA, by E. A. Jackson and M. Raether. Jan. 1965, 23p. incl. diagrs. (Rept. no. R-239) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under DA 28-043-00073(E)) Unclassified

Oscillations in finite, inhomogenous plasmas have received considerable attention recently in connection with the interpretation of the so-called Tonks-Dattner resonances. Although some progress has been made in calculating the resonance frequencies from the moment equations for a cold and warm plasma, attempts to calculate the Landau damping of these modes has not led to tangible results. This report presents detailed calculations of the eigen frequencies and their damping rates for a one-dimensional, inhomogenous plasma in the long wavelength regime.

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Illinois U. Coordinated Science Lab., Urbana.

PROGRESS REPORT FOR DECEMBER 1964, JANUARY AND FEBRUARY 1965. Apr. 7, 1965 [90]p. incl diagrs. tables. (Sponsored jointly by Advanced Research

Projects Agency; Air Force Office of Scientific Research under AF 49(638)1383, and Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00073(E), and National Science Foundation) Unclassified

The work reported in this quarterly progress report includes activites in the following areas: aerospace, surface and atomic physics, computer applications, systems PLATO, vacuum instrumentation, plasma physics, high magnetic field superconductors, high voltage breakdown, thin films, and computers.

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Illinois U. Coordinated Science Lab., Urbana.

PROGRESS REPORT FOR MARCH, APRIL, MAY 1965. July 26, 1965 [130]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1383 and AF AFOSR-65-903; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00073(E), National Aeronautics and Space Administration, and National Science Foundation) Unclassified

Summaries of the work of several investigations are presented. Work is reported in the areas of aerospace, physics, data processing, control systems, magnetic conductors and circuit and system theory.

1184

Illinois U. Coordinated Science Lab., Urbana.

PROGRESS REPORT FOR JUNE, JULY AND AUGUST 1965. Oct. 11, 1965, 130p. incl. diagrs. refs. (Sponsored jointly by Advanced Research Projects Agency, Air Force Office of Scientific Research under AF AFOSR-65-931; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 28-043-AMC-00073(E), National Aeronautics and Space Administration, and National Science Foundation) AD 623404 Unclassified

Progress is reported in the following fields: ionospheric data, surface and atomic physics, computer applications, computer systems, PLATO, plasma physics, superconductors, high voltage breakdown, thin films, switching systems, communication theory, and circuitry.

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[Illinois U. Coordinated Science Lab., Urbana]

SENSITIVITY CONSIDERATIONS IN OPTIMAL SYSTEM DESIGN, by R. A. Rohrer and M. Sobral, Jr. [1965] [6]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under DA 28-043-AMC-00073(E)) Unclassified

Published in IEEE Trans. Automatic Control, v. AC-10 43-48, Jan. 1965.

The sensitivity of a control system is usually taken to be the normalized variation of some desired characteristic with the variation of plant or controller parameters. Rather than the usual absolute sensitivity described above, a new definition of relative sensitivity is introduced for the optimal control problem, wherein the system performance is always compared with its optimum under the given circumstances. The implications of the relative sensitivity and its relevance to optimal system design are discussed in detail. Moreover, a theoretical approach to the problem of system optimization when plant parameters are subject to change or are incompletely specified is presented.

1186

Illinois U. Coordinated Science Lab., Urbana.

THE PARAMETER VARIATION PROBLEM IN STATE FEED-BACK CONTROL SYSTEMS, by W. R. Perkins and J. B. Cruz, Jr. Oct. 1963, 24p. incl. diagrs. (Rept. no. R-182) (AFOSR-5198) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under DA 36-039-AMC-02208(E)) Unclassified

Presented at Joint Automatic Control Conf., Stanford, Calif., June 24-26, 1964.

Also published in Jour. Basic Eng., v. 87: 120-124, Mar. 1965.

The plant-parameter variation problem in multivariable linear systems described by state-vector equations is formulated using a new sensitivity measure. This formulation involves a direct comparison of open-loop and state-feedback performance in the presence of parameter variations and provides a bssis for guaranteeing the superiority of the feedback design. Results are obtained for both continuous and discrete multi-input, multi-output systems. Furthermore, it is shown for single-input, multi-output plants that a low-sensitivity design is also an optimal feedback-control design with respect to a quadratic performance index. This provides a new interpretation of a similar result previously obtained by Kalman. (Contractor's abstract)

1187

Illinois U. Coordinated Science Lab., Urbana.

DISTRIBUTED NETWORK SYNTHESIS FOR A CLASS OF INTEGRATED CIRCUITS, by R. A. Rohrer, J. A. Resh, and R. A. Hoyt. [1965] [13]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under DA 36-039-AMC-02208(E)) Unclassified

Published in IEEE Internat'l. Conv. Rec. Pt. 7: 100-112, 1965.

A general approach to the synthesis of series R-shunt C distributed networks is presented. The synthesis technique relies on the projection of port signal requirements onto the network interior in a manner compatible

with the physical constraintes imposed. The theoretical approach culminates with an iterative technique for going from signal processing requirements—in either the time or the frequency domain—directly to the element va' .es.

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Illinois U. Dept. of Chemistry and Chemical Engineering, Urbana.

HIGH TEMPERATURE GAS KINETIC STUDY OF NITROUS OXIDE DECOMPOSITION PERFORMED WITH A SHOCK TUBE AND QUADRUPOLE MASS-FILTER, by D. Gutman. May 1965, 79p. incl. illus. diagrs. tables, refs. (Research rept. no. 2) (AFOSR-66-0952) (AF AFOSR-64-588) AD 634399 Unclassified

A quadrupole mass-filter was built and coupled to a shock tube in order to study high temperature gas kinetics. The chemical kinetics of the decomposition of nitrous oxide was studied with this apparatus in order to establish the mechanism of the reaction at temperatures above 1000°K. Several instrumentation problems unique to shock tube mass-spectrometry were solved. The most serious problem, that of a rapid-pumping ion source, was overcome by the design and construction of an unusually thin ion source. The thermal decomposition of nitrous oxide was studied by shock-heating a mixture of 4% N_2O in argon and monitoring the ion currents corresponding to all of the principal species involved in the reaction: N_2O, N_2, O_2, NO, and O. In each run with the shock tube, the mass-filter was tuned to follow the concentration of a single species. Because enough runs were made with all of the species, a run for each species at the same temperature was made for several temperatures.

1189

Illinois U. Dept. of Chemistry and Chemical Engineering, Urbana.

INVESTIGATION OF WALL TURBULENCE USING A DIFFUSION-CONTROLLED ELECTRODE, by J. E. Mitchell and T. J. Hanratty. July 1965, 149p. incl illus. diagrs. tables, refs. (Rept. no. 1) (AFOSR-65-1199) (AF AFOSR-65-547) AD 619304 Unclassified

This study was performed to demonstrate that a diffusion-controlled electrode technique can be used to measure the average and fluctuating shear stresses at a pipe wall and to obtain a better understanding of the structure of turbulence near the wall. The technique was established after compensations for 2 effects, also common to the hot wire anemometer, were determined. The problem of non-uniform flow across the electrode was solved by determining experimentally a correction factor, whereas the problem of the time response of the electrode to fluctuations in the shear stress was handled by numerically solving the governing equations. The data for fully developed turbulence showed that the limiting velocity intensity at the wall was 0.32, based on the local average velocity, and that it was independent of Reynolds number. The circumferential scale was found to be very small near the wall but the longitudinal scale did not decrease from the values reported for the center of a pipe. Some velocity disturbances near the wall appeared to be as large as the local average velocity. A simplified model for a low frequency disturbance near the wall was investigated and found to be promising although several of the assumptions were not well substantiated.

1190

Illinois U. [Dept. of Mathematics] Urbana.

WEAK TOPOLOGIES ON THE BOUNDED HOLOMORPHIC FUNCTIONS, by L. A. Rubel and A. L. Shields. [1965] [4]p. (AFOSR-65-1411) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-406] and National Science Foundation) AD 621258 Unclassified

Also published in Bull. Amer. Math. Soc., v. 71, 349-352, Mar. 1965.

G is a region in the complex plane such that there is a nonconstant bounded holomorphic function on G. The algebra of all such functions is denoted by $B_H(G)$. $H_\infty(G)$ denotes the Banach algebra that arises when $B_H(G)$ is endowed with the supremum norm, and β denotes the strict topology of all bounded analytic functions in G. In this note a number of intrinsic complex-variables methods are introduced and used in conjunction with the theory of topological linear spaces to investigate the structures of β and $B_H(G)$. The main new tool used is the balayage, or sweeping, of measures. Main results are presented, without proof.

1191

Illinois U. Dept. of Mining, Metallurgy and Petroleum Engineering, Urbana.

IRRADIATION-INDUCED BROADENING OF THE F-ABSORPTION BAND IN KCl, by H. Mizuno and W. B. Fowler. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2589) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-179 and AF AFOSR-65-803, and Atomic Energy Commission) AD 627747 Unclassified

Also published in Jour. Phys. Soc. (Japan), v 20: 1888-1894, Oct. 1965.

Earlier workers observed that in the initial stages of room temperature F-band irradiation of additively-colored, freshly-quenched alkali halide crystals a low energy broadening of the F band appeared. Here this broadening in KCl was measured and similar results for 2 very different sodium concentrations were obtained. This indicates that sodium FA centers are not responsible for the effect. The resonance broadening due to the dipolar interaction of 2 F centers was calculated. It was found that this mechanism could account for the observed phenomenon if most of the F centers were about 3 nearest neighbors apart, or if 5% of them were about 2 nearest neighbors apart. Published experimental

results indicate that in the early stages of irradiation few of the F centers are this close together, although a number as small as 5% is not necessarily ruled out. Other possible explanations of the experimental results are discussed. (Contractor's abstract)

1192

Illinois U. [Dept. of Mining, Metallurgy and Petroleum Engineering] Urbana.

BOUND STATES ON STACKING FAULTS (Abstract), by R. M. Thomson and Z. Usmani. [1965] [1]p. [AF AFOSR-62-179] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Nov. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 309, Mar. 24, 1965.

The electronic singularity at a stacking fault in a solid has a strong similarity to Shockley's theory of surface states. It is reasonable to suppose that, within the Wigner-Seitz cell surrounding an atom near a stacking fault, the local potential for the valence electrons is nearly unchanged by the presence of the stacking fault, since there is no long-range strain associated with the stacking fault, and the correct number of nearest neighbors is present. However, the long-range order has an abrupt singularity, and we suppose with Shockley that this can have an important effect on the criterion for the existence of bound states. We build the theory within the Slater-Koster framework, but in the Bloch representation, reducing the problem to the solution to a determinantal equation. The criteria for the presence of surface states are discussed on the basis of preliminary qualitative considerations and simplified models.

1193

Illinois U. Dept. of Mining, Metallurgy and Petroleum Engineering, Urbana.

ELECTRIC-FIELD IONIZATION OF THE EXCITED F CENTER IN KCl, by G. Spinolo and W. B. Fowler. [1965] 25p. incl. diagrs. tables, refs. (AF AFOSR-62-179 and AF AFOSR-62-215) Unclassified

Based on Luty's original observation that excited F centers could be ionized by applied electric fields, Euwema and Smoluchowski calculated the probabilities for 2 effects, a low-temperature tunneling effect and a higher-temperature Schottky effect. This research extends the Euwema and Smoluchowski theory and reports on luminescence measurements of both effects for the KCl F center. The results are analyzed on the basis of the "large-orbit" picture of the relaxed excited state developed by Fowler. The Schottky data fit the theory very well, and yield an effective dielectric constant about equal to the static dielectric constant. The tunneling data are in qualitative agreement with the theory. (Contractor's abstract)

1194

Illinois U. [Dept. of Mining, Metallurgy and Petroleum Engineering] Urbana.

OPTICAL PROPERTIES OF DEFORMED SEMICONDUCTORS (Abstract), by M. Meyer, T. Ninomiya, and M. H. Miles. [1965] [1]p. [AF AFOSR-62-179] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 344, Mar. 24, 1965.

Optical absorption of deformed germanium and silicon have been measured at room and liquid-nitrogen temperatures. Deformed crystals containing predominantly edge or screw dislocations exhibited an almost temperature-independent absorption tail extending from the intrinsic edge. The tail was independent of the Fermi level, varied as the inverse square of the wavelength, and its magnitude depended markedly upon the direction that the light was propagated relative to the slip plane. Surface-plating techniques were employed to minimize impurity contamination. Hall measurements down to liquid-nitrogen temperature demonstrated the reliability of these techniques. Forwardscattering of the transmitted radiation through silicon was observed, using an infrared-sensitive plate. Sufficient scattering was observed to account for the apparent optical absorption measurements and its anisotropy features. The scattered radiation of light incident normal to the surface and parallel to the slip planes showed narrow lobes extending in the direction of the normals to the slip plane. A tentative model of refraction due to a varying dielectric constant across the slip plane is used to interpret the results. This variation is supposed due to the strain fields surrounding the dislocation arrays in slip planes.

1195

Illinois U. Dept. of Mining, Metallurgy and Petroleum Engineering, Urbana.

NUCLEAR MAGNETIC RESONANCE IN LIQUID COPPER AND ANTIMONY METALS, by R. L. Odle and C. P. Flynn. [1965] [2]p. incl. refs. (AFOSR-65-2594) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-633, and Atomic Energy Commission) AD 629868 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1685-1686, Nov. 1965.

The Cu^{63} resonance in solid copper was observed to narrow in the neighborhood of 650°C. The line width was not limited by the excessive field inhomogeneity and was found to narrow to an eventual width of 0.3 ± 0.1G. The width to be anticipated if the low temperature result, $T_1T = 1.27$ sec°K may be extrapolated to 1350°K is 0.18G The value of 0.37G obtained from the Korringa relationship and the observed Knight shift is in somewhat better accord with experiment. The Knight shift of solid copper increased by 5 ± 1.5% on heating from room temperature to the melting point. The nuclear resonance of

Sb^{121} in liquid antimony was observed at T = 630°C. The line is a Lorentzian of width 2.6 ± 0.5 gauss and the Knight shift of 0.72% is close to the values 0.79% and 0.72% found in the neighboring liquid metals indium and tin. The measured line width is reasonably close to the value of 1.9G obtained from the Knight shift and the Korringa relation.

1196

Illinois U., Dept. of Mining, Metallurgy and Petroleum Engineering, Urbana.

DIFFUSION OF VANADIUM^{48} AND IRON^{59} IN VANADIUM, by R. F. Peart. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-1535) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-633, and Atomic Energy Commission) AD 641780 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1853-1861, Dec. 1965.

Measurements have been made of tracer diffusion coefficients of V^{48} and Fe^{59} in single crystals of vanadium over the temperature range 849-1830°C. The V^{48} results show temperature dependent diffusion characteristics that are represented by activation energies of 94 kcal/mol above 1356°C and 72 kcal/mol below this temperature, and those for Fe^{59} by an activation energy of 70 kcal/mol in the temperature range 840-1170°C. No single explanation of these results is offered but the low temperature data appear to be consistent with the operation of a vacancy mechanism of diffusion.

1197

Illinois U. [Dept. of Mining, Metallurgy and Petroleum Engineering] Urbana.

AN INTERNAL FRICTION STUDY OF VACANCIES IN A QUENCHED Au-Ni SOLID SOLUTION, by J. R. Cost. [1965] [5]p. incl. diagrs. refs. (AFOSR-66-1601) (AF AFOSR-64-633) AD 641786 Unclassified

Also published in Acta Metall., v. 13: 1263-1267, Dec. 1965.

Changes in the vacancy concentration in a quenched Au-30 at-% Ni alloy are followed using isothermal internal friction measurements of the Zener relaxation rate. Analysis of the vacancy annealing yields a value of approximately 21 kcal/mol for the energy for vacancy motion. From this energy of motion, typical rates of shifting of the Zener peak temperature are obtained. This peak shift is used to interpret a previously unexplained internal friction peak observed in this alloy. (Contractor's abstract)

1198

Illinois U. Dept. of Physics, Urbana.

X-RAY GENERATION OF COLOR CENTERS IN ZONE-REFINED KCl AND KBr, by T. M. Srinivasan and W. D. Compton. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-0767) (AF 49(638)529) AD 616J36 Unclassified

Also published in Phys. Rev., v. 137: A264-A272, Jan. 1965.

The techniques of zone purification of KCl and KBr crystals are described, and the success of this technique in removing impurities such as hydroxyl ions and divalent cations is demonstrated. A comparison of the defects introduced into zone-purified salts and commercial salts by x-irradiation at room temperature and at liquid-helium temperature is given. Studies of the optical bleaching of F, H, and V_K centers by F-band light at liquid-helium temperature gives evidence of the spatial proximity of these centers. (Contractor's abstract)

1199

Illinois U. Dept. of Physics, Urbana.

ELECTRON CAPTURE BY α AND F CENTERS IN KBr, by R. S. Crandall. [1965] [5]p. incl. diagrs. refs. (AFOSR-65-2032) (AF 49(638)529) AD 627632 Unclassified

Also published in Phys. Rev., v. 138: A1242-A1246, May 17, 1965.

Photoconductivity measurements are made on KBr containing α, F, and F' centers to determine the electron-trapping probability (probability per unit time that one defect per cm^3 traps an electron) of this F center and α center or negative-ion vacancy. The electron-trapping probability of the α center increases from 3×10^{-7} cm^3/sec at 118°K to 6×10^{-4} cm^3/sec at 24°K. The electron-trapping probability of the F center increases from 3×10^{-7} cm^3/sec at 118°K to 4×10^{-6} cm^3/sec at 24°K. The initial capture of an electron by an α center results in the formation of an excited F center. The binding energy of this excited state is found to be 0.130 ev, corresponding to the first excited state of the F center. Electron capture of an F center is interpreted as occurring through the formation of an excited F' center. The binding energy of this state is found to be between 0.04 and 0.08 ev.

1200

Illinois U. Dept. of Physics, Urbana.

PHOTOCONDUCTIVITY OF KBr CONTAINING F CENTERS, by R. S. Crandall and M. Mikkor. [1965] [3]p. incl. diagrs. refs. (AFOSR-65-2157) [AF 49-(638)529] AD 629033 Unclassified

Also published in Phys. Rev., v. 138: A1247-A1249, May 17, 1965.

The quantum efficiency or number of conduction-band electrons produced per adsorbed photon in the region

of the L bands at 21 °K in KBr was found to be nearly unity. Photoconductivity measurements indicated that the L bands are due to electronic transitions to energy levels which are in the conduction band and that the K band is composed of two or more overlapping optical-absorption bands, of which the higher energy ones are due to electronic transitions to the conduction band. The temperature dependence of the L-band photoconductivity below 45 K can be explained by the temperature dependence of the mobility. (Contractor's abstract)

1201

Illinois U. Dept. of Physics, Urbana.

L CENTERS IN POTASSIUM BROMIDE, by H. K. Rockstad. [1965] [6]p. incl. diagrs. table, refs. (AFOSR-65-2557) (AF 49(638)529) AD 627?9 Unclassified

Also published in Phys. Rev., v. 140: A311-A316, Oct. 4, 1965.

The absolute quantum efficiency for the destruction of L centers and the formation of anion vacancies in KBr at 76 K has been found to be 0.61 ± 0.07 when the U optical absorption band is bleached by 225-mμ radiation absorbed at the maximum of the U band. The quantum efficiency decreases significantly as the energy of the absorbed photons increases. It is suggested that the high-energy tail of the U band is due to a secondary band and that the quantum efficiency of this band is 61% of that of the primary U band. Previous results concerning the formation of isolated anion vacancies and interstitial hydride ions and interacting pairs of these entities are confirmed. However, the oscillator strengths of the perturbed α bands are found to be equal to that of the unperturbed α band. (Contractor's abstract)

1202

Illinois U. Dept. of Physics, Urbana.

THE MOSSBAUER EFFECT OF Fe^{57} ON THE SURFACE OF TUNGSTEN, by J. W. Burton. [1965] [85]p. incl. diagrs. tables, refs. (Technical note no. 2) (AF 49(638)1048) AD 609315 Unclassified

The Mössbauer effect of Fe^{57} on the surface of polycrystalline tungsten was measured over a temperature range of 80 - 500 °K, and at angles of 0° and 60° with respect to the normal. The Mössbauer spectra consist of 3 unresolved lines, the middle one agreeing with measured spectra of Fe^{57} in the bulk of tungsten, and the outer 2 being attributed to surface effects. The asymmetry of the surface spectra, the angular dependence of the shape, and the magnitude of the splitting of the 2 surface lines indicate an electric field gradient at the surface of 2.4×10^{16} V/cm^2 directed along the normal. An effective Debye temperature of 406 ± 12 °K is found for the bulk, from a study of the temperature dependence of the intensity of the Mössbauer absorption. The effective Debye temperature for the surface is 354 ± 30 °K along the normal, and 255 ± 30 °K parallel to the surface. The angular dependence of the total intensity of the 2 surface lines agrees with a simple theory for an atom bound above the top layer of the host lattice. The isomer shift with respect to iron at 300 °K is 0.51 ± .0002 cm/sec in the bulk, and .018 ± .002 cm/sec on the surface.

1203

[Illinois U. Dept. of Physics, Urbana]

VARIATIONAL TREATMENT OF HIGH-FREQUENCY TRANSPORT PROBLEMS IN SOLIDS, by N. K. Hindley and F. Garcia-Moliner. [1965] [10]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-328, and Office of Naval Research) Unclassified

Published in Phys. Rev., v. 140: A343-A352, Oct. 4, 1965.

A variational method of solving the Boltzmann transport equation in a magnetic field is extended to high-frequency problems. The variational functional does not have an extremum at the solution, but a saddle point. It is shown that the approximations to the conductivity satisfy a sum rule which is also satisfied by the exact result, provided reasonable trial functions are used. Alternative variational principles have been formulated by several authors and some of these are discussed. The variational equations used in this paper can also be derived by Blount's method, and this casts more light on their nature. It is shown that when the current carriers are not degenerate and the band is parabolic, the use of Sonine polynomials in the carrier energy as trial functions has certain formal advantages, but that in actual calculations simple powers of the energy give the same results. The method is applied to a calculation of the frequency-dependent magnetoconductivity for mixed ionized-impurity and polar optical-phonon scattering, using parameters appropriate to n-InSb at 77 °K. The results are used to calculate the Faraday rotation and ellipticity as a function of magnetic field at a frequency of 35 Gc/sec. It is suggested that measurements of the Faraday ellipticity can give useful information about the scattering mechanisms in a material. (Contractor's abstract)

1204

Illinois U. Dept. of Physics, Urbana.

K BAND IN COLORED ALKALI HALIDE CRYSTALS, by D. Y. Smith and G. Spinolo. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-1307) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-599 and National Science Foundation) AD 641770 Unclassified

Also published in Phys. Rev., v. 140: A2121-A2128, Dec. 1965.

Recently the results of a number of experiments relating to the K band in colored alkali halides have been reported and several new speculations have been put forth concerning this absorption. A comparison of the known properties of the band with the predictions of various

theories leads to the conclusion that the available experimental evidence supports the original suggestion of Mott and Gurney that the K band is an absorption of the F center to a series of higher excited states. To provide a semiquantitative theoretical test of this explanation the Simpson model for the F center was investigated in detail. The model problem was solved for the most important higher bound states, and transition energies and oscillator strengths for transitions to these states were calculated. It was found that for reasonable choices of parameters the model predicts an optical absorption spectrum that is strikingly similar to the composite F- and K-band absorption. Several experimental tests of the Mott-Gurney model are suggested and the possibility of K-band-like absorptions associated with other centers is discussed. (Contractor's abstract)

1205

Illinois U. Dept. of Physics, Urbana.

OPTICAL ABSORPTION AND PHOTOCONDUCTIVITY IN THE K BAND OF SOME COLORED ALKALI HALIDES, by G. Spinolo and D. Y. Smith. [1965] [4]p. incl. diagrs. refs. (AFOSR-66-1308) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-599 and National Science Foundation) AD 641771 Unclassified

Also published in Phys. Rev., v. 140: A2117-A2120, Dec. 1965.

The optical absorption of various alkali halides colored by different methods was measured in the K-band region at liquid-nitrogen and liquid-helium temperatures. Particular attention was devoted to RbCl, in which the K band is well resolved at liquid-helium temperature. It was found that the K band in RbCl is neither symmetric nor Gaussian and that the band has a relatively long high-energy tail. Photoconductivity studies on RbCl demonstrated that there is appreciable photoconductivity only in this high-energy tail. It is concluded that these data support the Mott-Gurney model of the K band which attributes the main part of the K absorption to allowed transitions of the F center to a series of bound excited states beneath the conduction band. (Contractor's abstract)

1206

Illinois U. Dept. of Physics, Urbana.

NEW DATA ON THE RELAXED EXCITED STATE OF THE F CENTER, by G. Spinolo. [1965] [2]p. incl. diagr. table, refs. (AF AFOSR-64-599) Unclassified

Published in Phys. Rev., v. 137: A1495-A1496, Mar. 1, 1965.

Ionization energies ΔE and lifetimes τ_R of the excited state of the F center have been measured in various alkali halides. The experimental values of ΔE have been plotted $(m^*/m)\,(1/\epsilon_S^2)$, following Fowler's idea that in emission the excited-state wave function is very broad. The hydrogenic model seems to fit the data very well, and Fowler's theory finds strong experimental support. (Contractor's abstract)

1207

Illinois U. Dept. of Psychology, Urbana.

EFFECTS OF TASK CHARACTERISTICS ON GROUP PROCESS, by C. G. Morris, II. July 1965 [133]p. incl. diagrs. tables, refs. (Technical rept. no. 2) (AFOSR-65-1519) (AF 49(638)1291) AD 624034 Unclassified

This study is a laboratory investigation of the effects on group interaction and leader behavior of 2 group task characteristics: task "type" (production, discussion, problem solving) and level of task difficulty (high, medium, low). Incidental evidence on the effects of the ordinal position of tasks is presented. Results show that task type significantly affects the distribution of more than 60% of the group or leader activity. Level of task difficulty does not greatly affect group or leader activity. Ordinal position significantly differentiates the first task from the other three. Methodological implications of the study are discussed.

1208

Illinois U. Dept. of Psychology, Urbana.

ROLE ASSIGNMENT AND ATTITUDINAL COMMITMENT AS FACTORS IN NEGOTIATION, by N. J. Vidmar and J. E. McGrath. Aug. 1965, 78p. incl. diagrs. tables, refs. (Technical rept. no. 3) (AFOSR-65-1557) (AF 49(638)1291) AD 625387 Unclassified

This study investigated the effects of role assignment and attitudinal commitment on task performance and attitudes in negotiation groups. Negotiation groups were studied in a laboratory situation using subjects from real reference groups negotiating on a meaningful subject. The findings fall into 2 main categories: (1) negotiation groups composed of 2 members from one reference group, with one negotiator having a cross-role assignment, were able to set forth more impartial solutions than standard negotiation groups composed of members representing their own reference groups; and (2) within a standard negotiation group the less committed the negotiators were to their respective reference groups, the better the group performed.

1209

Illinois U. Dept. of Psychology, Urbana.

SOCIAL MOTIVES AND DECISION-MAKING BEHAVIOR IN INTERPERSONAL SITUATIONS, by W. J. Higgs and J. E. McGrath. Sept. 1965, 145p. incl. diagrs. tables, refs. (Technical rept. no. 4) (AFOSR-65-1558) (AF 49(638)1291) AD 625487 Unclassified

An attempt was made to incorporate stable motivational states into the prediction of behavior in interpersonal

studies. From the literature on group processes 3 kinds of behavior were identified and tentative mappings into corresponding motives were made: (1) The first part investigated whether Ss would consistently describe their motives in terms of the 3 behavior areas. Items yielded 3 factors: affiliation, prominence, and achievement. (2) The second part constructed reliable scales for measuring these factors. (3) The third part was a partial investigation of the relevance of the scales to interpersonal behavior (specifically, a 2-person game situation).

1210

Illinois U. [Electrical Engineering Research Lab.] Urbana.

FAST NEUTRON IRRADIATION-EFFECTS ON $GaAs_{1-x}P_xP$-N DIODE LASER THRESHOLD CURRENTS, by J. H. Doede, R. H. Vonderohe and others. [1965] [2]p. (AFOSR-65-1377) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)417 and Atomic Energy Commission) AD 640782; AD 621308 Unclassified

Presented at Internat'l. Symposium on Laser-Physics and Applications, Berne (Switzerland), Oct. 12-15, 1964.

Also published in Zeitschr. Angew. Math. and Phys., v. 16: 99-100, 1965.

Two of the major problems associated with the construction of laser diodes from ternary system material are the chemical purity and the inhomogeneous polycrystalline nature of the final product. Both effects increase the current density necessary for laser action. In this investigation, 4 $GaAs_{1-x}P_x$ diodes of various phosphorus substitution percentages were bombarded with fast neutrons in order to determine the dependence of threshold current densities on the total neutron flux. It appeared that surface damage effects of the laser cavity masked any information concerning the crystalline homogeneity effects on laser current thresholds. Present investigation is being made of irradiations of the initial crystal material and subsequent polishing into laser cavities to remove such surface effects.

1211

Illinois U. [Electrical Engineering Research Lab.] Urbana.

MEMORY WITHOUT RECORD, by H. Von Foerster. [1965] [45]p. incl. diagrs. tables, refs. (AFOSR-67-0311) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-7 and National Institutes of Health) Unclassified

Also published in Learning, Remembering and Forgetting, Proc. of the First Conf., v. I. The Anatomy of a Memory, ed. by D. P. Kimble, Palo Alto, Science and Behavior Books, Inc., p 386-433, 1965

A mathematical description is given of possible modes by which memory is effected. The description is based on precise, quantitative definitions of the concept of uncertainty and the concept of order. The numerology of information theory is applied to some known features of the nervous system to derive an estimate of the amount of information necessary to specify a brain, based on a specification of the universe of brain in terms of a finite number of states and the probability of their occurrence. The number of states of the universe is estimated, i.e., the number of different networks that can be composed by directionally connecting n elements. The question as to what differentiates one network from another is approached from 2 different points: (a) purely structurally, where the operational modalities of the nodal elements are ignored, and (b) where the operational modalities of the nodal elements are considered in a structurally defined network. The description supports an hypothesis that the nervous system be viewed as if it were a computer whose internal orgamzation changes as a result of its interaction with an environment that possess some order. The changes occur in such a way that some constraints in the environment that are responsible for its orderliness are mapped into the computer's structure. This homomorphism "environment-system" reveals itself as "memory" and permits the system to function as an inductive inference computer.

1212

Illinois U. [Electrical Engineering Research Lab.] Urbana.

COMPUTER DESIGN OF LINEAR FREQUENCY SELECTIVE NETWORKS, by D. A. Calahan. [1965] [6]p. incl. refs. (AFOSR-66-0388) (AF AFOSR-63-177) AD 641489 Unclassified

Also published in Proc. IEEE, v. 53: 1701-1706, Nov. 1965.

An efficient algorithm is proposed for the computer synthesis of linear networks of arbitrary configuration. Given a circuit approximately realizing a network function T(s), the element values are perturbed until T(s) is precisely realized. In the process, positive elements may be "grown" across nodes as required, or may be forced to desired values. Examples in the areas of passive and active filter design are given, and limitations of the procedure are discussed. Also, the method is shown to be related to the theory of equivalent networks. (Contractor's abstract)

1213

Illinois U. Electrical Engineering Research Lab., Urbana.

ON CLASSIFICATION AND SUPERPOSITION PRINCIPLES FOR NONLINEAR OPERATIONS, by A. Inselberg. May 1965, 73p. incl. refs. (Technical rept. no. 4) (AFOSR-65-1712) (AF AFOSR-64-7) AD 624268 Unclassified

Superpositions (ways of expressing a solution of an equation as a function of other solutions of the equation) for nonlinear operators are discussed. For operators having certain kinds of superpositions, a unique

representation involving their superposition and additively linear operators is given. Equivalence classes of operators are obtained, each class being composed of operators having a given superposition. Generalized translations of operators are defined in terms of the superpositions. The classification of operators is further extended, and a number of well-known nonlinear differential operators are shown to belong to certain of these extended classes.

1214

Illinois U. Electrical Engineering Research Lab., Urbana.

A STUDY OF A FAMILY OF COMPLEX SYSTEMS, AN APPROACH TO THE INVESTIGATION OF ORGANISMS' BEHAVIOR, by C. C. Walker. June 1965, 250p. incl. diagrs. table, refs. (Technical rept. no. 5) (AFOSR-65-1713) (AF AFOSR-64-7) AD 624864
Unclassified

This paper examines a family of complex systems defined with reference only to theoretically basic characteristics of the systems' parts and their interrelationship. The systems considered are intricate structures built up of simple electrical devices, called elements, which interact with one another. Each element has 2 possible element-states, with its present state determined from states of other elements and from its previous state by a fixed transformation. Given a particular transformation, a system is constructed by taking 100 elements embodying that transformation and joining them at random. The system's behavior is studied by examining its cycles under operation. Then a different system is built using the same elements and the sampling of behavior repeated. Systems are compared, and it is found that for many transformations, details of structure are evidently unimportant in the occurrence of certain types of behavior.

1215

Illinois U. Electrical Engineering Research Lab., Urbana.

AUTOMATIC ADJUSTMENT IN A CONTINUOUS ENVIRONMENT, by A. M. Andrew. Sept. 1965, 19p. incl. diagrs. table. (Technical rept. no. 8) (AFOSR-65-2283) (AF AFOSR-64-7) AD 624548
Unclassified

Control devices, biological or otherwise, which are able to adjust their own internal parameters are discussed. It is shown that under certain circumstances, the adjustment process must depend on experimental fluctuations superimposed on either the parameters or the control signals. A study is made of a post office problem (automatic determination of postage) to illustrate the way in which "effective fluctuations" attributed to the parameters can best be computered from fluctuations of the control signals. A mathematical comparison is made of 2 ways in which a self-improving controller may operate, i. e., with and without an explicit model of the environment. For a simple control task, the 2 are shown to be almost exactly equivalent. (Contractor's abstract)

1216

Illinois U. Electrical Engineering Research Lab., Urbana.

A TECHNIQUE FOR THE ANALYSIS OF MUSICAL INSTRUMENT TONES, by M. D. Freedman. Oct. 1965, 137p. incl. diagrs. tables, refs. (Technical rept. no. 6) (AFOSR-65-2293) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-7 and National Insitutes of Health) AD 627181 Unclassified

A technique is described for analyzing the transient part of a musical tone. The analysis was made on the Illiac II computer, via analog-digital conversion. The analysis procedure consists of 4 steps: (1) determination of an adequate mathematical specification for an equation which represents the sound pressure wave, (2) determination of the constants in the equation for a given tone (inharmonic partials are detected and provided for in the specification function), (3) verification mathematically and by resynthesis of the tone using the Illiac II, and (4) iterating, if necessary, to improve the results. Examples of the analyses of the tones of 5 instruments are presented. Results provide a basis for the synthesis of tones and for the creation of new tones. By extension, the results are applicable to the analysis and synthesis of any signal possessing a certain degree of regularity. Use of the derived representation function to approximate unknown signals is illustrated. The method accounts for cascaded attacks, nonexponential attacks, attacks whose transient regions overlap, decays associated with inharmonic frequencies, and frequency changes.

1217

Illinois U. Electrical Engineering Research Lab., Urbana.

TABLE OF THE STIRLING NUMBERS OF THE SECOND KIND S (N, K) FOR N, K UP TO 100 AND FOR VALUES OF S (N, K) EQUAL OR SMALLER THAN 10^{109}-1, by A. M. Andrew and H. Von Foerster. Dec. 1965, 182p. incl. diagrs. tables. (Technical rept. no. 6) (AFOSR-66-2373) (AF AFOSR-64-7) AD 641081 Unclassified

A printout is given for a program for computing Stirling numbers of the second kind that uses the recursive formula $S(n, k) = S(n-1, k-1) + k \cdot S(n-1, k)$ for $k > 2$, and $S(n, k) = 1$ for $k = 1$. Computed values are given for $S(n, k) < 10 (\exp 109)-1$, $1 \leq k < n \leq 100$. In an introduction, the use of Stirling numbers in various combinatorial problems is discussed, together with an explanation of the use of the table of computed values. Application of the table is described to obtain the following sums for multi-valued logical systems: (a) the number of functions represented by a particular morphogram, and (b) the number of morphograms that may be constructed that admit k different values in an m valued system; a "morphogram" is defined as a particular distribution of possible value occupancies $o_1, o_2, o_3 \ldots$

1218

Illinois U. Electrical Engineering Research Lab., Urbana.

TUNNELING FROM METAL TO SEMICONDUCTORS, by P. V. Gray. [1965] [8]p. incl. illus. diagrs. refs. [AF AFOSR-64-7] Unclassified

Published in Phys. Rev., v. 140: A179-A186, Oct. 4, 1965.

Conductance and differential capacitance have been measured as a function of frequency and of bias on a number of silicon-silicon-dioxide-aluminum sandwiches. The results indicate that information about the density and energy of states near the silicon-silicon-dioxide interface may be deduced from these measurements. Conductance is due to electron tunneling transitions between the aluminum and silicon. Analysis of the tunnel current is given in terms of a single-particle WKB approximation. A simplified formula is derived to explain tunneling between the metal and the intrinsic semiconductor bands. A preliminary analysis of tunneling to impurity bands is discussed. Experimental data are shown which display details of impurity-band spreading near the valence-band edge of silicon samples containing 10^{18} and 10^{19} boron atoms/cm^3. Tunneling from silicon-silicon-dioxide interface states is analyzed by defining a tunneling lifetime and using this concept to explain the observed frequency dependence of the conductance and capacitance measurements. Quantitative experimental values are obtained giving the density of interface states vs energy. These results are in close agreement with those obtained by Statz et al, from inversion-layer conductance studies. (Contractor's abstract)

1219

Illinois U. [Electrical Engineering Research Lab.] Urbana.

STIMULATED CATHODELUMINESCENCE-LASING ACTION IN n-TYPE GaAs AT 4.2°K AND 77°K BY FAST ELECTRON BOMBARDMENT, by P. D. Coleman and G. E. Bennett. [1965] [14]p. incl. illus. diagrs. (AFOSR-65-2056) (AF AFOSR-65-272) AD 627727 Unclassified

Also published in Proc. Seventeenth Nat'l. Aerospace Electron Conf., Dayton, Ohio, May 10-12, 1965, p. 316-331.

An experimental study in pumping bulk n-type GaAs was conducted by bombarding the material with a 15 to 50 kv pulsed electron beam. Hole-electron pairs were created which can recombine by a radiative process across the band gap of the semiconductor. This work demonstrates that bulk semiconductors can readily be pumped with electron beams in the 20 to 40 kv range. There is reason to believe that doped insulator laser materials could also be pumped by this method.

1220

Illinois U. [Electrical Engineering Research Lab.] Urbana.

HARMONIC GENERATION IN HCN BY MULTIPLE QUANTUM CONVERSION, by D. P. Akitt and P. D. Coleman. [1965] [7]p. incl. diagrs. (AFOSR-65-2058) (AF AFOSR-65-272) AD 627724 Unclassified

Also published in Jour. Appl. Phys., v. 36: 2004-2010, June 1965.

A nonlinear, quantum-mechanics experiment in third-harmonic generation by a traveling wave, multiple photon interaction in HCN gas is presented. The J = 0, J = 1 rotational levels of HCN are used to multiply from 34.7 to 104 Gc/sec with a peak power output at 104 Gc/sec in excess of 1.5 W. The interaction takes place in a length of RG 96/U waveguide. Harmonic power output is plotted against fundamental power input for interaction lengths varying from 0.5 to 3.0 m in 0.5-m steps and gas pressures from 250 to 450 Torr. These data are compared with a theoretical analysis. (Contractor's abstract)

1221

Illinois U. [Electrical Engineering Research Lab.] Urbana.

QUANTUM THEORY OF OPTICAL BEATING IN PHOTOCONDUCTORS, by C. M. Penchina. [1965] 7p. (AFOSR-65-1191) (AF AFOSR-65-714) AD 620638 Unclassified

Also published in Proc. Seventh Internat'l. Conf. on the Physics of Semiconductors, Paris (France) (July 19-24, 1964), Paris, Dunod, 1965, p. 965-971.

The quantum theory of optical beating in photoconductors is examined. A model is considered in which electrons initially in a nearly filled band are optically excited to the next higher empty band. It is assumed that the energy gap between these 2 bands is much greater than kT. For ohmic material with a steady bias voltage, the change in current is proportional to the number of electrons excited by the radiation. Thus, to determine the photosignal, the total number of electrons excited by the radiation is calculated as a function of time. Results demonstrate that the recombination lifetime τ limits the resolution with which a photoconductive detector can distinguish between 2 light beams.

1222

Illinois U. [Electrical Engineering Research Lab.] Urbana.

VAPOR-LIQUID-SOLID GROWTH OF GALLIUM PHOSPHIDE, by N. Holonyak, Jr., C. M. Wolfe, and J. S. Moore. [1965] [2]p. incl. illus. (AFOSR-65-1179) (Sponsored jointly by Air Force Cambridge Research Labs.; and Air Force Office of Scientific Research under AF AFOSR-65-714) AD 621309 Unclassified

Also published in Appl. Phys. Ltrs., v. 6: 64-65, Feb. 15, 1965.

The successful vapor-liquid-solid (VLS) growth of GaP whiskers, rods, and blades is described. This lends confirmation to the generality of the VLS mechanism. It is suggested that the VLS mechanism can play a role in the growth of single crystal III-V compounds by affording an alloy at a step where the products from the halide vapor transport may deposit preferentially, cause supersaturation in the alloy, and nucleate on the crystal.

1223

Illinois U., [Electrical Engineering Research Lab.] Urbana.

LOCATION OF THE SOURCE OF RECOMBINATION RADIATION IN Ga($As_{1-x}P_x$) p-n JUNCTIONS BY ELECTRON BOMBARDMENT, by C. M. Wolfe, M. D. Sirkis and others. [1965] [1]p. incl. diagrs. (AFOSR-65-2073) (Sponsored jointly by Air Force Cambridge Research Labs.; and Air Force Office of Scientific Research under AF AFOSR-64-714) AD 627566 Unclassified

Also published in Jour. Appl. Phys., v. 36: 2087, June 1965.

The location of the source of recombination radiation is determined experimentally. Highly polished rectangular laser junctions were conductively mounted with the junction short-circuited on one side and with the opposite side exposed to free electron bombardment. Electron-hole pairs were injected uniformly at the junctions and on either side into n-type and p-type material. From observations of the sample at various beam current strengths, it was concluded that recombination radiation proceeds more efficiently and with shorter lifetime in material processing acceptor states; that is, in the junction region and slightly into the p-type side. Efficient recombination does not extend from concentration increases sharply. Efficient recombination radiation does not extend at all from the junction into the n-type side.

1224

Illinois U. [Electrical Engineering Research Lab.] Urbana.

GROWTH AND DISLOCATION STRUCTURE OF SINGLE-CRYSTAL Ga($As_{1-x}P_x$), by C. M. Wolfe, C. J. Nuese, and N. Holonyak, Jr. [1965] 12p. incl. illus. diagrs. table, refs. (AFOSR-66-1636) (Sponsored jointly by Air Force Cambridge Research Labs.; and Air Force Office of Scientific Research under AF AFOSR-65-714) AD 641185 Unclassified

Also published in Jour. Appl. Phys., v. 36: 3790-3801, Dec. 1965.

The preparation of single-crystal GaAsP by halide vapor transport is described. That dislocation free GaAsP can be achieved was verified experimentally for whiskers grown by the vapor-liquid-solid method. In the growth of monocrystalline ingots for device purposes, growth mechanics and the resulting crystal habit are strongly influenced by degenerate Zn, Te, and Se doping. Since n-type crystals require higher supersaturations, single-crystal growth is easier to obtain with Zn doping. The as-grown dislocation structure of ingots with low-index natural facets is examined by decoration and etching. Typical densities are 5×10^3 $10^6/cm^2$. From their simple crystallographic orientations different dislocations are identified. <211>, <111> and <100>, <110>, edge dislocations are observed in <110> polygonization walls. Values of mobility and carrier density are evaluated from a device point of view. Laser diodes with threshold currents as low as 3000 A cm^2 at 33.3% GaP have been obtained from this material

1225

Illinois U., [Electrical Engineering Research Lab.] Urbana.

A DISTORTION ANALYSIS OF THE MOS TRANSISTOR, by R. F. Pfeifer and C. T. Sah. June 1965, 26p. incl diagrs. (AFOSR-66-1340) (AF AFOSR-65-714) AD 641306 Unclassified

The experimental results verify the theoretical expressions considerably well when the equations are evaluated within their respective regions of validity. The deviation from the V_G dependence I_{dl} which is seen to extend into the saturation region by an amount greater than the modulation width of the input signal is assumed to be due to the approximation of zero drain conductance at the edge of the saturation region. The practical results of this experiment indicate that the MOS transistor can perform satisfactorily as a low distortion amplifier when operated in the saturation mode provided that the input signal is maintained at a sufficiently low level.

1226

Illinois U. Electrical Engineering Research Lab., Urbana.

GAS LASER STUDIES IN THE 100 TO 1000 MICRON RANGE, by P. D. Coleman. Final rept. Dec. 31, 1965, 8p. (AFOSR-66-0719) (AF AFOSR-65-804) AD 632306 Unclassified

The report summarizes the first year's activities of research on gas lasers in the 100 to 1000 μ range. A general description and experimental results of a water vapor laser covering the 46 to 118 μ is described. Research problems to be explored during the second year of the grant are discussed along with a brief comparison with classical electronic methods of generation.

1227

Illinois U. [Electrical Engineering Research Lab.] Urbana

EVOLUTIONARY PATTERN RECOGNITION SYSTEMS, by A. H. Klopf. Nov. 1965 [70]p. incl. diagrs. tables, refs. (AFOSR-66-1342) (AF AFOSR-65-978) AD AD 637492 Unclassified

An adaptive network is proposed which is capable of self-organization on 2 levels, a fundamental level involving the structure of the system and a secondary level involving a set of variable weights within the structure.

The system was simulated on a digital computer and its behavior investigated for the purpose of developing evolutionary processes by which systems could adapt structurally to their environment. The system was studied, first, as a non-evolutionary network; adaptation could occur only through variation of the weights. An empirical equation was established relating the structural parameters of this system to its capabilities. The evolutionary system, possessing the capability of structure modification, was then investigated. Several heuristics were developed which allowed the system to significantly improve its performance in a pattern recognition task through structure modification. (Contractor's abstract)

1228

Indiana U. Dept. of Chemistry, Bloomington.

ELECTRONIC COMMUTATOR DETERMINATION OF E° OF FORMATION AND RELATED THERMODYNAMIC QUANTITIES FOR MOLTEN LEAD CHLORIDE, by T. B. Warner and R. L. Seifert. [1965] [6]p. incl. illus. diagrs. refs. (AFOSR-65-2099) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)313 and Atomic Energy Commission) AD 628269 Unclassified

Also published in Jour. Phys. Chem., v. 69: 1034-1039, Mar. 1965.

The electronic commutator method for determinging E° of formation of molten halides has been improved and applied to obtain the following equations for E°, $\Delta G°$, $\Delta H°$, $\Delta S°$, and $\Delta C_p°$ of formation of liquid lead chloride in the temperature range 493-866°. The equation for E° reproduces the data within the experimental precision of 0.2 mv. The larger error limits in brackets are based on consideration of maximum probable temperature inhomogeneity in the melt and other possible systematic errors. The figures in brackets are average standard errors calculated for t = 493-750 and 750-866°, respectively; X = (t - 700)/100. E° (mv) = $1158.90 - 54.11X + 0.833X^2 + 0.062X^3 + 0.116X^4$ [± 0.8 mv, ± 1.2 mv]; $\Delta G°$ (kca /mol) = $53.451 + 2.496X - 0.038X^2 - 0.0029X^3 - 0.0054X^4$ [± 0.035 kcal, ±0.053 kcal]; $\Delta H°$ (kcal/mol) = $77.737 + 0.748X + 0.122X^2 + 0.2140X^3 + 0.0160X^4$ [± 0.12 kcal, ± 0.24 kcal]; $\Delta S°$ (e.u.) = $-24.957 + 0.768X + 0.086X^2 - 0.2140X^3$ [± 0.14 e.u., ± 0.19 e.u.]; and $\Delta C_p°$ (cal/mol deg.) = $10.41 - 0.34X - 0.075X^2$ [± 0.47 cal, ± 0.76 cal].

1229

Indiana U. Dept. of Chemistry, Bloomington.

CONTACT POTENTIAL DIFFERENCE BETWEEN SILVER NITRATE AND SILVER, by J. L. Copeland and R. L. Seifert. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-2110) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)313] and Atomic Energy Commission) AD 629075 Unclassified

Also published in Jour. Electrochem. Soc., v. 112: 831-836, Aug. 1965.

The silver nitrate-silver contact potential was determined from 190° to 280°C by the Zisman dynamic condenser method. At the melting point of the salt the contact potential of liquid silver nitrate relative to silver is -530 mv, with a temperature coefficient of 0.14 mv/deg, and that of the solid salt is -608 mv. The discontinuity of 78 mv at the melting point is attributed primarily to a greater excess surface concentration of silver ions in the liquid than in the solid salt. (Contractor's abstract)

1230

Indiana U. Dept. of Chemistry, Bloomington.

THE EVALUATION OF TWO CENTER INTEGRALS INVOLVED IN THE CALCULATION OF THE INTENSITY OF DIFFRACTED ELECTRONS AND X-RAYS FROM MOLECULES, by R. A. Bonham. [1965] [3]p. (Contribution no. 1323) (AFOSR-66-0585) (AF 49(638)1681) AD 632259 Unclassified

Also published in Jour. Phys. Soc. (Japan), v. 20: 2260-2262, Dec. 1965.

Fourier transform techniques are utilized to simplify the two center integrals encountered in the calculation of molecular and x-ray scattering factors in the first Born approximation. It is shown that the two center integrals can be reduced to a single numerical integration from 0 to 1 for a molecule in a fixed or random orientation in space. The many-electron wave function is taken as a product of hydrogen-like orbitals with arbitrary screening parameters. Explicit expressions for certain cases involving 1s, 2s and $2p_\sigma$ orbitals are given. (Contractor's abstract)

1231

Indiana U. Dept. of Chemistry, Bloomington.

APPROXIMATE NATURAL ORBITALS FOR FOUR-ELECTRON SYSTEMS, by G. P. Barnett, J. Linderberg, and H. Shull. [1965] [9]p. incl. tables, refs. (In cooperation with Uppsala U., Sweden) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-362] and National Science Foundation) Unclassified

Presented at Internat'l. Symposium on Atomic and Molecular Quantum Theory, Sanibel Island, Florida, Jan. 18-23, 1965.

Published in Jour. Chem. Phys., v. 43: S80-S88, Nov. 15, 1965.

Approximate natural orbitals for 4 electron wavefunctions for Be as calculated by Boys, Matsen, Watson, and Weiss, and LiH as calculated by Ebbing are obtained by diagonalization of the appropriate first-order reduced density matrices. The formalism for carrying out the process is extended to the case of a nonorthogonal basis. Occupation numbers are presented and compared for the functions reported. In addition, truncated natural expansions reproducing the original functions are tabulated. Natural-orbital occupation numbers, the orbitals

themselves, and the natural expansions are shown to have considerable value in comparing these functions. The nature of the approximations used in the individual functions is clarified by the analysis, and considerable insight is afforded to the nature of the physical system.

1232

Indiana U. Dept. of Chemistry, Bloomington.

AUTO- AND CROSS-CORRELATION FUNCTIONS USED AS TOOLS FOR INFORMATION RETRIEVAL IN ELECTRON DIFFRACTION STRUCTURE STUDIES, by M. Traetteberg and R. A. Bonham. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-0682) (AF AFOSR-64-602) AD 614534 Unclassified

Also published in Jour. Chem. Phy v. 42: 587-596, Jan. 15, 1965.

Three radial distribution functions [f(r)], the power spectrum, the diagonal power spectrum, and the sharpened radial distribution function have been introduced, and it is shown that these functions might be useful tools in extracting molecular information from a gas electron diffraction experiment. The two kinds of power spectra are based on short-interval auto- and cross-correlation functions of the molecular intensity function, while the sharpened radial distribution function is defined as the Fourier sine transform of the product of the molecular intensity function and the antidamping function $\exp[-\alpha(s_{max}-s)]$. The similarity between the power spectrum and the sharpened radial distribution function has been pointed out. By examples based on experimental data and numerical calculations based on theoretical data it is shown that the modified f(r) functions introduced here give better resolution between neighboring peaks than the radial distribution function that is normally applied in electron diffraction structure studies. The errors introduced in r_{ij} values determined from the various f(r) functions, due to additive random errors in the molecular intensity function, have been studied by numerical analysis, and it has been shown that accurate structural parameters can be extracted from sharpened f(r) functions. (Contractor's abstract)

1233

Indiana U. Dept. of Chemistry, Bloomington.

ON CERTAIN ATOMIC INTEGRALS INVOLVING PRODUCTS OF r_{ij}, by R. A. Bonham. [1965] [5]p. (Contribution no. 1243) (AFOSR-65-0888) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-602 and Atomic Energy Commission) AD 618443 Unclassified

Also published in Jour. Molec. Spectros., v. 15: 112-116, Feb. 1965.

The application of Fourier transform techniques has been used to reduce certain atomic integrals, involving products of r_{ij} terms with Slater 1s orbitals to convenient forms for computation. Integrals of this type with the r_{ij} products $r_{12}r_{23}$, $r_{12}r_{23}r_{34}$, $r_{12}r_{23}r_{31}$, $r_{12}r_{23}r_{31}r_{34}$, and $r_{12}r_{23}r_{34}r_{41}$ are treated in this paper. (Contractor's abstract)

1234

Indiana U. Dept. of Chemistry, Bloomington.

AN ELECTRON DIFFRACTION INVESTIGATION OF THE PERI-BONDS IN PERYLENE, by M. Traetteberg. [1965] [19]p. incl. diagrs. tables, refs. (Contribution no. 1249) (AFOSR-65-1135) (AF AFOSR-64-602) AD 619240 Unclassified

Also published in Proc. Roy. Soc. (London), v. 283A: 557-575, Jan. 1965.

The molecular structure of perylene is studied in the vapor phase by the sector electron diffraction method. The average carbon-carbon bond distance in perylene apart from the peri-bonds is found to be about 0.010A longer than the average carbon-carbon bond distance in the naphthalene molecule. The peri-bond length is determined to be 1.493 ± 0.015A. (Contractor's abstract)

1235

Indiana U. Dept. of Chemistry, Bloomington.

PRELIMINARY ELECTRON-DIFFRACTION STUDY OF H_2 AT SMALL SCATTERING ANGLES, by R. A. Bonham and T. Iijima. [1965] [2]p. incl. diagr. (Contribution no. 1246) (AFOSR-65-1673) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-602], Atomic Energy Commission, and U.S. Educational Commission in Japan) AD 624184 Unclassified

Also published in Jour. Chem. Phys., v. 42: 2612-2614, Apr. 1, 1965.

Sector electron-diffraction patterns of H_2 and He were obtained over the range $1 < s < 8$. The chamber pressure was maintained at 2×10^{-4} mm Hg. Comparison of experimental intensity curves with theoretical curves indicated that the intensity curve for H_2 was in much better agreement with the curve calculated by using the Weinbaum wave function than with the curve deduced from the independent atom model. This result implies that the scattering experiment is sensitive mainly to the contraction of volume occupied by a fixed percent of the electrons in the molecule when a chemical bond is formed.

1236

Indiana U. Dept. of Chemistry, Bloomington.

MULTIPLE ELASTIC INTRAMOLECULAR SCATTERING IN GAS ELECTRON DIFFRACTION, by R. A. Bonham. [1965] [7]p. (Contribution no. 1245) (AFOSR-65-2124) (AF AFOSR-64-602) AD 629024 Unclassified

Also published in Jour. Chem. Phys., v. 43: 1103-1109, Aug. 15, 1965.

The effects of multiple elastic intramolecular scattering on gas-electron-diffraction patterns are calculated in the second Born approximation. Expressions for the first-order double- and triple-scattering contributions are obtained. An approximate expression convenient for computation, for the first-order triple-scattering term is also given. The relationships of the magnitude of the multiple scattering to atomic number, atomic size, and molecular structure are investigated. It is shown that corrections to the reduced molecular-intensity function of the order of several percent can occur in the case of triple scattering from three or more heavy atoms in close proximity. (Contractor's abstract)

1237

Indiana U Dept. of Chemistry, Bloomington.

ON A POSSIBLE METHOD FOR CORRECTING ATOMIC WAVEFUNCTIONS FOR RELATIVISTIC EFFECTS, by R. A. Bonham. [1965] [2]p. (Contribution no. 1282) (AFOSR-65-2148) (AF AFOSR-64-602) AD 629022 Unclassified

Also published in Jour. Chem. Phys., v. 43: 1434-1435, Aug. 1965.

The primary effect of relativity in nonrelativistic atomic structure calculations is to increase the effective mass of the atomic electrons. The effect will be largest for the innermost electrons, but the electron exchange interaction will tend to spread the mass changes around among the other electrons in the system. This suggests that a possible way to include relativistic corrections in nonrelativistic calculations is to employ a different effective mass for each electron based on the Hartree one-electron energy ϵ_1 for that electron as a first approximation. The use of this technique is investigated for the case of K-shell electrons in He-like atoms.

1238

Indiana U. Dept. of Chemistry, Bloomington

ON THE GREEN'S FUNCTION METHOD FOR EVALUATING PERTURBATION SUMS, by R. A Bonham. [1965] [2]p. (AFOSR-65-2149) [AF AFOSR-64-602] AD 629023 Unclassified

Also published in Jour. Phys Soc Japan, v. 20 1098-1099, June 1965.

The polarizability of hydrogen is concisely derived by Lippmann-Schwinger techniques. The sum of the perturbation theory includes contributions from continuum levels and a knowledge of only the single wave function for the nth state of the unperturbed system.

1239

Indiana U. Dept. of Chemistry, Bloomington.

CORRECTIONS TO THE INCOHERENT SCATTERING FACTORS FOR ELECTRONS AND X-RAYS, by R. A. Bonham. [1965] [5]p. incl. table, refs. (Contribution no. 1269) (AFOSR-65-2395) [AF AFOSR-64-602] AD 625931 Unclassified

Also published in Jour. Chem. Phys , v. 43. 1460-1464, Sept. 1965.

The usual use of the closure relation in the derivation of the incoherent scattering factor for electrons and x-rays involves approximations and introduces errors in the final result. Corrections through third order for these errors are given. The correction terms are found to be of a simple form and can be quite important not only in the limit of low energy for the incident electron or x-ray beam but also for atoms of large atomic number. The magnitudes of the corrections for Ne and Ge are given for 40-kv electrons. In the x-ray case corrections are given for Ge for Cu K-α x radiation. (Contractor's abstract)

1240

Indiana U. Dept. of Chemistry, Bloomington.

SMALL-ANGLE SCATTERING FROM METHANE, AMMONIA AND WATER BY FAST ELECTRONS, by T. Lijima, R. A. Bonham and others. [1965] [4]p. incl. diagrs. refs. (Contribution no. 1295) (AFOSR-66-0311) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-602 and Atomic Energy Commission) AD 629849 Unclassified

Also published in Bull. Chem. Soc. Japan, v. 38: 1757-1760, Oct. 1965.

The total differential scattering cross sections for the 40 kv electron from the methane, ammonia and water molecules obtained experimentally over the $1 < s < 8$ s range have been compared with the theoretical results. Good agreement with the theoretical results have been obtained in the case of methane. In the cases of ammonia and water the results are in qualitative agreement with the theoretical predictions, but uncertainities in both the theory and experiment prevent a detailed comparison from being made in these cases.

1241

Indiana U Dept. of Chemistry, Bloomington.

INTERATOMIC AND INTERMOLECULAR SCATTERING IN GAS ELECTRON DIFFRACTION, by Y. Morino, K. Kuchitsu, and R. A. Bonham. [1965] [2]p. incl. diagr. (Contribution no. 1286) (AFOSR-66-0586) (AF AFOSR-64-602) AD 632733 Unclassified

Also published in Bull. Chem. Soc. Japan, v. 38 1796-1797, Oct. 1965

The effect of interatomic and intermolecular scattering on the total intensity of electrons scattered from a narrow beam of atoms or molecules is considered. Interatomic or intermolecular effects at sample pressures of the order of 10 mm Hg will usually not create any difficulty in the analysis of electron diffraction data. The potential function V(r) may be obtained experimentally by carrying out electron diffraction experiments with high beam pressures. This appears to be a feasible experiment provided gas pressures greater that 1 atm can be obtained while conditions for an optimum diffraction experiment are maintained.

1242

Indiana U. Dept. of Chemistry, Bloomington.

INELASTIC ELECTRON SCATTERING FROM ATOMS AND MOLECULES AT MEDIUM ENERGIES, by R. A. Bonham. Final rept. 1962-1965, 8p. incl. illus refs. (AFOSR-66-0605) (AF AFOSR-64-602) AD 630393 Unclassified

Achievements include the calculation of the effect of chemical binding on gas electron diffraction patterns and the experimental observation of this effect in the molecules H_2, NH_3, CH_4 and H_2O. Recent theoretical studies carried out in this and other laboratories indicate that these experimental measurements may yield estimates of total chemical binding energies and possibly some detailed information about electron charge distribution in simple molecules. New techniques were developed for the solution of the molecular and atomic integrals needed in the calculation of theoretical electron diffraction intensity curves for comparison with experiment. Partial wave elastic scattering factor calculations were carried out for a number of atoms and new least squares and auto correlation techniques were devised for the refined analysis of electron diffraction data in order to obtain precise molecular parameters. In addition the molecular structures of the compounds $C_6Cl_4H_2$, C_6Br_6, cycloheptatriene and perylene were carried out to test these newly developed techniques.

1243

Indiana U. Dept. of Chemistry, Bloomington.

ANALYTICAL EXPRESSIONS FOR THE TOTAL ELASTIC CROSS SECTION OF ELECTRON SCATTERING BY THOMAS-FERMI-DIRAC AND HARTREE-FOCK ATOM, by T. Tietz. [1965] [2]p (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-602] and National Science Foundation) Unclassified

Published in Jour Chem Phys., v 42 1462-1463, Feb. 15, 1965.

Equations were derived for the radial electron density, the atomic elastic scattering factor, and the total elastic cross section of electron scattering by Thomas-Fermi-Dirac and Hartree-Fock atoms.

1244

Indiana U. Dept. of Chemistry, Bloomington.

SIMPLE ANALYTICAL FORMULA FOR THE PHASE SHIFTS OF ELECTRON SCATTERING BY GIVEN ATOMIC FIELDS, by T. Tietz. [1965] [2]p. incl. tables (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-602] and National Science Foundation) Unclassified

Published in Jour. Chem. Phys., v. 42 2251-2253, Mar 15, 1965.

An analytical formula is given for phase shifts of electron scattering by a given atomic field of gas electron diffraction. Phase shifts for argon at 40, 80, and 100 kev are calculated.

1245

Indiana U Hearing and Communication Lab., Bloomington

MASKING-LEVEL DIFFERENCES AS A FUNCTION OF INTERAURAL DISPARITIES IN INTENSITY OF SIGNAL AND OF NOISE, by J. P. Egan. Dec 1965 [7]p incl. diagrs. tables, refs (AFOSR-66-1341) (AF AFOSR-66-448) AD 640850 Unclassified

Presented at Sixty-eighth meeting of the Acoust Soc of Amer., Austin, Tex., Oct. 21-24, 1965

Also published in Jour. Acoust. Soc. Amer., v 38, 1043-1049, Dec. 1965.

A marked release from masking, or masking-level difference (MLD), results when a monaural signal is presented with perfectly correlated (in-phase) binaural noise, NO—Sm, rather than with monaural noise, Nm—Sm. Furthermore, with NO—SO, when the sinusoid in one ear is reduced in intensity, rather than being removed entirely, a smaller MLD than for NO—Sm should result. Two experiments were conducted In the first, MLD's were determined as a function of the intensity of the noise in the nonsignal ear with the interaural conditions of NO, N_π, and NU as parameters. For NO, there is some release from masking even when the noise in the nonsignal ear is as much as 40 dB down from that in the signal ear. In the second experiment, MLD's were determined as a function of the ratio of the energies of the left- and right-ear sinusoids with correlated noise, NO. With SO, MLD's increase as the interaural disparity in intensity of the signal increases The large MLD obtained with S_π decreases with increasing interaural disparity in intensity of the signal. In both experiments, the signal (500 cps, 0.25 sec) was presented to the listener in one or the other of two temporal intervals, against a background of white noise. (Contractor's abstract)

1246

Indiana U. [Hearing and Communication Lab.] Bloomington.

MASKING-LEVEL DIFFERENCES AND THE FORM OF THE PSYCHOMETRIC FUNCTION (Abstract), by J. P. Egan, W. A. Lindner, and D. McFadden. [1965] [1]p. [AF AFOSR-66-548] Unclassified

Presented at Sixty-eighth meeting of the Acoust. Soc. of Amer., Washington, D. C., June 2-5, 1965.

Published in Jour. Acoust. Soc. Amer., v. 37: 1181, June 1965.

Psychometric functions were determined for various interaural conditions; these functions show the relation between the detectability and the energy of the signal. The signal was presented in one of two temporal intervals against a continuous noise. The relation between d' and signal energy E is approximately $d' = m (E/N_0)^k$, where m and k are constants for a particular function; $0 < d' < 4$. The data indicate that k is constant for a particular observer and that m depends upon interaural conditions. Therefore, $MLD = (10/k)\log(m_i/m_0)$, where m_i is the constant for condition i, and m_0 corresponds to a reference condition. Consequently, an MLD is independent of the d' chosen for determination of that MLD. Also, the form of the psychometric function is independent of the interaural condition. This result indicates that "release from masking" may be considered equivalent to a decrease in the noise at the input, rather than reduction in the amount of uncertainty for the observer concerning the parameters of the input.

1247

Innsbruck U., Inst. for Theoretical Physics (Austria).

MHD CHARACTERISTICS AND DISPERSION RELATION FOR FINITE ELECTRICAL CONDUCTIVITY, by H. Friedel. Mar. 13, 1965, 14p. (Scientific rept. no. 23) (AFOSR-65-1313) (AF 61(052)675) AD 617898 Unclassified

Magnetohydrodynamic (MHD) characteristics are investigated for the case of finite electrical conductivity in connection with disperson relations of linear waves. The basic equations are no longer totally hyperbolic but parabolically or elliptically degenerated. The nature of the characteristic directions for the degenerated MHD basic equations is explained. (Contractor's abstract)

1248

Innsbruck U. Inst for Theoretical Physics (Austria).

MHD OF A QUASINEUTRAL PLASMA WITH VANISHING INTERNAL FRICTION AND HEAT CONDUCTIVITY AND FINITE ELECTRICAL CONDUCTIVITY, by H. Friedel. Mar. 10, 1965, 23p. incl. diagr. refs. (Scientific rept. no. 24) (AFOSR-65-1314) (AF 61(052)675) AD 618138 Unclassified

The MHD basic equations for a quasineutral plasma are considered in the 1-dimensional unsteady and 2-dimensional steady cases. If the displacement current is neglected, the 1-dimensional unsteady system is parabolic, and the 2-dimensional steady system is elliptic. The influence of electrical conductivity on MHD solutions is investigated, and 3 methods for solving the general MHD equations are given.

1249

Innsbruck U., Inst. for Theoretical Physics (Austria).

TWO-DIMENSIONAL STEADY AND ONE-DIMENSIONAL UNSTEADY MGD FLOWS OF SMALL MAGNETIC REYNOLDS NUMBER, by K. Lackner. Feb. 1965, 8p. (Scientific rept. no. 25) (AFOSR-65-1320) (AF 61-(052)675) AD 622568 Unclassified

The applicability of the method of characteristics to the investigation of 2-dimensional steady and 1-dimensional unsteady MGD flows of small magnetic Reynolds number is studied. Preliminary results are shown to be promising. (Contractor's abstract)

1250

Innsbruck U. Inst. for Theoretical Physics (Austria).

LEGRENDRE TRANSFORMATION AND CHARACTERISTICS OF THE MAGNETOGASDYNAMIC POTENTIAL EQUATION, by F. Cap. [1965] [9]p. incl. diagrs. tables. (AFOSR-65-1431) (AF 61(052)675) AD 622652 Unclassified

Also published in Plasma Phys., Accelerators, Thermonuclear Research, v. 7: 69-77, Jan.-Feb. 1965.

For the potential equation of the 2-dimensional stationary potential flow of a plasma of infinite conductivity, a method of characteristics is derived which is set up in analogy to the Prandtl-Busemann method of gas dynamics. The differential form of the potential equation is subjected to a Legendre transformation in order to obtain a linear differential equation whose characteristics are determined once for all. Polar co-ordinates are introduced and solutions are obtained graphically which are in good agreement with the numerical curves. A graphical method for the solution of magnetogasdynamic 2-dimensional stationary flow problems can thus be based on the characteristic curves and the velocity curve.

1251

Innsbruck U. Inst. for Theoretical Physics (Austria).

MAGNETOGASDYNAMIC FLOWS OF SMALL MAGNETIC REYNOLDS NUMBER. PART I, by K. Lackner. June 29, 1965 [51]p. incl. diagrs. tables, refs. (Scientific rept. no. 27) (AFOSR-65-1621) (AF 61(052)675) AD 623812 Unclassified

The 2-dimensional steady case is investigated for magnetogasdynamic flows of small Reynolds number. A new method is developed for a numerical treatment of the equations for the 4 real characteristic directions

involved. The method is described by illustrating its use in the example of the MGD flow in a steady crossed field accelerator. Results are presented of calculations carried out on a Zuse Z 23V computer.

1252

Innsbruck U. Inst. for Theoretical Physics (Austria).

ON THE RELATION BETWEEN LOUGHHEAD'S PAPER ON ONE DIMENSIONAL STEADY MHD-FLOW AND THE CAP THEORY, by G. Kerer. [1965] 7p. (Technical note no. 5) (AFOSR-65-1799) (AF 61(052)-675) Unclassified

Loughhead treated the set of 4 magnetogasdynamical equations (induction equation, equation of motion, continuity equation, and Poisson equation) under the assumption of infinite electrical conductivity and adiabatic behavior, and obtained 4 families of characteristics for the basic equations. Use of the 1-dimensional unsteady potential equation, yields only two. In this note it is shown that Loughhead's characteristics can be reduced to those of 1-dimensional unsteady flow. Two of Loughhead's 4 equations result in the relationship, H = const ρ and thus only 3 are essential. Two of these equations are shown to be identical if Poisson's equation is substituted into them.

1253

Innsbruck U. Inst. for Theoretical Physics (Austria).

THERMODYNAMICS OF A MHD-PLASMA WITH INFINITE ELECTRICAL CONDUCTIVITY, by F. Cap. [1965] [6]p. incl. diagr. (AFOSR-65-2250) [AF 61-(052)675] AD 629262 Unclassified

Also published in Acta Phys. Austriaca, v. 19: 333-338, 1965.

Equations are derived for the thermodynamics of an inviscid adiabatic plasma with infinite electrical conductivity.

1254

Innsbruck U. Inst. for Theoretical Physics (Austria).

A NUMERICAL METHOD FOR SOLVING THE ONE-DIMENSIONAL UNSTEADY MGD BASIC EQUATIONS FOR FINITE MAGNETIC REYNOLDS NUMBER, by H. Friedel. July 3, 1965 [17]p. incl. diagrs. tables, refs. (Scientific rept. no. 28) (AFOSR-66-0348) (AF 61(052)675) AD 630632 Unclassified

A numerical method based on the theory of characteristics for solving the parabolically degenerated 1-dimensional unsteady MGD basic equations is described. Convergence and stability of the numerical method are analyzed in detail. (Contractor's abstract)

1255

Innsbruck U. Inst. for Theoretical Physics (Austria).

MAGNETOHYDRODYNAMIC PROPULSION, by H. Friedel and K. Lackner. Dec. 5, 1965 [30]p. incl. diagrs. tables, refs. (Scientific rept. no. 29) (AFOSR-66-0942) (AF 61(052)675) AD 634253 Unclassified

The applicability of magnetogasdynamic concepts to the description of the flow in plasma accelerators is studied. Two methods are proposed for the theoretical treatment of steady crossed-field and traveling wave accelerators.

1256

Innsbruck U. [Inst. for Theoretical Physics] (Austria).

MGD FLOWS OF FINITE ELECTRICAL CONDUCTIVITY (Abstract), by F. Cap, H. Friedel and others. [1965] [1]p. (Bound with its AFOSR-65-1266; AD 622527) (AF 61(052)675) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

A general method for the numerical treatment of the MGD fundamental equations for arbitrary values of the magnetic Reynolds number is discussed. This method, which can be used for both pure initial value and for mixed initial and boundary value problems, allows for a stepwise independent solution of the flow equations and of the induction equation. The first form is a totally hyperbolic system which can be treated by the method of characteristics. The induction equation, which is parabolic under the pertinent conditions, is solved by a net method using the same lattice as for the flow equations. It is intended to use this method for studying shock interaction with a magnetic field. Under the condition $R_M << 1$, the equations governing the flow of a conduction gas are basically the same as for ordinary non-isentropic gasdynamic flows, with the exception of an additional force term (the Lorentz force) and an intrinsic entropy source (due to ohmic heating of the gas). For the supersonic case, there exist 4 real characteristic directions for constructing a numerical integration method based on a lattice with constant mesh size. The use of this method is illustrated by application to the flow of a conducting gas through a divergent nozzle under the accelerating action of crossed electric and magnetic fields.

1257

Institut d'Optique, Paris (France).

STUDY OF OPTICAL AND TRANSPORT PROPERTIES OF THIN FILMS OF METALS AND ALLOYS, by F Abeles. Final scientific rept. July 9, 1965, 16p. incl. refs. (AFOSR-65-1677) (AF EOAR-63-48) AD 624101 Unclassified

The results of the following investigations are presented. (1) Improvements to the preparation and fabrications of evaporated thin metallic films; (2) Comparison

of thin film thickness using x-rays, the temperature coefficient of the resistivity and gomophotometric measurements, (3) Use of gomophotometric measurements for detecting very thin surface layers (oxides); (4) Use of ellipsometric measurements for the study of thin films and surfaces, with new instrumentation, (5) Measurement of resistivity and Hall constant of thin metal films in vacuo with high accuracy, (6) Use of the optical and electrical measurements performed on the same film in order to determine the scattering parameter and the optical effective mass of the conduction electrons, and the resistivity due to defects in the film, and (7) New results concerning the optical properties of Au, Cu, Pd, and Au-Pd (Contractor's abstract)

1258

Institut National des Techniques de la Documentation, Paris (France)

ON THE THEORETICAL BASIS OF INFORMATION RETRIEVAL SYSTEMS, by E. de Grolier. Final rept. Sept. 1965, 211p. incl. table, refs. (AFOSR-65-2720) (AF 61(052)505) AD 628183 Unclassified

This report is an extensive survey of and commentary on research and developments in the fields of information retrieval and linguistics and the applicability of results to the formulation of information retrieval languages and machine translation. Commentary is weighted toward imparting an awareness of many of the special requirements of a reasonably efficient IR language, the complexities involved in translating from one language to another (be it natural language, IR language, or other synthetic languages), and the difficulties inherent in describing concepts and representing meanings. Real and putative relations which have been made between logic, linguistics, and information retrieval are explored in some detail. An extensive discussion is included of classification from a theoretical point of view, under topic headings: classifications of language, traditional bibliographic classifications; the British classification research group; Ejnar Wahlin's system, Gardin's Syntol; the problem of categories in classifications; the "integrative levels" approach; and the problem of "relations." Activities in the United States, Europe, and the Soviet Union are considered.

1259

Institute for Advanced Study, Princeton, N. J.

CHARACTERIZATIONS OF TAME SURFACES IN E^3, by C. E. Burgess. [1965] [18]p. incl. refs. (AFOSR-65-1396) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)253] and National Science Foundation) AD 622750 Unclassified

Also published in Trans. Amer. Math. Soc., v. 114, 80-97, Jan 1965.

Some conditions under which a surface is tame in E^3 are considered. Using Bing's theorem that a surface is tame if its complement is 1-ULC, it is shown that a connected 2-manifold K is tame in E^3 if it can be locally spanned, with a disk, at each point from each side of K. This result is then generalized to a 2-manifold in a 3-manifold. The characterization of tame surfaces includes Harrold's theorem that a surface is tame in E^3 if it is locally peripherally unknotted, but it is not required that the boundary of a spanning disk should be tame or that at each point of K there should be 2 spanning disks that have the same boundary and are on opposite sides of K. This makes it possible to give conditions under which a surface is tame from one side.

1260

[Institute for Advanced Study, Princeton, N. J.]

QUANTUM HARD-SPHERE GAS, I, by M. Luban. [1965] [5]p. incl. refs. (In cooperation with Pennsylvania U., Philadelphia) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-42 and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 138: A1028-A1032, May 17, 1965.

The problem is posed of finding an operator, defined for all relative distances of 2 particles, which plays the role of a Hamiltonian such that the subsequent eigenvalue problem has as its only solutions precisely the eigenfunctions for 2 hard spheres, each of core diameter a. This operator is explicitly constructed. Its crucial aspect is that, despite its being defined for all relative distances r_{12}, its eigenfunctions serve as a complete set for expressing a 2-particle wave function only in the restricted interval $r_{12} > a$. Subsequent papers of this series will be devoted to the application of these results to the problem of quantum hard-sphere gases.

1261

Institute for Advanced Study, Princeton, N. J.

DIFFERENTIAL AND COMBINATORIAL TOPOLOGY: A SYMPOSIUM IN HONOR OF MARSTON MORSE, Princeton, N. J. [Apr. 2-5, 1963] ed. by S. S. Cairns. Princeton U. Press, 1965, 265p. incl. illus. diagrs. table, refs. (AFOSR-65-1593) (AF AFOSR-63-162) Unclassified

Papers are presented from the symposium in honor of Marston Morse on differential and combinatorial topology. Topics covered are: the smoothings of triangulated and combinatorial manifolds, the action of $\Theta^n(8\pi)$, critical submanifolds of the classical groups and Stiefel manifolds, spin manifolds, diffeomorphisms, bowls of a nondegenerate function on a compact differentiable manifold, higher dimensional knots, the groups J(X), Morse theory, the index theorem for homogeneous differential operators, minimal surfaces in E^n, homotopy spheres of low dimension, analytic varieties, differentiability in the complement of a point, and homologies of real algebraic varieties.

1262

Institute for Advanced Study, Princeton, N. J.

QUADRATIC FORMS Θ AND Θ-FIBRE-BUNDLES, by M. Morse. [1965] [37]p. (AFOSR-65-2630) [AF AFOSR-63-357] AD 627951 Unclassified

Also published in Ann. Math., v. 81: 303-340, Mar. 1965.

This report deals with the statement of a theorem on the extension and existence of f-fibre-bundles.

1263

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

THE REDUCTION OF A FUNCTION NEAR A NON-DEGENERATE CRITICAL POINT, by M. Morse. [1965] [5]p. (AFOSR-66-0670) (AF AFOSR-63-357) AD 641510 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 54. 1759-1763, Dec. 1965.

In a classical paper (Trans. Amer. Math. Soc., v. 27: 345-396, 1925), the author proved the following theorem. Let $x \to f(x)$: $x \to R$ ($f(0) = 0$) be a real-valued function of class C'' in an open neighborhood x of the origin in E_n. If the origin is a non-degenerate critical point of f of index k, there exists a C'-diffeomorphism ω: $U \to X$ of an open neighborhood U of the origin such that $\omega(0) = 0$ and

$$f(\omega(x)) = -x_1^2 - \cdots - x_k^2 + x_{k+1}^2 + \cdots + x_n^2, \quad x \in V.$$

A pseudo-quadratic form is a real-valued function on an open neighborhood V of the origin of E_n of the form $\Gamma(x) = a_{ij}(x)x_ix_j$, $a_{ij}(x) = a_{ji}(x)$, a_{ij} of class C^∞. A pseudo-linear form is an E_n-valued function ω on an open neighborhood of the origin in E_n of the form $\omega_i(x) = c_{ij}(x)x_j$, c_{ij} of class C^∞. In this paper the author analyzes this proof in terms of the pseudo-group of pseudo-linear diffeomorphisms and equivalence classes of pseudo-quadratic forms. (Math. Rev. abstract)

1264

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

A MODEL NON-DEGENERATE FUNCTION, by W Huebsch and M. Morse. [1964] [32]p. (AFOSR-66-0671) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-357 and National Science Foundation) AD 641514 Unclassified

Presented at Colloq. on Global.Differential Geometry, Bucharest (Romania), June 30-July 4, 1964.

Also published in Rev. Roumaine Math. Pures et Appl., v. 10: 691-722, 1965.

Let M be a connected, oriented, differentiable n-manifold ($n \geq 2$), f be a non-degenerate function on M, and w, ẇ be a 2 critical points of f with indices k-1 and k and f-values 0 and 1 respectively. The paper deals with the problem of the existence of an open subset N of M which contains w and ẇ and whose closure contains no other critical points of f and of a non-degenerate function f on M without critical points on $\bar{N}$ and such that $f = f$ on M-N. (Contractor's abstract)

1265

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J

POLES IN THE VERTEX FUNCTION, ZEROS OF THE PROPAGATOR, AND BOUNDS OF COUPLING CONSTANTS, by Y. S. Jin and S. W. MacDowell. [1965] [8]p. (AFOSR-66-0450) (AF AFOSR-64-42) AD 630361 Unclassified

Also published in Phys. Rev., v. 137: B688-B695, Feb. 1965.

Extending the arguments by Goebel and Sakita, it is shown in a general framework that a pole of the proper vertex function does not lead to a pole in the scattering amplitude. Connections between zeros of the propagator, poles of the proper vertex function, and upper bounds on the coupling constant are discussed in rather general terms as well as in terms of the Zachariasen model. By making use of the analytic continuation of the partial-wave scattering amplitude into the complex angular-momentum plane, a possible physical interpretation of the vertex function is given. (Contractor's abstract)

1266

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

INTRINSICALLY BROKEN U(6) CROSS U(6) SYMMETRY FOR STRONG INTERACTIONS. II, by K. Bardakci, J M. Cornwall and others. Jan. 1965 [4]p. incl. table, refs. (AFOSR-66-0460) (AF AFOSR-64-42) AD 630508 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 48-51, Jan 1965.

It was shown that the group W(6) arises naturally when one enlarges the group GL(6) to a 144-parameter, non-compact group which is denoted by M(12). It was then shown that W(6) is the maximal compact subgroup of M(12).

1267

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

MESON COUPLING IN THE INTRINSICALLY BROKEN

U(6) SYMMETRY SCHEME, by K. Bardakci, J. M. Cornwall and others. Feb. 1965 [4]p. incl. refs. (AFOSR-66-0461) (AF AFOSR-64-42) AD 630511 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 264-267, Feb. 1965.

The implications of the groups U(6) and W6 for trilinear meson interactions are discussed. It is shown that good values for parameters like the $\omega\sigma\pi$, $\omega\sigma\pi$, $K^*K\pi$, and $K^*\sigma K$ coupling constants are obtained from U(6) symmetry. Based on the U(6) values of these parameters, it is possible to calculate the decay rates for $\omega \to \pi^+ + \pi^- + \pi^0$ and $K^* \to K^* + \pi + \pi$ reactions and obtain results in agreement with experiment. The selection rule $\varphi \not\to \rho + \pi$ is also obtained. A systematic method is given for the construction of interactions that are both U(6) and Lorentz invariant. A method for handling the intrinsic symmetry breaking due to kinetic enery is also given.

1268

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

SOME SIMPLE CONSEQUENCES OF SU(4) SYMMETRY, by C.-H. Woo and A. J. Dragt. [1965] 2p. incl. refs. (AFOSR-66-0462) (AF AFOSR-64-42) AD 630362 Unclassified

Also published in Phys. Rev., v. 138: B945-B946, Aug. 1965.

The electromagnetic properties of the nucleons and N^*, as well as the meson-baryon coupling constants, are examined within the framework of an SU(4) symmetry combining spin and isospin. The motivation is to examine the consequences of such a symmetry at low energies without having to worry about the large mass differences within the SU(3) multiplets in the corresponding SU(6) theory. The coupling-constant ratios are in qualitative agreement with the experimental values The arbitrariness in the proton-neutron magnetic-moment ratio is discussed. In the model where the electromagnetic interaction of the baryons is mediated by the vector mesons in the adjoint representation of SU(4), the magnetic-moment ratios agree with the SU(6) results. (Contractor's abstract)

1269

Institute for Advanced Study. Dept. of Mathematics, Princeton, N. J.

QUANTUM EFFECTS ON THE ACCURACY OF MOMENTUM MEASUREMENTS, by C.-H. Woo. [1965] [4]p. incl. diagrs. (AFOSR-66-0464) (AF AFOSR-64-42) AD 630369 Unclassified

Also published in Phys. Rev., v. 139 B1103-B1106, Aug. 1965

It is shown in 2 examples that to measure the momentum of a particle with great accuracy, allowing for large uncertainties in the position, it is still necessary to consider additional quantum effects. For the case of measurements by electromagnetic means, the uncertainties in the measurability of field strengths and of charge-current densities should be considered. Within the framework of the Bohr-Rosenfeld analysis, uncertainties in the field measurements do not limit the accuracy of momentum measurements. What happens when the Bohr-Rosenfeld approximations are not made is an open question. (Contractor's abstract)

1270

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

PHASE REPRESENTATION AND HIGH-ENERGY BEHAVIOR OF THE FORWARD SCATTERING AMPLITUDE, by Y. S. Jin and S. W. MacDowell. [1965] [7]p. incl. refs. (AFOSR-66-0466) (AF AFOSR-64-42) AD 630365 Unclassified

Also published in Phys. Rev., v. 138: B1279-B1285, June 7, 1965.

By making use of the phase representation, the relation between the high-energy behavior of the symmetric forward scattering amplitude F(x) and the asymptotic properties of the ratio $\cot\delta = \mathrm{Re}F/\mathrm{Im}\,F$ is discussed. Starting assumptions are dispersion relations and the Greenberg-Low bound. Lower bounds as well as upper bounds are derived. Under the assumption of the Froissart bound, it is shown that $\cot\delta$ cannot stay indefinitely greater than an arbitrarily small positive number. Also if the total cross section decreases steadily to a finite limit, but slower than const/E, the real part must tend to $-\infty$. The results are discussed in connection with those of Khuri and Kinoshita. The unsymmetric case is also treated by the same methods.

1271

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

PHYSICAL PROPERTIES OF QUARKS, by P. G. O. Freund. [1965] [2]p. (AFOSR-66-0470) (AF AFOSR-64-42) AD 630363 Unclassified

Also published in Phys. Ltrs., v. 15: 352-353, Apr. 15, 1965.

Estimations are made of the strength of the coupling of quarks to the 35 odd parity mesons.

1272

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

EXPERIMENTAL IMPLICATIONS OF U(6)⊗U(6)-INVARIANCE FOR BARYONS, by K. Bardakci, J. M. Cornwall and others Mar. 1965 [37]p. incl. table, refs (AFOSR-66-0472) (AF AFOSR-64-42, AD 630507 Unclassified

Also published in Phys. Ltrs., v. 15: 79-81, Mar. 1965.

Evidence is presented from the experimental baryon spectrum to suggest that the product of W6 = U(6) ⊗ U(6) is the hadron symmetry group.

1273

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

MESON-BARYON SCATTERING IN THE INTRINSICALLY BROKEN M(12) SYMMETRY SCHEME, by J. M. Cornwall, P. G. O. Freund and others. Mar. 1965 [3]p. incl. tables, refs. (AFOSR-66-0473) (AF AFOSR-64-42) AD 630510 Unclassified

Also published in Phys. Rev. Ltrs., v. 14. 515-517, Mar. 1965.

The group M(12) proposed to underlie the symmetry of strong interactions was applied to the problem of meson-baryon scattering. A very rich body of sum rules for scattering amplitudes appeared to emerge. The significance of these sum rules was interpreted as tests for the M(12) symmetry scheme.

1274

Institute for Advanced Study. [Dept. of Mathematics] Princeton, N. J.

ANALYTICITY IN POTENTIAL SCATTERING, by A. Martin. [1965] 66p. incl. diagrs. refs. (AFOSR-66-0480) (AF AFOSR-64-42) AD 631101 Unclassified

Also published in Progress in Elementary Particle and Cosmic Ray Physics, ed. by J. G. Wilson and S. A. Wouthuysen, Amsterdam, North-Holland Publishing Co., v. 8: 1-66, 1965.

A review of a few approaches to the explanation of the theory of potential scattering amplitudes is presented.

1275

Institute for Scientific Information, Philadelphia, Pa.

AUTOMATIC SUBJECT RECOGNITION IN SCIENTIFIC PAPERS: AN EMPIRICAL STUDY, by J. O'Conner. [1965] 25p. incl. tables, refs. (AFOSR-66-0422) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1300 and Office of Naval Research) AD 626555 Unclassified

Also published in Jour. Assoc. Comput. Mach., v. 12: 490-515, Oct. 1965.

Two subject index terms (toxicity and penicillin) from an operating retrieval system were studied intensively to determine how well a computer could assign them. The humanly produced indexing for the system was used as a standard, with some checking for indexer errors. Thesaurus rules failed to identify one fourth of the toxicity papers. A new rule, using "connection forms," worked for almost all of the non-thesaurus papers. The combined rules identified toxicity papers as well as or better than the human indexers. However, these rules falsely selected as many papers as they correctly identified. False selection was reduced to this level by the use of two new indexing rules; relative frequency, and two methods previously proposed but not tested. The latter are emphasis measures by syntactic centrality and by first sentence-first paragraph position. The rules for reducing false selection did not work as well for penicillin as for toxicity. Comparisons are made with previous empirical studies. Some possible limitations of thesaurus methods, statistical association, etc., are indicated. Some affirmative suggestions are also made. (Contractor's abstract)

1275

Institute of Electrical and Electronics Engineers, Inc., New York.

1965 INTERNATIONAL SYMPOSIUM OF THE IEEE GROUP ON ANTENNAS AND PROPAGATION. PROGRAM AND DIGEST, Washington, D. C., Aug. 30-Sept. 1, 1965, 345p. incl. illus. diagrs. tables, refs. (IEEE Catalogue no 3C12) (AFOSR-65-1828) [AF AFOSR-65-957] AD 475985 Unclassified

This report contains summaries of 71 presentations from the 1965 International Antennas and Propagation Symposium. The symposium covered such subjects as. (1) radar and radio astronomy; (2) arrays; (3) log periodic antennas, (4) electromagnetic scattering; (5) electronic scanning; (6) optical and millimeter propagation; (7) mutual coupling; (8) tropospheric propagation; (9) feeds and reflectors; (10) waves and plasmas; (11) theory and measurement; and (12) guided waves.

1276

Institute of Work Physiology, Oslo (Norway).

STRENUOUS MUSCULAR EXERTION IN THE POLAR CLIMATE AND ITS EFFECT UPON HUMAN WORK CAPACITY AND TOLERANCE TO COLD, by K. L. Andersen, B. Hellstrom, and R. Eide. Final rept Jan. 31, 1965, 31p. incl. illus. diagrs. tables, refs. (AFOSR 65-1565) (AF EOAR-64-58) AD 623919 Unclassified

The physiology of 8 men who participated in a polar ice cap expedition was investigated with regard to work capacity and cold tolerance. Several tests were administered to the subjects before and after the expedition such as tests of cold tolerance and excercise fitness. A delay in the retesting made it difficult to accurately evaluate the results, but in general the study confirms earlier observations on how a period of cold exposure and hard physical work affects aspects of physiology underlying tolerance to cold.

1277

Instituto de Investigación de Ciencias Biológicas, Montevideo (Uruguay).

UPTAKE OF C^{14}-L-LYSINE INTO SEGMENTS OF NORMAL RAT SCIATIC NERVE, by G. S. L. Appletauer, C. Benech and others. [1965] [15]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-61-64 and Rockefeller Foundation) Unclassified

Published in Exper. Neurol., v. 12: 215-229, July 1965.

The uptake of activity along tibial and peroneal fibers of the sciatic nerves of normal rats was studied at periods ranging from 1 to 13 days after a single intrathecal injection of L-Lysine-C^{14}. The pattern of uptake was similar in tibial and peroneal fibers of 3-4 mo and 7-8 mo old animals. Younger animals incorporated three to four times more activity than older ones. The average specific activity of the whole nerve kept approximately constant during the duration of the experiment. A proximodistally decreasing gradient of specific activity was found as early as 24 hr and persisted at the thirteenth day. Peaks of activity appeared in the most proximal segment at days 1-3 and 7-10. Curves of the specific activity for each nerve segment are presented. The characteristics of the peaks of activity were studied in plottings of the second derivative of the activity vs nerve length and vs time. The results are briefly discussed in relation to endoneural transport mechanisms. (Contractor's abstract)

1278

Instituto de Investigación de Ciencias Biológicas, Montevideo (Uruguay).

CONDITIONING OF MIDBRAIN BEHAVIORAL RESPONSES, by N. Ross, M. Pineyrua and others. [1965] [16]p. incl. illus. diagrs. refs. (AFOSR-66-0751) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-332 and Rockefeller Foundation) AD 643008 Unclassified

Also published in Exper. Neurol., v. 11 263-276, Mar. 1965.

An acoustic stimulus was associated with the electrical stimulation of midbrain areas (reticular formation, central gray substance and stratum proximum of the superior colliculus) according to the trace and avoidance conditioning techniques. Habituation, reinforcement, differentiation and extinction were studied in cats with chronically implanted electrodes. Conditioned responses of attention, fear and flight patterns were obtained. It is suggested that these conditioned responses depend on the activation of the central neural mechanisms of emotion. No definite motivation was ascribed to the attention response, and intensely negative motivation was attributed to both emotional responses. (Contractor's abstract)

1279

[Instituto Geografico y Catastral. Spanish Seismological Survey, Madrid (Spain)]

IBERIAN PENINSULA CRUSTAL STRUCTURE FROM SURFACE WAVES DISPERSION, by G. Payo. [1965] [17]p. incl. diagrs. table, refs. (AFOSR-65-2889) (AF 61(052)657) AD 624173 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 727-743, Aug. 1965.

Phase velocity of Rayleigh waves traveling from Toledo to Málaga have been determined from 7 selected earthquakes. The direction of approach of the wave front in relation to the ground particle motion at the standard Spanish stations (Toledo and Málaga) and at Porto (Portugal) is discussed. Also these 3 observatories are considered as a triangular array to determine the phase velocity through the Iberian Peninsula region; this result is compared with the dispersion data determined by the 2 stations at Toledo and Málaga. Two similar crustal-mantle structures, named IB1 and IB2, have been obtained for this region, by modifying the models Dorman 8021 and CANSD respectively, and by means of the partial derivatives of the phase velocity with respect to the parameters of the layers. Both models IB1 and IB2 are almost identical and their corresponding dispersion curves fit the data with an error less than 0.1 km/sec. The crustal thickness given by these structures is about 33 km. Group velocities of Love and Rayleigh waves from near earthquakes have been also studied. Some Algerian earthquakes yielded a dispersion curve for the arm of the Mediterranean Sea between Algeria and Spain. The curve appears almost typically oceanic. (Contractor's abstract)

1280

Instituto Geografico y Catastral. Spanish Seismological Survey, Madrid (Spain).

SEISMIC MAGNITUDE AND SPECIFIC ABSORPTION COEFFICIENT IN THE IBERIAN REGION, by J. M. Munuera. July 1965 [16]p. incl. diagrs. tables, refs. (AFOSR-66-0430) (AF 61(052)657) AD 637674 Unclassified

Also published in Rev. Geofis., v. 24: 313-328, Oct.-Dec. 1966. (AFOSR-67-1200)

This report presents the magnitude scale used by Spanish Seismological Survey (SSS) for near earthquakes inside the area 5° E-10° W, 35°-44° N, which has been deduced from shear waves and with an explicit term for the specific absorption. The way for computation this coefficient is the difference between a theoretical expression for log E and other empirical one, which was previously determined for the Toledo Observatory. The method requests this base-station, besides the new standard calibration made for the other 4 stations handled and also abundant events and the corresponding m values as preliminary deduced by Laboratorio Central del

Servicio de Sismologia (LCSS), Madrid, since 1961 up to 1964. We have obtained: $Q = (62.5° + 67) \pm 32$ for $1.5 \leq \Delta° \leq 7.5$; the average $Q = 300$ is assumed for the whole crust in the said area.

1282

Instituto Geografico y Castral. Spanish Seismological Survey, Madrid (Spain).

[THE REGION INTERGOVERNMENTAL OF SEISMOLOGY AND INGENIERIA SEISMIC OF THE UNESCO] La Reunion Intergubernamental de Sismologia e In Ingenieria Sismica de la UNESCO, by J. M. Munuera. [1965] [145]p. (AFOSR-67-0559) (AF 61(052)657) AD 647952 Unclassified

A summary is given of the proceedings of the conference which was held at UNESCO headquarters in Paris, Apr. 21-30, 1964. Abstracts are included of the papers presented.

1283

Instituto Geografico y Catastral. Spanish Seismological Survey, Madrid (Spain).

[THE ACTIVITY SEISMIC OF THE REGION OF THE PENINSULA IBERICA UP TO YEAR OF 1960] La actividad sismica en la region de la peninsula Iberica hasta fines de 1960, by J. M. Munuera. [1965] [20]p. incl. diagrs. tables, refs. (AFOSR-67-0560) (AF 61-(052)657) AD 647669 Unclassified

Also published in Rev. Geofis., no. 95: 265-284, July-Sept. 1965.

This paper comments on the array of several seismic features corresponding to the Iberian Peninsula region which were deduced from handling 3307 earthquakes of possible epicentral location. Results and methods are compared with other different studies on seismicity. The ratio between both seismic and elastic energies, assuming an invariable focal volume, is deduced as $q = 2.98 + 0.37m$, for the Lomnitz factor, and $\epsilon = 6.88 \times 10^{-5}$, for the mean unitary elastic strain. The Iberian seismicity appears as intralpine, at majority, though there is also seismicity on the Platform. The flux line $\varphi = 6\text{-}7$ agrees with alignments of the intermediate and deep shocks and with the usual drawing of the Western Mediterranean Alpine Geosyncline. The average for the return period is 50 yr, more or less, which agrees with the cummulative energy release period deduced from the Benioff curve. Maximal seismic density shows migration, for the different epochs, and regression of frequency vs magnitude is a parabolic curve.

1284

Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain).

DIFFUSION FLAMES AND SUPERSONIC COMBUSTION, by I. Da Riva. Final rept. Apr. 1, 1963-Apr. 1, 1965, 21p. incl. diagrs. refs. (AFOSR-65-1604) (AF EOAR-63-43) AD 622581 Unclassified

This report presents a summary of work done on the behavior of reacting gases in supersonic combustion. The work undertaken comprises 3 areas: diffusion flames, combustion in the boundary layer, and combustion in a subsonic jet of fuel discharging in a supersonic coflowing stream of oxidizer. The structure of laminar diffusion flames has been analyzed in the limiting case of large, though finite, reaction rates. It is shown that the chemical reaction takes place only in a very thin region where convection effects may be neglected. The boundary layer flow past a hot wall is studied noting that the density at the outer edge of the boundary layer is much higher than the density close to the wall.

1285

Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain).

HETEROGENEOUS COMBUSTIONS AND FLAMES STRUCTURES, by C. S. Tarifa. Final rept. Apr. 1, 1963-Mar. 31, 1965. [58]p. incl. diagrs. tables, refs. (AFOSR-65-1791) (AF EOAR-63-44) AD 625015 Unclassified

The problem of flame spread along the fuel surface of a liquid fuel is studied by considering a model in which the flame propagates along the surface of a fueld contained in a channel. The theoretical model is compared with experiment, and it is reported that the agreement is fairly good, although for small values of temperature, the theoretical results are smaller than the experimental values. In the investigation of flame structures, the hydrogen-oxygen diffusion flame with spherical symmetry is studied and the theoretical results are compared with the experimental data obtained by burning oxygen or hydrogen injected through a porous sphere into a hydrogen or oxygen atmosphere. An application is made to the combustion of oxygen droplets in a hydrogen atmosphere.

1286

Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain).

FLAME PROPAGATION ALONG THE FREE SURFACE OF A LIQUID FUEL (Abstract), by C. S. Tarifa and M. A. Ortega. [1965] 2p (Bound with its AFOSR-65-0590; AD 623186) (AF EOAR-63-44) Unclassified

Presented at AFOSR Combined Contractors' Meeting on Combustion Dynamics Research, Patrick AFB, Cocoa Beach, Fla., June 1-4, 1965.

Flame propagation velocity as a function of fuel initial temperature, fuel depth, and for different values of the most important parameter of the process was calculated. It was shown that flame propagation speed increased

very rapidly as fuel temperature approached flash point temperature, and that flame speed may increase or decrease as the fuel flux decreased.

1287

Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain).

COMBUSTION OF OXYGEN DROPLETS IN A HYDROGEN ATMOSPHERE (Abstract), by P. P. del Notario and C. S. Tarifa. [1965] 2p. (Bound with its AFOSR-65-0590; AD 623186) (AF EOAR-65-70) Unclassified

Presented at AFOSR Combined Contractors' Meeting on Combustion Dynamics Research, Patrick AFB, Cocoa Beach, Fla., June 1-4, 1965.

Combustion of oxygen droplets by considering spherical symmetry and stationary conditions was studied. Proper values of all physical properties; thermal conductivities, diffusion coefficients and others were selected carefully. Rate reaction studies were also conducted on the combustion process.

1288

Instituto Venezolano de Investigaciones Cientificas, Caracas (Venezuela).

ACTION OF ANTIDIURETIC HORMONE ON THE DC RESISTANCES OF THE ISOLATED TOAD SKIN (Abstract), by G. Whittembury, F. Fragachan, and F. Rawlins. [1965] [1]p. (AFOSR-65-1515) (AF AFOSR-64-620) Unclassified

Presented at Ninth annual meeting of the Biophys. Soc., San Francisco, Calif., Feb. 24-26, 1965, p. 117.

Abdominal skins from Bufo marinus bathed in Na_2SO_4-Ringer were impaled with microelectrodes, in vitro. With the micropipette tip located in a cell of the stratum germinativum, the DC resistance (Ro) between the cell and the outer bathing solution and the resistance (Ri) between the cell and the inner bathing solution were measured. Addition of ADH produced no change in Ri, but Ro diminished both in the K and Na containing solutions. After changing the inner solution, Ri was higher in the Na than in the K containing solutions. The changes observed in the potential difference steps suggest that alteration of one of the bathing solutions induces changes in the cell composition and presumably in the characteristics of the membrane facing the other side.

1289

Instituto Venezolano de Investigaciones Cientificas, Caracas (Venezuela).

SODIUM EXTRUSION AND POTASSIUM UPTAKE IN GUINEA PIG KIDNEY CORTEX SLICES, by G. Whittembury. [1965] [19]p. incl. diagrs. tables, refs. (AFOSR-65-1516) (AF AFOSR-64-620 and AF AFOSR-61-85) AD 623499 Unclassified

Also published in Jour. Gen. Physiol., v. 48: 699-717, Mar. 1965.

Slices from the cortex corticis of the guinea pig kidney were immersed in a chilled solution without K and then reimmersed in warmer solutions. The Na and K concentrations and the membrane potential V_m were then studied as a function of the Na and K concentrations of the reimmersion fluid. It was found that Na is extruded from the cells against a large electrochemical potential gradient. Q_{10} for net Na outflux was ~ 2.5. At both K concentrations larger than 8 mm, the behavior of K was largely passive. At the outset of reimmersion (V_m > E_K), K influx seemed secondary to Na extrusion. Na extrusion would promote K entrance, being limited and requiring the presence of K in the bathing fluid. At bath K concentrations below 8 mm, K influx was up an electrochemical potential gradient. Thus a parallel active K uptake is apparent. Q_{10} for net K influx was ~ 2.0. Dinitrophenol inhibited net Na outflux and net K influx, Q_{10} became < 1.1 for both fluxes. The ratio between these fluxes varied. Thus at the outset of reimmersion the net Na outflux to net K influx ratio was ~ 1. After 8 min it was < 1. (Contractor's abstract)

1290

Instituto Venezolano de Investigaciones Cientificas, Caracas (Venezuela).

[SODIUM EXTRUSION AND SODIUM FOR POTASSIUM EXCHANGE IN KIDNEY CELLS] Movimiento de sodio y potasio en celulas renales, by G. Whittembury. [1965] [2]p. incl. tables. (AFOSR-66-2639) (AF AFOSR-66-620) AD 645096 Unclassified

Also published in Acta Cient. Venezolana, v. 16: 140-141 [July-Aug.] 1965.

Slices from the cortex corticis of the kidney of Guinea pigs were immersed in a chilled medium without potassium and then reimmersed in media of various compositions. Sodium, potassium, chloride, tissue water and extracellular space were determined using conventional methods. The use of cell ion concentrations per solid weight shows under some experimental conditions, an active electrogenic sodium extrusion which is accompanied by a passive chloride efflux. This extrusion of sodium does not require potassium in the bathing medium. In other experimental conditions, a sodium for potassium exchange mechanism is noted.

1291

[International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.]

MATHEMATICAL STUDIES OF NONLINEAR CIRCUITS, by H. Cohen. Final rept. Feb. 1, 1962-Jan. 31, 1965 [7]p. (AFOSR-65-0550) (AF 49(638)1139) Unclassified

The nonlinear systems studied in the investigation include both lumped-element networks and distributed-element networks. The mathematical questions considered are those involved in stability, tolerance, existence and the

nature of periodic solutions. The form of the equations, and the application of numerical techniques. The types of equations describing these networks are ordinary and partial differential equations, difference-differential equations, and integral equations.

1292

International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

EPR IN Gd^{3+} IN BaO (Abstract), by J. Overmeyer and R. J. Gambino. [1965] [1]p. [AF 49(638)1198] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 58, Jan. 28, 1965.

Paramagnetic resonance studies have been performed on single crystals of barium oxide doped with gadolinium. For the $\Delta M_S = -\frac{1}{2} \leftrightarrow +\frac{1}{2}$ transition, the observed linewidths (full $\Delta U = 0.3$ G at 77°K) are among the narrowest found in alkaline earth oxide lattices, and the nuclear hyperfine structure due to Gd^{155} and Gd^{157} is completely resolved. This part of the spectrum is described by $g = 1.9916 \pm 0.0003$, $A^{155} = 3.7 \pm 0.1 \times 10^{-4}$ cm^{-1}, $A^{155}/A^{157} = 0.76 \pm 0.1$. The cubic field splitting appears to be small, as expected from the trend observed for Gd^{3+} in CaO and SrO lattices. Unless crystal imperfections are responsible, the data are further evidence of the inadequacy of current theories of the splitting of the $^8S_{7/2}$ ground state.

1293

International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

DIFFUSION VERSUS SURFACE LIMITATIONS IN VAPOR-SOLVENT GROWTH OF GERMANIUM, by F. Jona. [1965] [3]p. incl. diagrs. (AFOSR-65-2028) (AF 49(638)1201) AD 625970 Unclassified

Also published in Jour. Chem. Phys., v. 42: 1025-1027, Feb 1, 1965.

Measuremerts of transport rates as functions of pressure in the systems germanium-iodine and germanium-bromine were carried out. The results are discussed in terms of Lever's theory for diffusive transport. It is concluded that .hile the germanium-iodine system is highly diffusion limited, the germanium-bromine system is noticeably surface controlled. (Contractor's abstract)

1294

International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

PREPARATION OF ATOMICALLY CLEAN SURFACES OF Si AND Ge BY HEATING IN VACUUM, by F. Jona. [1965] [2]p. incl. illus. (AFOSR-65-2029) (AF 49-(638)1201) AD 625993 Unclassified

Also published in Appl. Phys. Ltrs., v. 6: 205-206, May 15, 1965.

Low-energy electron diffraction patterns indicate that atomically clean surfaces of silicon and germanium can be obtained with heat treatments in vacuo. For silicon, the temperature is lower and the duration shorter than heretofore reported. For germanium, it is demonstrated that ion bombardments are not necessary. In both cases, the surfaces obtained are not planar but often pitted, sometimes heavily.

1295

International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

VAPOR TRANSPORT AND THERMODYNAMIC EQUILIBRIA IN THE GERMANIUM-GALLIUM-IODINE SYSTEM, by R. F. Lever. [1965] [13]p. incl. diagrs. tables, refs. (AFOSR-65-2570) (AF 49(638)1201) AD 629291 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1629-1641, Nov. 1965.

Thermodynamic information is used to correlate the composition of germanium-gallium solid solutions with the temperature pressure and composition of a gas mixture with which the solid is in equilibrium. At temperatures below 1000°K, and gallium concentrations in excess of 10^{16} atoms/cm^3 of solid, the dominant gas phase species are GaI, GeI_2 and GaI_3 with the mol fraction of GeI_2 in the gas mixture becoming very small at gallium concentrations greater than 10^{18} atoms/cm^3 and temperature below 900°K. Epitaxial gallium doped germanium layers were grown and their composition found to be close to the calculated equilibrium composition. The growth rate agreed quantitatively with that predicted on the assumption that gaseous diffusion was the rate limiting process. The very low mol fraction of GeI_2 prevents rapid quasi equilibrium single crystal growth of heavily doped material at low temperatures. (Contractor's abstract)

1296

International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

OBSERVATIONS OF "CLEAN" SURFACES OF Si, Ge, AND GaAs BY LOW-ENERGY ELECTRON DIFFRACTION, by F. Jona. [1965] 14p. incl. illus. diagrs. tables, refs. (AFOSR-66-0271) (AF 49(638)1201) AD 629298 Unclassified

Also published in IBM Jour. Research and Develop., v. 9: 375-389, Sept.-Nov. 1965.

The {100}, {110} and {111} surfaces of silicon, germanium and gallium arsenide, cleaned in ultra-high

vacuum by heat-treatments alone or by ion bombardments followed by anneals, were studied with the display-type low-energy electron diffraction technique. Most surface structures reported in the literature by others could be reproduced, namely, Si (111)7, Ge 111 8, GaAs (111)2, and GaAs (100)1. Some, however, could not, namely, Si (111)5 and Ge (111)12. Two unreported structures were found to exist, even simultaneously, on the GaAs (100) surface and 6 different structures were detected on Si (110) surfaces after annealing treatments at different temperatures. The significance of a 'clean' state of semiconductor surfaces, as identified by the observation of low-energy electron diffraction patterns, is discussed. (Contractor's abstract)

1297

International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

PREPARATION OF ATOMICALLY CLEAN SURFACES OF GERMANIUM AND SILICON (Abstract), by F. Jona. [1965] [1]p. [AF 49(638)1201] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull Amer. Phys. Soc., Series II, v. 10 67-68, Jan. 28, 1965.

Experimental evidence is presented for the fact that atomically clean surfaces of germanium and silicon can be produced by heating alone at moderately high temperatures in good vacuum. The evidence is provided by observation of well-defined low-energy electron diffraction patterns similar to those obtained by Lander and Morrison with surfaces cleaned by ion bombardment followed by annealing and a variety of chemical treatments Prior to their introduction into the vacuum system, the germanium samples were solution-polished, while the silicon samples were vapor-polished Well-resolved patterns of the Ge(111) -8 and Ge(100)-4 structures were observed after several hours heating at temperatures between 850 and 900 C. Very clear patterns of the Si(111)-7 structure were obtained after only 1 hr treatment at 850°C Ge(110) and Si(110) surfaces were also investigated. The cleaning procedure described here may often be more convenient than the procedures described in the literature.

1298

International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

PREPARATION AND CRYSTAL CHEMISTRY OF DIVALENT EUROPIUM COMPOUNDS, by M. W. Shafer [1965] [8]p. incl. diagrs. tables, refs. (AF 49(638)1230) Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 16-19, 1964.

Published in Jour. Appl. Phys., v. 36. 1145-1152, Mar. 1965.

The discovery that the europium chalcogenides are a particularly simple and important group of magnetic materials has resulted in considerable work being done on the synthesis of these materials. Several methods of preparing pure EuO have been investigated and the results are reported. The method which resulted in the best EuO is when an excess of europium metal is reacted with Eu_2O_3 at 800°C and then distilled off at 1150° in a high vacuum. Chemical analyses, microstructures, and magnetization measurements were used to determine the stoichiometry of EuO_3 as a function of temperature. The results indicated that the rock salt phase can accomodate about 4 mol % trivalent europium in solid solution at 1300°C. Very little (< %) europium metal was found to go into the EuO phase, but by the addition of 5% to 7% the paramagnetic Curie temperature θ was increased from 73° to 79°K. A number of new divalent europium compounds have been prepared and their magnetic properties investigated. Ferromagnetism was found in the silicates Eu_2SiO_4 and Eu_3SiO_5, the aluminates $Eu_3Al_2O_6$ and $Eu_5Al_2O_8$, and the phosphate $Eu_3(PO_4)_2$. Other divalent europium compounds in which the europium concentration is lower but which had simple well-known crystal structures were also investigated. These included $EuThO_3$, $EuZrO_3$, and $CsEuF_3$ with the perovskite structure, EuF_2 with the fluorite, $EuWO_4$ with the scheelite, Eu_2CaWO_6 and Eu_2SrWO_6 with the cryolite, and Eu_2ZrO_4 with the K_2NiF_4 structures. None of these compounds were shown to be ferromagnetic despite the fact that the nearest-neighbor Eu-Eu distances were less than 4.5A, the distance determined from the chalcogenide series to be the critical one for a positive ferromangetic Eu-Eu interaction. The absence of ferromagnetism in these compounds is discussed in relation to the fact that, except in $CsEuF_3$, the coordination number of the Eu^{+2} ion is not six as it is in the chalcogenides. The assumption that the ferromagnetic interaction takes place via overlap of 5d orbitals is considered and discussed in relation to their structures. (Contractor's abstract)

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International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

SPECIFIC HEAT SINGULARITY IN MnF_2, by D. T. Teaney. May 31, 1965 [3]p. incl. diagr. table. (AFOSR-65-2580) (AF 49(638)1379) AD 628728 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 898-900, May 1965.

Measurements are reported of the specific heat of a classic magnetic system, MnF_2. The results demonstrate clearly the essential similarity between magnetic and gaseous systems and are in encouragingly good agreement with theoretical predictions, especially with respect to the strength of the singularity.

1300

International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

MAGNETIC PROPERTIES OF CuF, by R. J. Joenk and R. M. Bozorth. [1965] [2]p. incl. diagr. (AFOSR-65-2582) (AF 49(638)1379) AD 629292 Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 16-19, 1965.

Also published in Jour. Appl. Phys., v. 36 1167-1168, Mar. 1965.

The moment of a pressed powder sample of monoclinic CuF_2 was measured from 4.2° to 300°K in fields to 25 kG. $\chi(T)$ indicates an AFM transition at T_N = 69°K, and analysis gives $g \sim 2.3$ and Θ 200°K. T_N and Θ are consistent with magnetic ordering of the first kind with AFM exchange interactions J_1 (corner-bc) 34°K and J_2 22°K. Weak ferromagnetism of anisotropic exchange origin is expected on the grounds of symmetry; the measured ferromagnetic moment is $\sigma_0 \approx 1$ G cm^3/mol, corresponding to a canting angle $\varphi \approx 0.01°$. Assuming magnetic dipolar anisotropy and estimating principal axes and values for the anisotropic g tensor, we find the spin axis to be about 2° from c and 99° from a in the ac plane with anisotropy field $H_A \sim 2000$ Oe, and the weak moment to be parallel to the monoclinic axis b with canting field $H_{DM} \sim 1000$ Oe. Pseudodipolar anisotropy may be expected to change the orientation, but not the order of magnitude of these fields. The uniform mode AFM resonances are not degenerate in general, but both would be expected to occur at $\nu/c \sim 9$ cm^{-1} using these values. (Contractor's abstract)

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International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

ANOMALOUS SPLITTING OF ν^{55} IN ANTIFERROMAGNETIC $RbMnF_2$ (Abstract), by D. T. Teaney and J. S. Leddy. [1965] [1]p. [AF 49(638)1379] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Nov. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 315-316, Mar. 24, 1965.

In the course of studying the Mn^{55} NMR in the cubic antiferromagnet $RbMnF_2$, under certain conditions a splitting of the resonance line into 2 components clearly resolved in frequency was observed. The general features of the NMR have been found to be in excellent agreement with the pulling theory: at 4.2°K, the field variation of the single ν^{55} line fits precisely a theoretical curve that extrapolates to 686.2 mc/sec in the high field-unpulled limit. However, in the vicinity of 680 mc/sec, the experimental curve breaks into 2 branches, one approaching 680 mc/sec from below and the other from above. The effect immediately suggests some kind of mode crossing, as it is unable to excite resonance close to 680 mc/sec and the branches remain separated by about 75 kc/sec. The linewidth of 280 kc/sec shows no variation, and the intensities of the 2 resonances qualitatively sum to that of the single line above and below the branching. The frequency of the anomaly is insensitive to temperature below 4.8 K and varies with angle from 680 mc/sec for the applied field along <110> to 678.5 mc/sec for the field along <100>. The temperature dependence above 4.8 K is presented, and possible explanations for the effect are discussed.

1302

International Business Machines Corp. Thomas J. Watson Research Center, Yorktown Heights, N. Y.

EFFECT OF ELECTRON CONCENTRATION ON MAGNETIC PROPERTIES OF NdS-EuS (Abstract), by M. J. Freiser, F. Holtzberg and others. [1965] [1]p. [AF 49(638)1379] Unclassified

Presented at meeting of the Amer. Phys Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 32, Jan. 27, 1965

The NdS-EuS system shows a strong increase in the positive value of the paramagnetic Curie temperature (θ) as a function of electron concentration similar to that found in the semiconducting region of the LaSe-EuSe and GdSe-EuSe systems. The θ value increases from 20 K for EuS to a maximum of 41 K for $Nd_{0.1}Eu_{0.9}S$ followed by a gradual decrease to θ 0 at $Nd_{0.9}Eu_{0.1}S$. Pure NdS was found to be antiferromagnetic with T_N 11 and θ -18°K; however, effects of the crystalline field may influence θ in the neodymium-rich samples. For high europium concentrations, Nd^{3+} behaves similarly to Gd^{3+} in donating an excess electron to the 5-d band, which strengthens ferromagnetic exchange interactions between Eu^{2+} ions. Low-temperature saturation moments indicate that Nd is not coupled to the ferromagnetic Eu^{2+} lattice. The effective magnetic moment from the Curie-Weiss law varied linearly with composition and is consistent with $J = \frac{9}{2}$, $g_J = 8/11$ for Nd^{3+} and $J = \frac{7}{2}$, $G_J = 2$ for Eu^{2+}. Under the assumption that the conduction electron coupling is additive to the europium coupling in insulating EuS, the data for Nd in EuS is found to be consistent with La in EuSe and Gd in EuS up to 25% concentration

1303

Iowa State U. [Dept. of Mathematics] Iowa City.

A MATRIX EQUATION RELATED TO A NON-OSCILLATION CRITERION AND LIAPUNOV STABILITY, by W. T. Reid. [1965] [5]p. (AFOSR-65-2629) (AF AFOSR-63-438) AD 629595 Unclassified

Also published in Quart. Appl. Math., v. 23 83-87, Aug. 1965

In this note it is shown that recent work of the author on Riccati matrix differential equations and non-oscillation criteria for associated linear differential systems implies a result on the solution of an algebraic matrix equation that is intimately related to the existence of a Liapunov function for linear differential systems with constant coefficients.

1304

Iowa State U. [Dept. of Mathematics] Iowa City.

A CLASS OF MONOTONE RICCATI MATRIX DIFFERENTIAL EQUATIONS, by W. T. Reid. [1965] 8p. incl. refs. (AFOSR-65-0655) (AF AFOSR-63-438) AD 641702 Unclassified

Also published in Duke Math. Jour., v. 32. 689-696, Dec. 1965.

Necessary and sufficient conditions for a solution W(t) of the real Riccati matrix differential equation $W' = A(t) + D(t)W + WB(t) + WC(t)W$, $S \leq t < S_1$, to have non-negative elements throughout $[S, S_1]$ whenever W(s) has non-negative elements were obtained. Conditions for the extensibility of such solutions on the interval $[s, \infty]$ were also investigated. For the particular equation with A, B, D, identically zero, there were established extensions of classical results of Perron and Frobenius on the dominant proper value and associated proper vector of an irreducible, non-negative constant matrix. (Math. Rev. abstract)

1305

Iowa State U. [of Science and Tech.] Dept. of Physics, Ames

SOUND DISPERSION IN BINARY MIXTURES OF HOLOMETHANE GASES, by R. R. Boade and S. Legvold. [1965] [5]p. incl diagrs. tables, refs. (AFOSR-65-2779) (AF AFOSR-62-319) AD 629531 Unclassified

Also published in Jour. Chem. Phys., v. 42 539-573, Jan. 15, 1965.

Sound dispersion has been experimentally examined in all binary combinations of the halomethane gases, CH_2F_2, CHF_3, CF_4, CCl_2F_2, and $CHCl_2F$. Concentrations of 25%, 50%, and 75% were examined in each combination. The experimentally determined vibrational relaxation time of each mixture was related to the equation $\tau^{-1} = X^2\tau_{AA}^{-1} + (1-X)^2\tau_{BB}^{-1} + X(1-X)(\tau_{AB}^{-1} + \tau_{BA}^{-1})$. A single relaxation time was observed in all the mixtures and the above equation was found to be valid when the relaxation times of the individual gases in the mixture were similar and when their vibrational specific heats were similar. Values of $(\tau_{AB}^{-1} + \tau_{BA}^{-1})$ were deduced from the data and compared with values calculated from an extended version of the Schwartz and Herzfeld theory. A Lennard-Jones 7-28 interaction potential was used for the calculations and appears to be an appropriate potential for these molecules. (Contractor's abstract)

1306

Iowa State U. [of Science and Tech.] Dept. of Physics, Ames.

SOUND ABSORPTION IN SUBSTITUTED METHANE-INERT-GAS MIXTURES, by E. B. Miller, R. R. Boade, and S. Legvold. [1965] 2p. incl. tables (AFOSR-65-2862) (AF AFOSR-62-319) AD 628830 Unclassified

Also published in Jour. Chem. Phys., v. 42 2982-2983, Apr. 15, 1965.

Velocity dispersion in the substituted methane gases CF_4, CHF_3 + CCl_2F_2 with the noble gases Ar, Ne, and He, was previously reported. The velocity measurements were made with a Pierce-type acoustic interferometer in conjunction with a Brown chart recorder, which provided a plot of oscillator plate current vs the separation between the sound source and the reflector. The present work is a result of re-examining these charts in order to determine the frequency dependence of the acoustic absorption coefficient and thus to obtain relaxation data in an alternative manner.

1307

Iowa State U., Inst. for Atomic Research, Ames.

FIFTH RARE EARTH RESEARCH CONFERENCE, BOOKS 1-6, Iowa State U., Ames, Aug. 30-Sept. 1, 1965, 6p. incl. diagrs. illus. tables, refs. (AFOSR-65-1917) [AF AFOSR-65-812] AD 627221 - AD 627226 Unclassified

A total of 69 papers were presented at the Rare Earth Conference. The papers, with abstracts, are contained in 6 volumes. Book 1 deals with spectra; Books 2, 4, and 6, solid state; Book 3, chemistry, and Book 5, metallurgy.

1308

Iowa State U. Inst. for Atomic Research, Ames.

TERMINAL REPORT FOR THE FIFTH RARE EARTH RESEARCH CONFERENCE, Iowa State U., Ames, Aug. 30-Sept. 1, 1965, by S. Legvold and W. R. Moore. [1965] 32p. (AFOSR-66-0764) (AF AFOSR-65-812) Unclassified

The rare-earth compounds containing oxygen, sulfur, selenium and tellurium were discussed with emphasis on their structural chemistry and reactions they undergo. Spectral data, which included optical spectroscopy, chemical bonding, orbital energy differences and interactions of rare-earth ions with their crystalline environments, was presented and discussed at length. In the field of metallurgy it was found that the alloying behavior of the rare earths with a common partner was not easily predicated because of the variation in crystal structure and stoichiometries. Research was also presented on electrolysis and dependance of temperature upon density.

1309

Israel Inst. of Applied Social Research, Jerusalem.

NEW DEVELOPMENTS IN FACET DESIGN AND ANALYSIS, by U. G. Foa. [1965] [13]p. incl. refs. (AFOSR-65-2674) (AF 61(052)121) AD 629265 Unclassified

Also published in Psychol. Rev., v. 72 262-274, July 1965.

In multivariate research design the systematic definition of the set of variables in terms of more basic sets, the facets, leads to the prediction of the empirical interrelationship among the variables. Two principles are suggested for predicting the results from the facet structure of the variables: the principle of contiguity and the semantic principal components. The application of these concepts to a number of studies in different behavioral areas suggests that they have predictive power. It is further shown that facet elements can be classified into specific and nonspecific to the set of variables and that variables containing specific elements tend to be related to the set of variables more than variables containing nonspecific elements. Systematic design alone does not guarantee correct prediction of empirical results. In fact, for a given area of behavior several alternative formalizations appear possible, and they will usually lead to different hypotheses. While the choice of a given facet design rather than another may depend on the intuition of the investigator, it appears also to be related to the psychology of concept formation and to the influence of language on this process.

1310

Istituto Documentazione Associazione Meccanica Italiana, Milan (Italy).

"MULTISTORE" A PROCEDURE FOR CORRELATIONAL ANALYSIS, by E. von Glasersfeld, P. P. Pisani, and J. Burns. Informal rept. Jan. 1965, 80p. incl. diagrs. tables, refs. (Rept. no. ILRS-T10, 650120) (AFOSR-65-0584) (AF EOAR-64-54) AD 615486 Unclassified

Also published in Automazione e Antomatisimi, v. 9: 5-28, Mar.-Apr. 1965.

A short introduction to correlational theory is given, and a new procedure for correlational analysis for single sentences in English is described. It shows how grammatical, syntactic, and semantic data can be handled in 1 coherent program by means of a specially organized memory called "MULTISTORE." The system eliminates the need for comparisons of indices and ascertains the compatibility of elements by inserting the indices that characterize each element into preestablished individual columns, each of which has its own fixed combination rules based on the rules of word-order in current English. The system yields a complete listing of the operative correlations, roughly corresponding to syntactic connections and their hierarchical structure in a given sentence. Summary flow charts and an example of the procedure are also given.

1311

Istituto Documentazione Associazione Meccanica Italiana, Milan (Italy).

ENGLISH PREPOSITIONS IN MACHINE TRANSLATION, by J. Burns. Informal rept. Jan. 1965 [15]p. incl. diagr. (Rept. no. ILRS-T9, 650115) (AFOSR-65-0861) (AF EOAR-64-54) AD 617793 Unclassified

Also published in Beitrage Sprachkunde und Informationsverabeit, v. 7: 50-61, Dec. 1965 (Title varies)

The problem of the analysis of prepositions, part of a project for analyzing English-language sentences by computer, is considered. The system used in this investigation is based upon the recognition of correlata, their arrangement in correlations and the characterization of their correlators. The problem is one of many involved in the attempt to make a translation-algorithm approximate the relevant procedures of the human translator. The project is directed toward future application in machine translation from English into other languages.

1312

Istituto Documentazione Associazione Meccanica Italiana, Milan (Italy).

AUTOMATIC ENGLISH SENTENCE ANALYSIS PART I. RESEARCH OF THE LINGUISTICS GROUP. PART II. RESEARCH OF THE MATHEMATICS GROUP, by E. von Glasersfeld and P. P. Terzi Final rept Mar. 1, 1964-June 30, 1965 [120]p. incl. diagrs. tables, refs. (Rept. no. ILRS-T11, 650630) (AFOSR-65-1908) (AF EOAR-64-54) AD 622570 Unclassified

Part I: The Linguistics Group describes work on the Multistore Procedure for analysis of English sentences. Previous reports are given as abstracts and subsequent developments are described. Machine-economics have been introduced in various aspects of the procedure; the general table of correlators has been refined, a corpus of texts has been key-punched and processed to provide data for analysis of explicit correlators, this analysis is partly completed The procedure for reclassification of intermediate products is described Part II: The Mathematics Group reports work on aspects of the structure of language Considering the sentence as codification of thought, and thought as a complex of mental items between which certain relations hold, the report considers the source of these mental items, under three headings: (1) sense-perceptions, (2) reflections, (3) inter-personal communication The structure of language is found to be characterized by the way in which relations between mental items are codified (Contractor's abstract)

1313

Istituto Elettrotecnico Nazionale ["Galileo Ferraris"] Turin (Italy)

FURTHER RESULTS ON Cu REPRECIPITATION AND

ELECTROLUMINESCENCE. by G. Bonfiglioli and A Mojoni. [1965] [2]p incl illus (AFOSR-65-1897) (AF EOAR-63-87) AD 625704 Unclassified

Also published in Phys. Ltrs., v. 15 300-301, Apr. 15, 1965.

An extension is presented of previous work (Phys. Ltrs., v. 13 197, 1964) dealing with the connection of electroluminescence (EL) of ZnS(Cu) single crystals to Cu reprecipitation and related thermal aging effects. Annealings were performed on a new group of specimens at a lower temperature (250 C) Precipitation was successfully followed through hardness measurements. Optical microscopy in dark-field showed patterns of decorated dislocations even at early 300 C annealing stages of EL specimens. Thermally treated specimens under microscopic observation, showed peculiar patterns of bright, mostly straight lines composed of many thin lines just after quenching, growing thicker with annealing to produce a typical pattern with C_3 symmetry when cuts normal to c-axis were used.

1314

Istituto Elettrotecnico Nazionale "Galileo Ferraris," Turin (Italy).

EXPERIMENTS OF AC-ELECTROLUMINESCENCE OF Cu DOPED ZnS SINGLE CRYSTALS, by G. Bonfiglioli, P. Brovetto, and A. Mojoni., Sept. 1965 [13]p. incl. illus. diagrs refs. (Technical note no. 5) (AFOSR-65-2098) (AF EOAR-63-87) AD 627470 Unclassified

Also published in Internat'l Symposium on Luminescence, Phys. and Chem Scintillators, Munich (Germany) (Sept. 5-9, 1965) Munich, Karl Thiemig, 1966, p 378-386 (AFOSR-67-0355)

The ac electroluminescence (EL) of Cu-doped ZnS single crystals is reported Several aspects of a thermally induced aging effect are briefly described, which include evolution with the thermal treatment of the light-voltage relationship parameters, hardness increase, dislocations decoration, and optical microscope evidence of the conversion of the EL patterns from "hairlike" to "comet-shaped" form Pictures are also shown, that give information as to the phase relationship of the light emitted from different specimen areas The qualitative implications of these results as to the current theories are discussed, particularly their inconsistency with the mechanism of impact ionization.

1315

Istituto Elettrotecnico Nazionale "Galileo Ferraris," Turin (Italy).

SELF MODULATION DERIVATIVE OPTICAL SPECTROSCOPY. PART 2. EXPERIMENTAL, by G. Bonfiglioli, P. Brovetto and others. Oct. 1965 [27]p. incl. diagrs. (Technical note no. 6) (AFOSR-65-2304) (AF EOAR-63-87) AD 624765 Unclassified

A complete description is given of a first prototype of a SMODOS instrument, namely of its optical as well as electronic components. The project criteria are thoroughly discussed and some performances are shown, practically demonstrating the power of the method.

1316

Istituto Nazionale di Ottica, Florence (Italy).

PROBLEMS RELATED TO VISUAL PERFORMANCE OF PILOTS, by A. Fiorentini and L. Ronchi. Annual summary rept. Dec. 20, 1965, 112p. (AF 61(052)850) Unclassified

The report is divided into four sections. The first section is devoted to the study of the small eye movements during voluntary monocular fixation of a bright point in a completely dark field, and of the determiners of these movements, the autokinetic movements of the point and their possible relationships with the eye movements; and the perceived direction of a bright point as a function of retinal locus. Fixation of a point fixed in the visual field is compared with fixation of a point whose image is stabilized on the retina and with attempted fixation in the dark. The second part deals with some aspects of the perception of light signals. The third part deals with the reliability of electroretinographic response, in relation to changes in recording resistance, influence to previous exposure to sunlight, and lack of centrifugal control. In the fourth session the response of the eye to a step pattern of illumination is described in term. of the increment threshold for a small light patch added to the pattern at various distances from the illumination step.

1317

John Carroll U. [Dept. of Physics] Cleveland, Ohio.

LOW TEMPERATURE ELASTIC CONSTANTS OF POTASSIUM, by W. R. Marquardt and J. Trivisonno. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-1193) (AF AFOSR-65-862) AD 621606 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 273-278, 1965.

The adiabatic elastic constants of single crystal potassium were measured as a function of temperature from 195°K to 4.2°K by the ultrasonic pulse-echo technique. The measured elastic constants at 4.2°K (in units of 10^{10} dyn-cm^{-2}) are as follows: C = 2.86, C′ = 0.377, C_n = 6.65, and B_S = 3 66. The shear constants C and C′ are interpreted in terms of Fuchs' electrostatic contribution to the shear stiffnesses of the alkali metals Significantly, this work yields an elastic anisotropy, C/C′, at 4.2°K which is in agreement with Fuchs' theoretical calculation. The results are also compared to Bender's values of the elastic constants at 83°K and with Swenson's isothermal compressional data.

1318

[John Carroll U. Dept. of Physics, Cleveland, Ohio]

[MAGNETO-ACOUSTIC ABSORPTION IN SOLIDS] by J. Trivisonno. Final rept. [1965] 8p. incl. refs. (AFOSR-65-1483) (AF AFOSR-62-224) AD 621130 Unclassified

The elastic constants of 3 alkali metals were measured as a function of temperature. The ultrasonic pulse-echo technique was used to measure potassium in the temperature range 4.2° - 195°K and sodium in the range 78° - 300°K. Results were in good agreement with other published data. Single crystals of rubidium were grown by a modified Bridgeman technique in an argon atmosphere; elastic constants were not obtained, however, due to an inability to orient crystals by x-ray techniques. Magneto-acoustic measurements were made on crystals of potassium at 10, 30, and 50 mc/sec to obtain dimensions of Fermi surface; change in attenuation with magnetic field was also measured. Ultrasonic attenuation measurements were also conducted on magnesium single crystals at 10 - 290 mc/sec. A list of the publications and theses emanating from this grant are presented.

1319

Johns Hopkins U. Dept. of Biophysics, Baltimore, Md.

A DEMONSTRATION OF CODING DEGENERACY FOR LEUCINE IN THE SYNTHESIS OF PROTEIN, by B Weisblum, F Gonano and others [1965] [7]p incl diagrs. table, refs (AFOSR-65-0956) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1304, National Institutes of Health, and National Science Foundation) AD 617985 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 53: 328-334, Feb. 1965.

Different leucine sRNA's in E coli are separable by countercurrent distribution When these sRNA s are used as donors of labeled leucine during the synthesis of rabbit hemoglobin, in vitro, they distribute leucine differently into various peptides of the α-chain. One of the sRNA's introduces leucine only into a single position The results indicate that there are at least 2 distinct codons for leucine in the amino acid code.

1320

Johns Hopkins U. [Dept. of Chemistry] Baltimore, Md.

POLYMORPHISM IN HYDROGEN IODIDE, by F. A. Mauer, C. J. Keffer and others. [1965] [2]p. incl. table, refs. (AFOSR-65-1243) [AF 49(638)1430] AD 621656 Unclassified

Also published in Jour. Chem. Phys., v. 42: 1465-1466, Feb. 15, 1965.

The crystal structure of hydrogen iodide was investigated over the temperature range 4.2° - 180°K, using CuKα radiation, λ = 1.54051A. Values of the Bragg angle were plotted as a function of temperature in an effort to detect any anomaly in the thermal expansion. The results showed that the pattern obtained at temperatures up to at least 120°K could be indexed on the basis of a face-centered tetragonal cell; a face-centered cubic arrangement existed from 130 - 180°K, but at 180°K there was some splitting of lines presumably resulting from spottiness of the powder pattern caused by grain growth.

1321

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

FAR-INFRARED SPECTRUM OF TETRAHYDROFURAN· SPECTROSCOPIC EVIDENCE FOR PSEUDOROTATION, by W. J. Lafferty, D. W. Robinson and others. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-1644) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1430 and National Science Foundation) AD 624492 Unclassified

Also published in Jour Chem Phys., v. 42: 2915-2919, Apr. 15, 1965.

The infrared spectra of tetrahydrofuran and tetrahydrofuran-d_8 are reported between the limits 10 and 300 cm^{-1}. The rather complex spectrum obtained for this molecule is interpreted in terms of the theory of pseudorotation of a puckered ring. The spectroscopically derived value of the parameter mq_0^2 is (8.56 ± 0.13) x 10^{-40}g · cm^2 for the ground, ν = 0, radial state and (8 48 ± 0.15) x 10^{-40}g · cm^2 for the excited, ν = 1, radial state The conclusions drawn from the far-infrared spectra are quite consistent with the existing Raman and thermodynamic data.

1322

Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

OPTIMAL ESTIMATION OF INITIAL CONDITIONS FOR NUMERICAL PREDICTION, by R. H. Jones. [1965] [6]p. (AFOSR-66-0221) (AF 49(638)1302) AD 638835 Unclassified

Also published in Jour. Atmos. Sci., v. 22. 658-663, Nov. 1965.

A numerical-statistical forecasting method is presented in which statistical techniques are used on the errors of numerical predictions. This, in effect, uses earlier numerical predictions to obtain best estimates of the initial conditions. A technique is given whereby the method can be applied by estimating the necessary parameters, and it is shown that this procedure converges to the optimal estimate. (Contractor's abstract)

1323

Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

A REAPPRAISAL OF THE PERIODOGRAM IN SPECTRAL ANALYSIS, by R. H. Jones. [1965] [12]p. incl. diagrs. refs. (AFOSR-66-0264) (AF 49(638)-1302) AD 639016 Unclassified

Also published in Technometrics, v. 7: 531-542, Nov. 1965

The purpose of this paper is to revive interest in the periodogram approach to time series analysis which, at present, is only of historical interest and is seldom used. During the late 1940's, when it was realized that the smoothed periodogram could be used to estimate the spectral density of a stationary time series, the method was impractical because of the amount of computations. This is no longer the case, but not realized by many applied workers. In this paper the smoothed periodogram is considered from the point of view of its spectral window. The results are compared with two standard spectral windows by a method which avoids defining a bandwidth. The spectral windows are normalized so that they have the same variance, and plotted. The user can then choose the window which best suits his needs. Rejection filtering, trigonometric regression and cross-spectral analysis are discussed. An example is given in which the spectra and cross-spectrum of a bivariate time series are estimated. (Contractor's abstract)

1324

Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

AN EXPERIMENT IN NON-LINEAR PREDICTION, by R. H. Jones. [1965] 5p. incl. diagrs. (AFOSR-66-0656) (AF 49(638)1302) AD 639987 Unclassified

Published in Jour. Appl. Meteorol., v. 4 701-705, Dec. 1965.

The role of statistics in numerical weather prediction should be to aid in the handling of random errors and disturbances. The actual prediction is a problem in dynamics. When the initial conditions are observed with error, there is information in the past forecasts which could increase the accuracy of the numerical predictions. The techniques of control theory provide an optimal method for combining past forecasts with current observations. This paper demonstrates the method on simulated non-linear time series.

1325

Johns Hopkins U [Dept. of Mathematics] Baltimore, Md.

ON ISOMETRIC IMMERSIONS IN EUCLIDEAN SPACE OF MANIFOLDS WITH NON-NEGATIVE SECTIONAL CURVATURES, by P. Hartman. [1965] [16]p. (AFOSR-65-1969) [AF 49(638)1382] AD 626302 Unclassified

Also published in Trans. Amer. Math. Soc., v. 115: 94-109, Mar. 1965.

Isometric immersions of a complete d-dimensional manifold $M = M^d$ in a Euclidean space are considered. The following theorem is proved. Let $M = M^d$ be a complete Riemann manifold of class C^2 such that all 2-dimensional sections have non-negative curvatures. Let $\phi : M^d \to E^{d+\delta}$, $S = \phi(M^d)$ be a C^2 isometric immersion of M^d in $E^{d+\delta}$, $\delta > 0$, such that the relative nullity function ν is a positive constant. Then S is ν-cylindrical. The proof depends in part on a generalization, involving simultaneous gradient mappings, of the implicit function theorem, in the large, for gradient mappings presented in a former paper. The implicit function theorem is further generalized.

1326

Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

GENERALIZED LYAPUNOV FUNCTIONS AND FUNCTIONAL EQUATIONS, by P. Hartman. [1965] [19]p. (AFOSR-66-0266) [AF 49(638)1382] AD 638692 Unclassified

Also published in Ann. Matem., v. 69. 305-320, 1965.

Some results of Minty and Browder on the existence of solution of functional equations are generalized by replacing the notion of monotony by one involving a Lyapunov function. In the last section, analogous arguments are used to obtain an existence theorem for an initial value problem belonging to an ordinary differential equation on Hilbert space.

1327

Johns Hopkins U. Dept. of Mechanics, Baltimore, Md.

SELF-SIMILAR HYDRODYNAMICS WITH VORTEX SHEETS, by R. C. Alexander. June 1965, 118p. incl illus. diagrs. tables, refs (AFOSR-65-0642) (AF 49-(638)496) AD 620323 Unclassified

The problem of vortex sheets caused by the motion of sharp obstacles with respect to fluid may be treated with the aid of a similarity law. The subject is given further breadth by including the Helmholtz instability phenomenon. This is accomplished by posing a problem in which the plane interface of a 2-dimensional jet is subjected to a self-similar disturbance. Unity of the analysis is achieved by a semi-inverse approach which treats all problems asymptotically in the neighborhood of rolled-up vortex sheets, or as time $t \to \infty$. A suggested iterative technique for finding total solutions is given.

1328

Johns Hopkins U. Dept. of Mechanics, Baltimore, Md.

ON THE FLOW PAST A SEMI-INFINITE FLAT PLATE, by C. Kaplan. June 1965 [29]p. incl. diagrs. (AFOSR-65-0975) (AF 49(638)496) AD 623326 Unclassified

The Navier-Stokes equations for 2-dimensional flow are linearized around a dominant uniform stream velocity. The concept of field modes in fluid mechanics is then applied to the problem of viscous incompressible flow over a semi-infinite flat plate fixed in an unbounded uniform stream. One result is that the usual notion of a displacement thickness leads naturally to a displacement boundary beyond which the streamlines of the viscous flow past the flat plate are indistinguishable from the streamlines due to potential flow past this boundary.

1329

Johns Hopkins U. Dept. of Mechanics, Baltimore, Md.

THE HALL EFFECT IN THE TWO-DIMENSIONAL FLOW ALONG AN INSULATING PLANE, by H. Hasimoto and G. S. Janowitz. June 1965, 31p. incl. diagrs refs. (AFOSR-65-1201) (AF 49(638)496) AD 620324 Unclassified

Two-dimensional flow of a conducting gas interacting weakly with an external inhomogeneous magnetic field was considered. It was proven that for flow over an insulating wall, the total drag force is reduced by the Hall effect, and the total transverse force is zero. General expressions for the Hall current and the induced transversal flow are obtained for the case of flow with small Hall parameter over an infinite insulating plane. Examples are given for the dipole magnetic field. An inversion of the transversal flow, varying with the dipole orientation was found. It was suggested that there is a transversal deflection of the flow behind a magnetized body in the flow of a plasma. (Contractor's abstract)

1330

Johns Hopkins U. [Dept. of Mechanics] Baltimore, Md.

ELECTROGASDYNAMICS, by H. Hasimoto and S. Kuwabara. [1965] [10]p. incl. diagrs. tables. (In cooperation with Cornell U., Ithaca, N. Y., under AF AFOSR-64-399) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)496 and Ministry of Education of Japan) Unclassified

Published in Jour. Phys. Soc. Japan, v. 20: 859-868, May 1965.

Gasdynamic equations for an electrically charged gas are simplified on the basis of quasi-static approximation. Electrogasstatics of the charged gas on a sinusoidal insulator wall is studied for various external electric fields and polytropic indices. Irrotational steady 2-dimensional circulatory flow is also studied with special reference to the diameter of the vacuum core, which is shown to be increased in general by the electrostatic repulsion. (Contractor's abstract)

1331

Johns Hopkins U. [Dept. of Mechanics] Baltimore, Md.

GENERALIZED LARGE DEFORMATION BEHAVIOR FOR FACE-CENTERED CUBIC SOLIDS: NICKEL, ALUMINUM, GOLD, SILVER AND LEAD, by J. F. Bell. [1965] [22]p. incl. diagrs. tables, refs. (AFOSR-65-1738) (AF 49(638)1067) AD 625967 Unclassified

Also published in Philos. Mag., v. 11: 1135-1156, June 1965.

The stage III deformation of 318 single crystal tests of 40 experimentalists in aluminum, nickel, gold, silver, lead, and copper is quantitatively compared, through the Taylor aggregate theory, with a generalized linearly temperature-dependent stress-strain law for completely annealed polycrystals. From calculations dependent upon a knowledge of stage II parameters, and from independent direct stage III calculations, the single crystal deformation of these 6 f. c. c. metals is found to be in close agreement with prediction. This parabolic linearly temperature dependent stage III deformation is found to be independent of purity, of strain rate, of type of test, and of initial orientation when the resolved shear strain is calculated for single slip. The universal constant, $\tau_0 = 58.0$ Kg/mm^2, from the polycrystalline deformation is found to be determinable from the single crystal tests of all 6 metals at temperatures varying from 4.2°K to 1173°K, with single crystal parabolas grouped according to lattice spacing and atomic volume.

1332

Johns Hopkins U. [Dept. of Mechanics] Baltimore, Md.

THE DYNAMIC PLASTICITY OF METALS AT HIGH STRAIN RATES: AN EXPERIMENTAL GENERALIZATION, by J. F. Bell. [1965] 23p. incl. diagrs. tables, refs. (AFOSR-66-0336) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-1067, Army Research Office (Durham), and Ballistics Research Laboratories) AD 631388 Unclassified

Also published in Behavior of Materials under Dynamic Loading (ASME), Huffington, ed. by J. Norris, 1965, p. 19-41.

Extended quasi-static impact experiments and indirect dynamic impact experiments are critically compared with direct dynamic experiments. The success of the direct dynamic experiments in establishing the applicability of the finite amplitude wave theory to a variety of metals is described. The fact that in such direct experiments diffraction grating measurement of dynamic plastic strain and wave speeds in the symmetrical free-flight impact of polycrystals may be used to predict the stage III deformation of nearly 400 aluminum, copper, nickel, lead, gold, and silver crystals in the metal physics literature is evidence of the generality of these results. Recent experiments on initially work-hardened metals are discussed. These data include a brief description of the success of the writer's linearly temperature-dependent generalized parabolic stress-strain law governing strain rate independent finite amplitude wave propagation in predicting dynamic ultimate strength data of numerous earlier experimentalists. (Contractor's abstract)

1333

Johns Hopkins U. Dept. of Medicine, Baltimore, Md

DISTRIBUTION OF CORPUS CALLOSUM AND ANTERIOR COMMISSURE IN CAT AND RACCOON, by F. F. Ebner and R. E. Myers. [1965] [13]p. incl. diagrs. refs. (AFOSR-65-2743) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-61-38 and National Institutes of Health) AD 629560 Unclassified

Also published in Jour. Compar. Neurol., v. 124: 353-365, June 1965.

The distribution of the forebrain commissures was studied using the Nauta-Gygax silver technique. Following total forebrain commissure transaction in the cat the striate cortex or visual area I was remarkably free of degenerating fibers, while peristriate or visual area II showed dense degeneration. Somatic sensory arm and distal hindlimb areas appeared degeneration free while proximal leg and face areas revealed heavy degeneration. The somatic motor area of the anterior sigmoid gyrus contained dense numbers of degenerating fibers. The auditory areas of ectosylvian gyrus showed moderate degeneration over their entire surface except the most ventrally situated cortical areas which were degeneration free. Fibers from the corpus callosum also terminated in the dorsolateral portions of the head of the caudate nucleus. The anterior limb of anterior commissure distributed mainly to the inner granular layer of the olfactory bulb. In addition, it disseminated considerable numbers of fibers in the anterior olfactory nucleus. The accessory olfactory bulk was degeneration free. The distribution of the forebrain commissures in the raccoon was very similar to the cat. The outstanding feature of the commissural pattern in the raccoon was the total absence of degenerating fibers in the lobular complex relating to the digits of the forepaw. (Contractor's abstract)

1334

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

FREE-ION AND CRYSTALLINE SPECTRA OF Pr^{3+} (Pr IV), by H. M. Crosswhite, G. H. Dieke, and W. J. Carter. [1965] [8]p. incl. illus. tables, refs. (AFOSR-65-2804) [AF 49(638)1497] AD 628349 Unclassified

Also published in Jour. Chem. Phys., v. 43: 2047-2054, Sept. 15, 1965.

The spectrum of the free tripositive praseodymium ion (Pr IV) has been obtained under high resolution between 1200A and the infrared. The analysis has yielded all 49 levels of the four lowest configurations $4f^2$, 4f5d, 4f6s, 4f6p. A comparison with the crystal levels of Pr^{3+} in various lattices shows a depression of up to 5% in the anhydrous chlorides. (Contractor's abstract)

1335

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

SPECTRA OF DOUBLY AND TRIPLY IONIZED YTTERBIUM, Yb III AND Yb IV, by B. W Bryant. [1965] [9]p. incl. illus. diagrs. tables. (AFOSR-65-2875) (AF 49(638)1497) AD 629333 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 55: 771-779, July 1965.

The emission spectrum of ytterbium was photographed under varied conditions from 600 to 11,000A in order to obtain a complete description of the spectra of the doubly and triply ionized species. The main transition arrays of these species were identified, and where feasible, the analysis was carried through. All 41 energy levels, 28 odd and 13 even, belonging to the $4f^{14}$, $4f^{13}5d$, $4f^{13}6s$, $4f^{13}6p$, and $4f^{13}7s$ configurations of Yb III have been experimentally determined along with the appropriate quantum numbers. Eleven of 20 possible $4f^{13}6d$ levels and their quantum numbers have also been determined. Many Yb III levels are supported by intermediate coupling calculations. The ionization potential of Yb III was determined to be 25.4 ± 0.5 ev from the Rydberg formula. The two ^2F $4f^{13}$ levels of Yb IV have been determined in addition to 20 of a possible 107 $4f^{12}5d$ levels, of which a few are expected to be spurious. (Contractor's abstract)

1336

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

EXPERIMENTAL DETERMINATION OF BRANCHING RATIOS OF VECTOR MESONS INTO LEPTON PAIRS, by R. A. Zdanis, L. Madansky and others [1965] [4]p. incl. diagrs. table, refs. (AFOSR-65-1952) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-234, Atomic Energy Commission, and National Science Foundation) AD 626896 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 721-724, Apr. 26, 1965.

The decay of neutral vector mesons ($V^0 = \rho, \varphi, \omega$) into leptons ($l = \mu$ or e) are studied in the reation $\pi^- + p \rightarrow n + V^0$ with subsequent decay $V^0 \rightarrow l^+ + l^-$. The measured branching ratios in the present note are a factor of 10 lower than previously measured upper limits for electron decay. The experimental arrangement is described. A discussion is presented of the Monte Carlo generated, electron-pair events.

1337

Johns Hopkins U., [Dept. of Physics] Baltimore, Md.

SINGLE PARTICLE EXCHANGE IN 3 PARTICLE FINAL STATES OF THE REACTION K^+p AT 2.26 BEV/C, by F. Bomse, J. Cole and others. [1965] [20]p. incl. diagrs. (AFOSR-65-1953) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-234], Atomic Energy Commission, and National Science Foundation) AD 626786
Unclassified

Studies were made of the production differential cross sections and decay angular distributions of the K^* and N^* resonances produced in the reactions: $K^+P \rightarrow K^*P \rightarrow K^0\pi^+p$ and $K^+p \rightarrow N^*K^0 \rightarrow K^0\pi^+p$. The incident K meson laboratory momentum was 2.26 bev/c. The spin-space density matrix elements of the K^* and N^* were calculated. They indicate a strong preference for vector meson exchange in the production of both resonances. The N^* data is consistent also with the predictions of Stodolsky and Sakurai (Phys. Rev. Ltrs., v. 11, 90, 1963). Results of a study of the differential production cross sections incorporating absorptive effects in the single particle exchange model are also presented. (Contractor's abstract)

1338

Johns Hopkins U., [Dept. of Physics] Baltimore, Md.

SIX-PRONG π^-p INTERACTIONS AT 5.5 GEV/c (Abstract), by J. A. Cole, F. Bomse and others. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-234] and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10, 502, Apr. 26, 1965.

Six-prong interactions were analyzed from a sample of 50,000 pictures of 5.5-bev/c negative pions on protons exposed at the Brookhaven 80-in. hydrogen bubble chamber. A first scan of 20,000 pictures yielded 2966 six-prong events. In a preliminary analysis of the first 500 of these events, the beam momentum was found to be 5475 ± 5 mev/c with a half-width of 25 ± 5 mev/c. Details are presented.

1339

Kansas State U., Dept. of Chemical Engineering, Manhattan.

THE EFFECTS OF ELECTRICAL CONDUCTANCE OF WALL MAGNETOHYDRODYNAMIC CHANNEL FLOW WITH HEAT TRANSFER, by U.-P. Hwang, W. Tripp and others. [1965] [51]p. incl. diagrs. refs (Special rept. no. 52) (AFOSR-65-1312) (AF AFOSR-64-463) AD 619101 Unclassified

Also published in Kansas State U. Bull., v. 49, Mar. 1965.

The purpose of the report is to present the detailed as well as critical review of some mathematical and physical aspects of the MHD flow. This review should benefit the beginning investigators in this field. First, the details of the pioneering work by Hartmann and Lazarus on the subject of channel flow are described. The modified Hartmann flow with the electrical conductance of walls investigated by Chang and Lundgren, and by Chang and Yen are then reviewed. The effect of electrical conductance of the walls for both the thermally and hydrodynamically fully developed region was investigated very recently by Alpher, Yen, and Snyder. While their treatments are reviewed generally, only Snyder's approach is presented in detail.

1340

Kansas State U. [Dept. of Chemical Engineering] Manhattan.

FINITE DIFFERENCE ANALYSIS OF FORCED-CONVECTION HEAT TRANSFER IN ENTRANCE REGION OF A FLAT RECTANGULAR DUCT, by C.-L Hwang and L.-T. Fan [1965] [22]p. incl. diagrs. tables, refs. (AFOSR-65-1481) (AF AFOSR-64-463) AD 623199 Unclassified

Also published in Appl. Sci. Res., v. 13A: 401-422, 1965.

The laminar forced-convection heat transfer in the entrance region of a flat rectangular duct is studied. In this region temperature and velocity profiles are simultaneously developed. The basic governing equations of momentum, continuity, and energy are expressed in finite difference form and solved numerically by use of a high speed computer for a mesh network superimposed on the flow field. All fluid properties are assumed to be constant. The cases of uniform constant wall temperature and of uniform constant heat flux from wall to fluid are considered. Nusselt numbers are reported for Prandtl numbers in the range of 0.01 to 50. The exact solution of the energy equation obtained by means of the numerical method is compared with the results of approximate solutions.

1341

Kansas State U. [Dept. of Chemical Engineering] Manhattan.

EFFECTS OF VISCOUS DISSIPATION OF HEAT TRANSFER PARAMETERS FOR FLOW BETWEEN PARALLEL PLATES, by C.-L. Hwang, P. J. Knieper, and L.-T. Fan. [1965] [12]p. incl. diagrs. refs. (AFOSR-66-0056) (AF AFOSR-64-463) AD 632742 Unclassified

Also published in Zeitschr. Angew. Math. und Phys., v. 16: 599-610, Sept.-Oct. 1965.

In this investigation the effects of viscous dissipation on the temperature profile in the thermal entrance region between parallel plates are presented. The flow is laminar and the velocity profile is fully developed. The heat flux at the walls is considered constant. The heat generation parameter is introduced and its relation with Eckert number and Brinkman number is discussed. The derivation of the boundary condition that the constant of the heat flux at wall is equivalent to unity in dimensionless form, is presented in detail because such expression has never been presented in literature. The finite difference analysis and numerical method are presented in detail to show the application of Thomas method to the solution of the linear simultaneous equations derived from the energy equation. An advantage of Thomas method as compared with the usual matrix inversion method or Gaussian elimination method is the significant reduction in computer storage requirement and computing time.

1342

Kansas State U. [Dept. of Chemical Engineering] Manhattan.

HEAT TRANSFER TO AN MHD FLUID (Abstract), by L.-T. Fan and C.-L. Hwang. [1965] [2]p. (Bound with its AFOSR-65-1266; AD 622527) (AF AFOSR-64-463) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Research progress and future plans for analytical and numerical investigation of heat transfer accompanying the flow of a magnetohydrodynamic fluid between parallel plates are summarized, including, heat transfer accompanying the flow of an MHD fluid in the flat duct under the condition of the fully developed Hartmann velocity profile, forced-convection heat transfer accompanying the flow of a non-MHD fluid on the entrance region of a flat duct where the temperature and velocity develop simultaneously, and numerical values of various parameters of the forced convection heat transfer to an MHD fluid in the entrance region where both the velocity and temperature are not fully developed. A critical survey of the recent literature on the effects of the electrical conductance of walls on MHD flow and heat transfer was made. An analysis of the residence time distribution of a tracer in the MHD fluid flowing between parallel plates was made in order to study the dynamic and dispersion characteristics of the system.

1343

Kansas State U. Dept. of Chemistry, Manhattan.

THE REACTIONS OF METHYL- AND N-BUTYLLITHIUM WITH DICHLOROMETHYL METHYL ETHER AND DICHLORODIPHENOXYMETHANE, by R. N. McDonald and R. A. Krueger. [1965] [4]p. incl. refs. (AFOSR-66-0317) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-145 and National Science Foundation) AD 629683 Unclassified

Also published in Jour. Org. Chem., v. 30: 4372-4375, Dec. 1965.

Reaction of dichloromethyl methyl ether (I) with MeLi in the presence of isobutylene was in agreement with previously published work, but the treatment of I with BuLi gave Me 5-nonyl ether (II) and 6 butyl-5-decanone (III). Reduction of III with $LiAlH_4$ gave 6-butyl-5-decanol. A similar reaction of BuLi with dichloromethyl methyl ether gave II, III and $Bu_2C{:}C(OMe)Bu$ (IV). IV was considered as the precursor of III. Dichlorodiphenoxymethane with BuLi gave tetraphenoxyethylene V. V was also obtained when the reaction was run with MeLi.

1344

Kansas State U. Dept. of Chemistry, Manhattan.

NONBENZENOID AROMATIC SYSTEMS. I. SYNTHESIS OF 1-VINYLAZULENE AND CERTAIN SUBSTITUTED 1-VINYLAZULENES, by R. N. McDonald and W. S. Stewart. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-0537) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-145 and National Science Foundation) AD 61[illegible]91 Unclassified

Also published in Jour. Org. Chem., v. 30: 270-273, Jan. 1965.

One of the principal goals in these studies has been to determine the effects of an azulene ring system on a carbonium ion center. It is considered to be of interest to determine whether the effect of changing the site of the α-carbinyl carbonium ion is directly related to the calculated π-electron densities for this nonbenzenoid aromatic system. One approach to such studies is to follow the rates of addition of some acid, HA, to vinyl azulenes. The synthesis of 1-vinylazulene, cis- and trans-2-phenyl-1-vinylazulene, and trans-2-phenyl-3-vinylguaiazulene by the Wittig reaction are reported. Their physical and spectral properties, and their reactivities (or lack thereof) are discussed.

1345

Kansas State U. Dept. of Chemistry, Manhattan.

THE SYNTHESIS AND THERMAL DECOMPOSITION OF THE SODIUM SALTS OF SOME N'-(p-TOSYL)HYDRAZIMIDOCARBOXYLATE ESTERS, by R. N. McDonald and R. A. Krueger. [1965] [5]p. incl. tables, refs. (AFOSR-65-0883) (AF AFOSR-63-145) AD 617975 Unclassified

Also published in Tetrahedron Ltrs., v. 14: 857-861, Apr. 1965.

Diethoxycarbene is postulated, in the literature, as the intermediate in the preparation of alkoxycarbenes from the thermal decomposition of the [illegible]dium salt of diethyl N'-(p-tosyl)hydrazimidocarbonate. In this investigation, a convenient synthesis is presented for N'-(p-tosyl)-hydrazimidocarboxylate esters which are possible precursors to these carbenes, and the thermal decomposition of the sodium salts of 3 of these hydrazimidocarboxylate esters is examined.

1346

Kansas State U. [Dept. of Psychology] Manhattan.

TASK PREDICTABILITY IN THE ORGANIZATION, ACQUISITION, AND RETENTION OF TRACKING SKILL, by D. Trumbo, M. Noble and others. [1965] [12]p. incl. diagrs. refs. (AFOSR-65-2659) (AF AFOSR-62-17) AD 629566 Unclassified

Also published in Jour. Exper. Psychol., v. 70: 252-263, Sept. 1965.

Two hundred fifty male students were assigned to 4 conditions of task predictability, 3 retention intervals, and 2 levels of training in a 4 x 3 x 2 design. Predictability was determined by irregular step-function tasks that differed in the proportions of systematically repeating (predictable) targets, ranging from fixed to random sequences. Integrated absolute error served as a performance criterion. In addition, 6 indexes of temporal-spatial patterning were obtained. Results showed greatest improvement and greatest absolute retention losses for the fixed task and a fixed-direction task added to the design. Intermediately predictable tasks did not differ in error from the random task; however, differences in response organization were found among all tasks. Results suggest the nature of changes in response organization, and indicate that timing may be most crucial for acquiring and maintaining skill.

1347

Kansas State U. [Dept. of Psychology] Manhattan.

NUMBER OF ALTERNATIVES AND SEQUENCE LENGTH IN ACQUISITION OF A STEP-FUNCTION TRACKING TASK, by D. Trumbo, M. Noble, and L. Ulrich. [1965] [7]p. incl. diagr. table. (AFOSR-65-2668) (AF AFOSR-64-526) AD 629856 Unclassified

Also published in Perceptual and Motor Skills, v. 21: 563-569, Nov. 1965.

The roles of 2 task parameters, sequence length (N) and number of alternatives in the population from which the sequence was drawn (K), were examined in a tracking

task. The tasks were irregular step-function inputs wherein N was defined as the number of targets (steps) in a repeating sequence and K was defined as the number of alternative target positions. N and K were varied independently in a 3 x 3 factorial design with 9 Ss per cell. The major findings were that tracking performance, as measured by integrated error scores, is affected by increases in N, but not proportionately, while neither K nor the N x K interaction was significant. Relations of the results to verbal learning data are discussed.

1348

Kansas State U. [Dept. of Psychology] Manhattan.

VERBAL CODING AND DISPLAY CODING IN THE ACQUISITION AND RETENTION OF TRACKING SKILL, by D. Trumbo, L. Ulrich, and M. E. Noble. [1965] [8]p. incl. diagrs. table, refs. (AFOSR-66-1157) (AF AFOSR-64-526) AD 641623 Unclassified

Also published in Jour. Appl. Psychol., v. 49 368-375, Oct. 1965.

One-hundred twenty Ss were trained on a pursuit tracking task with an irregular step-function input. Cues for coding the task were introduced via pretraining and rehearsal of a numerical code and by display overlays in a 2 x 2 x 3 design, 3 levels of specificity of cues were provided by the overlays with the most specific condition providing a numerical code like that of pretraining. The results showed that both pretraining and display coding facilitated early reduction of tracking error, but that neither these nor rehearsal of the numerical code affected retention performance after 1 week. Taken together, these findings suggested that the verbal and display cues were used in the early coding of the task, but were less important later in practice and at retention.

1349

Kansas State U. [Dept. of Psychology] Manhattan.

ANALOG COMPUTER METHODS FOR SCORING CONTINUOUS PERFORMANCE RECORDS, by D. Trumbo and M. E. Noble. [1965] [8]p. incl. diagrs. (AFOSR-66-2093) (AF AFOSR-64-526) AD 642949 Unclassified

Also published in Perceptual and Motor Skills, v. 21 707-714, Dec. 1965.

Methods for scoring continuous records of tracking performance with analog signal correlator and frequency analysis systems are described. An index of lead-lag obtained from the correlator output is compared with discrete lead-lag scores obtained by hand scoring oscillographic records for three tasks which differ in amount of task coherence. The results indicate relatively high agreement between the two scoring methods and support the use of the correlator as the more efficient method. Sample data from the analog frequency analysis system are compared for operators with high and low integrated error scores. The results indicate consistently greater power in the response than in the input at the fundamental for both good and poor Ss, indicating a tendency to overshoot the target with the primary movement, but relatively more power in the initial odd harmonics for the better Ss. Ratios of target spectra to response spectra provide transfer functions for the human operator.

1350

Kansas U. Dept. of Chemistry, Lawrence

LOW TEMPERATURE VOLTAMMETRY AND ELECTRON PARAMAGNETIC RESONANCE STUDIES, by R. N. Adams. Final rept. [1965] [6]p. (AFOSR-65-0340) (AF AFOSR-62-14) AD 611806 Unclassified

A brief summary is given of EPR investigations involving radical ion intermediates in various electrode reactions. A bibliography of publications generated under the contract is included.

1351

Kansas U. Dept. of Chemistry, Lawrence.

THE PREPARATION AND INFRARED EXAMINATION OF THE 2-, 3-, and 4-CYANOPYRIDINE COMPLEXES OF COPPER(I), SILVER(I), AND GOLD(I) PERCHLORATES, by F. Farha, Jr. and R. T. Iwamoto. [1965] [5]p. incl. tables, refs. (AFOSR-65-1656) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-220 and Petroleum Research Fund) AD 624326 Unclassified

Also published in Inorg. Chem., v. 4 844-848, June 1965.

The preparation of the bis 2-, 3-, and 4-cyanopyridine complexes of copper(I), silver(I), and gold(I) perchlorates and the tris 3-cyanopyridine complex of silver(I) perchlorate is described. Because both the nitrile group and the pyridine group in the cyanopyridine are capable of coordinating strongly with these ions, the IR spectra of the complexes were examined to determine the coordination site of the metal ions. In 3- and 4-cyanopyridine, the metal ions are bound to the pyridine nitrogen, and in 2-cyanopyridine they are bound to the nitrile nitrogen.

1352

Kansas U. Dept. of Chemistry, Lawrence

MECHANISM OF INORGANIC REACTIONS, by R. T. Iwamoto. Final scientific rept. Oct. 15, 1965, 6p. incl. refs. (AFOSR-65-1913) (AF AFOSR-63-220) AD 626137 Unclassified

Under this project, information has been sought which is fundamental to understanding better the mechanism of inorganic oxidation-reduction reactions by the use of nonaqueous solvents and of electrodes in place of either the oxidant or the reductant. Contents include studies on the problem of comparing electromotive force series

in various solvents the nature of ion-solvent and ion-ion interactions, the determination of the formation constants of aquo-copper(II) complexes in acetone, anion solvation, the effect of the secondary solvation sphere, and the electrochemical behavior of a selected group of metal ions in acetic acid. Acetylacetone is found to be the only nonaqueous solvent examined in which copper (II) perchlorate is reduced in one step as in water.

1353

Kansas U. Dept. of Chemistry, Lawrence

COMPARISON OF THEORIES OF HEAT OF TRANSPORT AND THERMAL DIFFUSION WITH EXPERIMENTS ON THE CYCLOHEXANE-CARBON TETRACHLORIDE SYSTEM, by R. J. Bearman and F. H Horne. [1965] [5]p. incl. diagr. table, refs. (AFOSR-65-1258) (AF AFOSR-63-376) AD 621262
Unclassified

Also published in Jour. Chem. Phys., v. 42· 2015-2019, Mar. 15, 1965.

Theories of the heat of transport and the related thermal diffusion factor have been developed previously for nonelectrolyte solutions. The theories are compared with experimental results for the carbon tetrachloride-cyclohexane system Both theories represent adequate first approximations since they both predict the sign and magnitude of the experimental results without adjustment to experimental transport data.

1354

Kansas U. Dept. of Chemistry, Lawrence.

RADIAL DISTRIBUTION FUNCTIONS FOR MIXTURES OF HARD SPHERES, by G. J. Throop and R. J. Bearman. [1965] [6]p. incl. diagrs table. (AFOSR-65-1658) [AF AFOSR-63-376] AD 624328
Unclassified

Also published in Jour. Chem. Phys., v. 42 2838-2843, Apr. 15, 1965.

The exact solution of the Percus-Yevick equation for the radial distribution functions for a mixture of hard spheres is evaluated. The Laplace transforms found by Lebowitz are inverted numerically to obtain the radial distribution functions for a two-component mixture of hard spheres under varying conditions of size ratio, mol fraction, and number density Results are presented graphically. The distribution functions should portray valid information about the geometrical structure of fluid mixtures.

1355

Kansas U Dept. of Chemistry, Lawrence

NUMERICAL SOLUTIONS OF THE PERCUS-YEVICK EQUATION FOR THE HARD-SPHERE POTENTIAL, by G J Throop and R. J Bearman. [1965] [4]p incl. diagrs. tables, refs. (AFOSR-65-1659) (AF AFOSR-63-376) AD 624327
Unclassified

Also published in Jour. Chem. Phys., v 42· 2408-2411, Apr 1. 1965

The exact solution of the Percus-Yevick equation for the radial distribution function of a classical fluid of hard spheres found by Wertheim is evaluated numerically for a range of number densities Comparison is made with the radial distribution functions found using other integral equations and Monte Carlo calculations (Contractor's abstract)

1356

Kansas U Dept of Chemistry, Lawrence

PHOTOLYSIS STUDIES UTILIZING RADIOACTIVE TRACERS, by F S Rowland. Final technical rept Oct 1, 1961-Sept 30, 1965, 77p incl diagrs, tables, refs (AFOSR-67-1079) (AF AFOSR-64-535) AD 652282
Unclassified

The objective of the research was the attack on 2 important photochemical problems through the use of radioactive tracer techniques. These problems are (1) the reaction of methylene with olefins utilizing CHT from the photolysis of CHT CO, and (2) the reactions of energetic hydrogen atoms (2 8 ev) with alkanes, using T atoms from the photolysis of TBr Trace levels in bulk components was utilized. In addition, isotopic differences in the reactions themselves have been evaluated. The most important results of the research have depended heavily on the development of techniques for gas chromatographic separation of isotopic isomers of olefins and alkanes

1357

Kansas U Dept. of Chemistry, Lawrence

KINETIC ISOTOPE EFFECTS IN RECOIL TRITIUM REACTIONS THROUGH MEASUREMENT OF ISOTOPIC MOLECULE YIELDS, by E. K C. Lee, J. W Root, and F. S Rowland. [1965] [15]p. incl diagrs tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-534 and Atomic Energy Commission) Unclassified

Published in Chemical Effects of Nuclear Transformations Proc. of the Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformations, Vienna (Austria) (Dec 7-11, 1964), Vienna, International Atomic Energy Agency, v. 1 55-71, 1965

Direct gas chromatographic separation of isotopic tritiated molecules has made it possible to obtain new data on both the intermolecular and intramolecular kinetic isotope effects on the hot displacement reaction These data provide results for several new systems, as well as confirming some of the experimental isotope effects determined previously by indirect competition methods The intermolecular kinetic isotope effect in

atom displacement reactions 1h and 1d

$$T^* + CH_4 \rightarrow CH_3T + H \qquad 1h$$

$$T^* + CD_4 \rightarrow CD_3T + D \qquad 1d$$

has been shown to be 1 33 ± 0.04 for the ratio (CH_3T CH_4) (CD_3T CD_4) in experiments carried out in CH_4 - CD_4 mixtures. The intramolecular kinetic isotope effect in the replacement of an alkyl group by an energetic tritium atom has been shown to be 1.25 ± 0.04 for the ratio CH_3T/CD_3T from CH_3CD_3. The 4 isotopic isomer molecules of propylene-t have been separated by gas chromatography and a similar separation carried out for several other tritiated butenes. Application of this analytical method to the olefinic radioactive products from recoil tritium reactions with gaseous propane, isobutane, n-butane and neo-pentance has provided information about the origin of these products The propylene-t formed from reactions of tritium with propane is about half CH_2TCH CH_2, indicating that the primary mechanism of its formation is by secondary decomposition of an excited molecule, rather than by a simultaneous double displacement of 2H atoms The separation of the products C_2H_3T, C_2H_2DT, C_2HD_2T and C_2D_3T from recoil tritium reactions with CH_3CD_3 has shown the major yields to be only of the 2 molecules, C_2H_2DT and C_2HD_2T. The ratio of C_2HD_2T C_2H_2DT is about 1.6. Taken with the other experiments concerning the origin of tritiated olefins from alkanes, these results show an isotope effect in the elimination of HD from $CH_2TDC_3^*$ vs CH_3CD_2T. The probable explanation for this effect is related to the energy deposition in the replacement of H vs D in very high energy reactions.

1358

Karolinska Inst. Dept of Medical Physics, Stockholm (Sweden)

THE INSECT CORNEAL NIPPLE ARRAY, by C. G. Bernhard, W H. Miller, and A. R. Møller. [1965] [63]p incl. illus. diagrs. refs. (AFOSR-65-2730) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-13, National Institute of Neurological Diseases and Blindness and Swedish Medical Research Council) AD 627825 Unclassified

Also published in Acta Physiol. Scand., v. 63; Suppl. 243 9-79, 1965.

Also published in Gen. Systems v. 11, 63-91, 1966. (AFOSR-67-0913)

In electron microscopic studies it was found that the corneal surface of the facets of certain insect compound eyes is completely covered with congruent cone-shaped protuberances. This nipple array was found in different species of moths, butterflies, netflies, mosquitos, and caddisflies but not in species of bees, houseflies, and dragonflies. The function of this nipple array was elucidated by microwave experiments on scaled dielectric models and by spectrophotometric investigations on insect corneas. The results were confirmed by the application of a mathematical model. It is concluded that the nipple array acts as an impedance transformer to match the characteristic impedance (inverse of refractive index) of air to that of the lens material (chitin) and thus functions to decrease reflection from the corneal front surface and concomitantly increase the transmission of light through the cornea over a broad wavelength range. The biological significance of the nipple array for camouflage and increased visibility is discussed.

1359

Karolinska Inst. Dept. of Physiology, Stockholm (Sweden).

EFFECT OF DRUGS ON THE STORAGE GRANULES OF ADRENERGIC NERVES, by U. S. von Euler and F. Lishajko. [1965] [15]p. incl. diagrs. tables, refs. (AFOSR-65-1541) (AF EOAR-62-14) AD 624007 Unclassified

Also published in Pharmacology of Cholinergic and Adrenergic Transmission; Proc. Second Internat'l. Pharmacol. Meeting, Prague (Czechoslovakia) (Aug. 20-23, 1963), New York, Pergamon Press, 1965, p. 245-260.

A number of drugs have been tested on the spontaneous NA-release rate in isolated adrenergic nerve granules and on the ATP-dependent uptake of NA. The spontaneous loss of NA from granules is prevented or inhibited by NA (0.05-0 1 mm) and by ATP (1-5 mm) owing to NA-uptake balancing the release. ATP also has a marked protective effect. The L-isomer of NA is more active than the D-isomer in this respect, suggesting a preferential storage of the L-isomer.

1360

Karolinska Inst. [Dept. of Physiology] Stockholm (Sweden).

[DISTRIBUTION OF BIOLOGICAL ACTIVE COMPOUNDS IN THE BODY] by U. S. von Euler. Final rept. Feb. 28, 1965, 6p. (AFOSR-65-0670) (AF EOAR-64-31) AD 615628 Unclassified

Investigation has largely centered around the uptake, storage, and release of catecholamines in the sympathetic nerves and studies on the mechanism of adrenergic nerve transmission. This report summarizes papers prepared during the study on (1) Some morphological features of catecholamine storing nerve vesicles, (2) Free and bound noradrenaline in the rabbit heart, (3) Uptake of catecholamines by the hearts of rabbits treated with Segontin; (4) Uptake and exchange of catecholamines in rat tissues after administration of d- and l-adrenaline, (5) Effect of nicotine and nicotine analogues on tissue and urinary catecholamines in the rat, and (6) On the occurrence of tyramine in the rabbit brain. The Symposium, 'Mechanisms of Release of Biogenic Amines" is also mentioned.

1361

Karolinska Inst. Dept. of Physiology, Stockholm (Sweden).

UPTAKE OF CATECHOLAMINES BY THE HEARTS OF RABBITS TREATED WITH SEGONTIN, by B. R. MacKenna. [1965] [10]p. incl. diagrs. table, refs. (AFOSR-65-1550) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-31 and Swedish Medical Research Council) AD 623374 Unclassified

Also published in Acta Physiol. Scand., v. 63 413-422, 1965.

A single i. v. injection of 8 mg/kg of Segontin caused a fall in the NA content of rabbit hearts to approx 8% of their normal value in 2 hr. After 4 hr the tissue content of NA started to rise again, and after 24 hr it had recovered to approx.1/3 of its normal value. An i. m. injection of 0.75 mg/kg NA 2 hr after Segontin treatment caused a temporary rise in the NA content of the heart to the normal value. NA was increased in the coarse particle fraction, the high speed sediment, and in the particle free supernatant fraction of the heart after homogenization, indicating that the exogenous NA was temporarily filling the available storage sites. An i. v. infusion of NA caused an uptake of NA into the heart previously depleted by Segontin, followed by a rapid and then slower release of the NA. The uptake of l-NA and d-NA and also of l-A and d-A showed stereochemical specificity in favor of the l-isomers. Phenoxybenzamine blocked the uptake of NA into the heart of rabbits depleted by Segontin, whereas dichlorisoproterenol had only a small blocking effect. Phenoxybenzamine by itself reduced the NA content of all fractions of the heart.

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Karolinska Inst. Dept. of Physiology, Stockholm (Sweden).

UPTAKE AND EXCHANGE OF CATECHOLAMINES IN RAT TISSUES AFTER ADMINISTRATION OF d- AND l-ADRENALINE, by T. C. Westfall. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-65-1551) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-31, National Institutes of Health, and Swedish Medical Research Council) AD 623373 Unclassified

Also published in Acta Physiol. Scand., v. 63 336-342, 1965.

The effect of d- and l-adrenaline (A) on the catecholamine (CA) content of heart and liver of the rat was studied at various times following i. m. administration. It was observed that both isomers are readily taken up by these tissues and exchanged for the normal neurotransmitter, noradrenaline (NA). The present experiments also present evidence for the uptake of both d- and l-NA into subcellular storage granules. The fall in the NA content of the organs was accompanied by an increased urinary excretion of NA. A slight steric preference for the storage in favor of the l-isomer is also shown.

1363

Karolinska Inst. Dept of Physiology, Stockholm (Sweden)

EFFECT OF NICOTINE AND NICOTINE ANALOGUES ON TISSUE AND URINARY CATECHOLAMINES IN THE RAT, by T. C Westfall [1965] [7]p incl diagrs table, refs (AFOSR-65-2522) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-31, National Heart Institute, and Swedish Tobacco Co.) AD 627548 Unclassified

Also published in Acta Physiol Scand., v 63 77-83, 1965.

The time response pattern of nicotine and the nicotine analogue 3-pyrrolidine-methyl-pyridine (W-16) on the noradrenaline (NA) content of heart, spleen, kidney and liver was studied following intraperitoneal administration in rats. It was found that both compounds produced a transient but significant decrease Nicotine produced an effect that was visible within 5 min with the NA content returning to control levels in 60-180 min. Although quantitatively different, W-16 produced an effect qualitatively similar to nicotine The effect of nicotine and several nicotine analogues on the 24-hr urinary excretion of catecholamines was also studied in rats Three out of four analogues investigated produced a slight increase in the excretion of adrenaline (A) and NA at high dose levels (5-10 mg/kg) At a dose of 1 mg/kg, nicotine produced a significant increase in the 24 hr urinary excretion of A but not NA

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Karolinska Inst. Dept. of Physiology, Stockholm (Sweden)

FREE AND BOUND NORADRENALINE IN THE RABBIT HEART, by U S von Euler and F Lishajko [1965] [4]p. incl. illus table, refs (AFOSR-65-2523) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-31 and Swedish Medical Research Council) AD 627549 Unclassified

Also published in Nature, v 205 179-180, Jan 9, 1965

The results show that the proportion of vesicle-bound NA in the terminal parts of the axons is considerably higher than that in the pre-terminal parts and that the proportions of NA in the high-speed sediment and in the soluble fractions of the homogenized rabbit heart was approximately constant and independent of the total amount of NA in the organ, suggesting a state of equilibrium between these fractions.

1365

Karolinska Inst Dept. of Physiology, Stockholm (Sweden)

ON THE OCCURRENCE OF TYRAMINE IN THE RABBIT BRAIN, by L -M Gunne and J Jonsson [1965] [6]p incl diagrs refs (AFOSR-66-1125) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-31 and Swedish Scientific Research Council) AD 639538 Unclassified

Also published in Acta Physiol. Scand., v. 64: 434-438, 1965.

After chromatographic separation on a strong cation exchange resin no tyramine could be detected in an extract of 6 pooled rabbit brains. This indicates that the whole brain content of tyramine must be below 10 ng/g wet tissue weight. This observation does not support the concept that tyramine should be an important metabolic precursor of noradrenaline in the brain.

1366

Karolinska Inst. Dept. of Physiology, Stockholm (Sweden)

UPTAKE OF CATECHOLAMINES IN THE RABBIT HEART AFTER DEPLETION WITH DECABORANE, by U. S. von Euler and F. Lishajko. [1965] [4]p. incl. tables, refs. (AFOSR-65-1553) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-52 and Swedish Medical Research Council)
AD 622770 Unclassified

Also published in Life Sci., v. 4: 969-972, 1965.

After 80 - 90% depletion of the rabbit heart with decaborane, injection of noradrenaline (NA) causes an increase of the amine content to near normal values. The amines taken up show normal distribution between the high speed sediment and supernatant, indicating a dynamic equilibrium between the particulate and the supernatant fractions. The amines taken up leave the heart gradually in approx. 20 hr. When either the l- or d-isomer of adrenaline (A) is injected together with l-NA, 2 - 3 times more of l-A than of d-A is taken up for the same amount of l-NA. The 2 isomers appear to leave the stores at a similar rate.

1367

Karolinska Inst. Dept. of Physiology, Stockholm (Sweden)

THE ADRENERGIC INNERVATION OF THE VAS DEFERENS AND THE ACCESSORY MALE GENITAL GLANDS, by N. O. Sjostrand. [1965] [82]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1919) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-52 and Swedish Medical Research Council)
AD 626660 Unclassified

Also published in Acta Physiol. Scand., Suppl., 257, v. 65: 1-82, 1965.

The adrenergic innervation of the vas deferens and the accessory male glands of some mammals, and the presence of adrenaline and chromaffin cells in these organs were investigated. The results are presented in 3 sections. (1) The effect of ganglionic blocking agents on the motor response of the isolated guinea-pig vas deferens to hypogastric nerve stimulation. (2) The catecholamine content of the accessory male genital organs of different species and the effect of sympathetic denervation upon this content. and (3) The cellular localization of the catecholamines. From the results it is concluded that: (1) The vas deferens and the accessory male genital glands of the examined species – in contrast to the general pattern of adrenergic innervation in mammals – are innervated by short adrenergic neurons and have an exceptionally rich adrenergic innervation, and (2) Adrenaline in the internal male genital organs is mainly stored in "chromaffin" cells.

1368

Karolinska Inst., Dept. of Physiology, Stockholm (Sweden).

STEREOSPECIFIC CATECHOLAMINE UPTAKE IN RABBIT HEARTS DEPLETED BY DECABORANE, by U. S. von Euler and F. Lishajko. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-2050) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-52 and Swedish Medical Research Council)
AD 627476 Unclassified

Also published in Internat'l. Jour. Neuropharmacol., v. 4: 273-280, Sept., 1965.

After 80 - 90% depletion of its noradrenaline (NA) content following decaborane, the rabbit heart may take up both NA and A to the normal capacity upon injection of amines. The amines taken up are well retained for several hr, but gradually disappear in the course of about 20 hr. The high speed sediment and supernatant of a homogenate of the heart contain approximately constant proportions of NA, irrespective of the total amount, indicating a dynamic equilibrium between these pools. When the D- or the L-isomer of A are given together with L-NA, simultaneously and in equal amounts, the uptake of L-A is 2 - 3 times larger than that of D-A, relative to the uptake of L-NA. This ratio is unchanged over a period of from 1 min-4 hr after the injection of the amine mixture. It is suggested that the uptake is partly stereospecific but that once taken up in the specific stores, the L- and D-isomer are released at approximately the same rate.

1369

Karolinska Inst. Dept. of Physiology, Stockholm (Sweden)

REFILING OF NORADRENALINE STORES IN THE PRINYLAMINE-DEPLETED RABBIT HEART AFTER INJECTION OF OCTOPAMINE AND TYRAMINE, by U. S. von Euler and F. Lishajko. [1965] [4]p. incl. diagr. (AFOSR-65-2051) (AF EOAR-65-52)
AD 627473 Unclassified

Also published in Life Sci., v. 4: 1421-1424, 1965.

Under normal conditions only small amounts of octopamine or tyramine are converted to noradrenaline (NA) in vivo or in the isolated perfused heart. After depletion of the stores with prenylamine, it is found that both these amines are capable of rapidly restoring the NA content in the rabbit heart to a considerable extent. Similar refilling effects were observed with dopamine, phenylethylamine, l-dopa and l-tyrosine but not with phenylalanine. Synephrine caused a refilling with noradrenaline and adrenaline. It is assumed that the amines studied could act partly by being converted to noradrenaline, not only by releasing performed transmitter.

1370

Karolinska Inst. Dept. of Physiology, Stockholm (Sweden)

DISTRIBUTION AND FUNCTION OF ADRENERGIC NERVES IN THE RABBIT FALLOPIAN TUBE, by J. Brundin. [1965] [53]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2510) (AF EOAR-65-52) AD 628115 Unclassified

Also published in Acta Physiol. Scand., Suppl 259, v. 66: 5-57, 1965.

The distribution and function of the adrenergic nerves in the rabbit oviduct were studied by several experimental procedures. Catecholamine estimations revealed high amounts in the ampulla-infundibulum, indicating that the adrenergic innervation was rich in the isthmus and sparse in the rest of the organ. Pretreatment with estrogen and progesterone did not alter the oviduct content of noradrenaline but influenced the weight of the organ. In non-mated estrous and anestrous rabbits a mean isthmic opening pressure of about 30 mm Hg indicated that the isthmus was actively closed. Electrical stimulation of the hypogastric nerves immediately below the inferior mesenteric ganglia increased the opening pressure of the isthmus The various degrees of constriction in the isthmus, obtained at different stimulation frequencies, could be reproduced by different doses of noradrenaline injections. The similarity of the distribution of adrenergic nerves in the rabbit oviduct and in the human Fallopian tube is pointed out on the basis of certain functional gynecological disorders

1371

Karolinska Inst. Dept of Physiology, Stockholm (Sweden)

RELEASE OF CARDIAC NORADRENALINE BY DECABORANE IN THE HEART-LUNG PREPARATION OF GUINEA PIG, by A Oliverio [1965] [6]p. incl diagr. table (AFOSR-66-0790) (AF EOAR-65-52) AD 633331 Unclassified

Also published in Biochem. Pharmacol., v 14: 1689-1692, Nov. 1965.

Merrit et al reported the ability of decaborane ($B_{10}H_{14}$) to deplete noradrenaline from the rat brain. Recently Euler and Lishajko have found that decaborane (10^{-5}M) releases catecholamines from isolated adrenergic nerve granules A striking decrease of the noradrenaline content in the rabbit organs 24-48 hr after the administration of 4 mg/kg of this drug has been shown by the same authors. The depletion of the heart catecholamines was found to be 80-90%. The action of decaborane was previously studied in vivo by i.p or s.c. administration. With this procedure it is difficult to follow the first phase of the depletion process In an attempt to gain further information on the problem the effects of acute administration of decaborane on the release of ^{3}H noradrenaline from the heart were studied using the heart-lung preparation of guinea pig.

1372

Karolinska Inst Dept. of Physiology, Stockholm (Sweden)

CATECHOLAMINE DEPLETION AND UPTAKE IN ADRENERGIC NERVE VESICLES AND IN RABBIT ORGANS AFTER DECABORANE, by U S von Euler and F. Lishajko. [1965] [8]p. incl diagrs table, refs. (AFOSR-66-0998) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-52, National Institutes of Health, and Swedish Medical Research Council) AD 634551 Unclassified

Also published in Acta Physiol Scand., v 65: 324-330, 1965.

Decaborane ($B_{10}H_{14}$) increases the release rate of noradrenaline (NA) from isolated nerve vesicles in concentrations of 10^{-5}M and stronger. The NA retention in nerve vesicles incubated in the presence of NA and of ATP is decreased by decaborane 10^{-4}M, which also inhibits the ATP_4-dependent NA uptake in partially depleted vesicles In a dose of 4 mg kg i p decaborane gradually decreases the catecholamine stores in various organs of the rabbit Between 24-48 hr after the decaborane injection the NA content in the heart is about 10-20% of the normal value Injection of NA, 0.3 - 0.4 mg/kg i.m., increases the NA content in the heart to near normal in 1-2 hr, whereafter it falls to the previous low value in some 20 hr. The NA taken up by the rabbit heart after depletion with decaborane is distributed between the high speed sediment and the supernatant in the same proportions as found in the normal heart suggesting a dynamic equilibrium between the vesicles and the non-vesicular pool

1373

Karolinska Inst Dept of Physiology, Stockholm (Sweden).

ADRENOMEDULLARY RESPONSE TO 2-DEOXYGLUCOSE IN THE HYPOTHYROID, EUTHYROID, AND HYPERTHYROID RAT, by D G Johnson [1965] [7]p. incl diagrs table, refs. (AFOSR-66-1000) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-52, Public Health Service, and Swedish Medical Research Council) AD 634580 Unclassified

Also published in Acta Physiol. Scand., v 65: 337-343, 1965.

Hypothyroid animals show an increased hyperglycemic response to 2-deoxyglucose (2-DG) administration, while hyperthyroid animals show a decreased response when compared to euthyroid controls This quantitative difference in response is reflected in a much greater depletion of the adrenaline content of the adrenals of the hypothyroid animals, while the hyperthyroid animals appear less depleted than euthyroid controls Estimation of urinary catecholamine excretion following 2-DG administration indicates that the hypothyroid rats excrete much larger amounts of adrenaline than the other groups The hearts of all animals treated with 2-DG contain increased absolute and relative amounts of adrenaline, with the largest absolute increase being seen in the

hyperthyroid animals. These results suggest that the adrenomedullary response to cellular glucopenia is modified by the thyroid status This action may be exerted either at the level of the adrenal medulla itself or on the blood glucose receptor neurons of the hypothalamus

1374

Karolinska Inst Dept. of Physiology, Stockholm (Sweden).

ACCELERATION OF NORADRENALINE TURNOVER IN THE MOUSE HEART BY COLD EXPOSURE, by A. Oliverio and L Stjarne [1965] [5]p. incl diagrs refs. (AFOSR-66-1126) (AF EOAR-65-52) AD 639827 Unclassified

Also published in Life Sci., v. 4: 2339-2343, 1965.

The rate of disappearance of tritiated noradrenaline (^{3}H-NA) from the hearts of mice was markedly increased by cold exposure This indicates that local NA synthesis in the sympathetic nerves of the heart may be feed-back regulated by changes in nervous activity However, even the severest tolerable cold-exposure accelerated the NA disappearance rate, and thus possibly NA synthesis, at the most 2-3-fold Since cold exposure may not be an adequate stimulus to produce a maximum activity in the cardio-accelerator nerves, it is conceivable that other types of stimulation might further accelerate the NA turnover in the heart

1375

Keele U Dept of Communication (Gt. Brit.)

APERIODIC STIMULUS PRESENTATION WITH A CLOSED-LOOP MAGNETIC TAPE AVERAGING SYSTEM, by D. A Jeffreys and D M MacKay [1965] [3]p (AFOSR-66-0738) (AF EOAR-63-16) AD 633325 Unclassified

Also published in Electroencephalog and Clin Neurophysiol., v. 19 404-406, Oct 1965

A simple triggered circuit has been developed to produce near-randomly variable delays of the order of msec to seconds It requires only one valve, an ordinary post-office type relay and a transformer A description is given of the use of the device to permit aperiodic loop of magnetic tape

1376

Kent State U Dept of Chemistry, Ohio

PURE ACETIC ACID AND ACETIC ANHYDRIDE AND THE ELECTRICAL CONDUCTANCE AND DIELECTRIC CONSTANT OF THIS SYSTEM, by R. T Myers. [1965] [3]p incl. diagr table. (AFOSR-65-0677) (AF 49(638)641) AD 614755 Unclassified

Also published in Jour. Phys Chem., v. 69: 700-702, Feb 1965

Acetic anhydride was used in the purification of acetic acid, and the effects of added acetic anhydride on the properties of the acid were studied. The density, electrical conductance, and dielectric constant of the system of acetic acid-acetic anhydride are reported along with simple but novel methods of purifying these substances.

1377

Kentucky U. [Dept. of Physics] Lexington.

HYPOTHESIS OF ORBITAL OVERLAP SHIFTING, by L. Gildart. [1965] [2]p incl. refs. [AF 49(638)90] Unclassified

Published in Jour. Appl. Phys., v 36: 335-336, Jan. 1965.

A description of the action of the stibnite solid state switch (formed from Sb_2S_3 doped with 1% Sb) is given. The action is interpreted in terms of the hypothesis that the conduction process in semiconductors should alter as the orbitals of the donors begin to overlap.

1378

[Kentucky U Research Foundation Dept. of Engineering Mechanics, Lexington]

ON THE STATIC RESPONSE OF ANNEALED ALUMINUM, by M. J Kenig and O W Dillon, Jr [1965] [9]p incl. diagrs. table, refs (AFOSR-67-2447) (AF 49(638)1306) AD 660386 Unclassified

Presented at Ninth Midwestern Mechanics Conf. Wisconsin U., Madison, Aug 16-18, 1965.

Experimental data on biaxially stressed, commercially pure (1100 alloy) annealed aluminum loaded in tension and torsion are presented Very slow loading is used so that the duration of each test is about 6 weeks. The first derivative of the resulting stress-strain relation is discontinuous. At discrete values of the average stress small increases in load cause large irreversible changes in strain. At these stresses, the material is said to be mechanically unstable. The main point of this paper is the demonstration that at unstable loads a single "yield surface" in stress space corresponds to two surfaces in strain space Therefore, compliances used in incremental theories of plasticity are discontinuous and the regions of applicability of such theories are restricted

1379

Laval U., Quebec (Canada)

[AUTORADIOGRAPHIC STUDY OF H3-PROLINE INCORPORATION BY THE BASOPHILE CELLS OF RAT ADENOHYPOPHYSIS] Etude autoradiographique de l'incorporation de la proline tritiée par les cellules basophiles de l'adenohypophyse du rat, by S Ducommun. [1965] [8]p. incl. illus. diagrs. tables, refs. (AFOSR-66-0962) (AF AFOSR-64-511) AD 635438
Unclassified

Also published in Ann. Endocrinol. (Paris), v. 26: 385-392, Aug. 1965.

Kopriwa and Leblond's autoradiographic procedure was successfully adapted to the study of the basophil cells of the rat adenohypophysis under the following conditions: I P injection of 1 microcurie of H3-proline/g, B.W., 4 u sections of appropriately fixed and embedded pituitaries stained with P A S and coated with a photographic emulsion, counting of individual silver grains, after 30 days of exposure, in the emulsion overlying the whole adenohypophysis, as well as in the thyrotroph and gonadotroph cells In material from intact animals the incorporation of H3-proline, rapid during the first hr after the injection, slows down to a relatively constant rate during the subsequent 17 hr Thyroidectomy, performed 4 weeks prior to the injection, resulted in markedly enhanced incorporation of the tritiated amino acid by the thyrotrophs, and in depressed incorporation by the gonadotrophs. These changes are interpreted in terms of altered synthesis of the corresponding pituitary hormones.

1380

Laval U., Quebec (Canada)

NEUROHUMORAL CONTROL OF THYROTROPIC ACTIVITY, by C. Fortier. Final technical rept. Oct 1, 1963-Sept 30, 1965 [23]p. incl. diagr refs. (AFOSR-66-1476) (AF AFOSR-64-511) AD 636083
Unclassified

Studies on the levels of interaction between ACTH, TSH, corticosteroid and thyroid hormones are described.

1381

Laval U , Quebec (Canada).

PITUITARY-THYROID-ADRENOCORTICAL INTERACTIONS DURING COLD EXPOSURE IN THE RAT (Abstract), by M Jobin and C. Fortier [1965] [1]p (AFOSR-66-2471) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-511 and Medical Research Council) AI 643139
Unclassified

Also published in Federation Proc., v. 24, Mar.-Apr. 1965.

The effect of cold on the activity of the 3 glands was studied by concurrent assays of pituitary and plasma Thyroid Stimulating Hormone, plasma thyroxine and plasma corticosterone In short term studies, temperatures from 13 C to -10 C caused increased TSH secretion and progressively greater corticosterone responses Intervals from 2 5 min to 64 days were then used for a detailed study of acute and long-term changes following continuous exposure to 5 C Plasma TSH reached an initial peak at 40 min, a second at 12 hr, and then remained slightly elevated Depletion of pituitary TSH after 1 day gave way to supernormal concentrations after 5 days followed by a return to normal A significant rise in plasma thyroxine was not recorded before 24 hr; longer exposure led to low levels (60-70%), suggesting increased inactivation or decreased binding of T-4 to plasma proteins Maximum plasma corticosterone was reached in 20 min Slightly elevated values, seen after a few days, gradually returned to normal The 40 min plasma TSH response was unaltered by prior adrenalectomy High post-thyroidectomy levels were further increased at 5 C

1382

Laval U , Quebec (Canada).

TWO METHODS FOR DETERMINING THE CORTICOSTERONE-BINDING CHARACTERISTICS OF TRANSCORTIN (Abstract), by F. Labrie, M. Norman and others. [1965] [1]p (AFOSR-66-2468) (AF AFOSR-65-511) AD 643250
Unclassified

Presented at Eighth annual meeting of the Canad. Fed Biol Soc., Ottawa U., Ontario (Canada), June 9-11, 1965

Also published in Proc Canad Fed. Biol Soc., v 8: 40, 1965

Thyroxine-induced enhancement of plasma corticosterone binding by transcortin was evidenced, in previous studies, by equilibrium dialysis and gelfiltration The binding capacity of transcortin being a function of the total number of its binding sites (NS_t), and of its association constant (K_t), the observed effect of thyroxine was analyzed in these terms by two related methods respectively involving combined dialysis and gel-filtration, and dialysis alone for determining the equilibrium of corticosterone with plasma proteins for increasing concentrations of the steroid. Graphic solution of the first method was obtained from the regression of the reciprocals of the transcortin-bound corticosterone concentrations over the reciprocals of the unbound corticosterone concentrations, the slope corresponding to $1/K_t$; and the intercept on the 'Y' axis, to $1/K_tNS_t$ For the second approach, the total corticosterone concentration was plotted vs the unbound moiety. The slope of the rectilinear component of the resulting curve gave the ratio of albumin-bound corticosterone to its unbound moiety Extrapolation of this linear component to the 'Y' axis yielded NS_t, whereas $1/K_t$ was obtained by extending to the 'X' axis a perpendicular dropped from the intercept of the curve by a line parallel to its linear component and originating at $NS_t \cdot 2$ on the 'Y' axis. Similar results were obtained by the 2 methods, showing a markedly predominant effect of thyroxine on the number of binding-sites of transcortin

1383

Lawrence U. Dept. of Chemistry, Appleton, Wis.

SURFACE STATES IN PURE PALLADIUM, by R W. Zuehlke Final rept. Oct 1, 1962-Mar. 1, 1965 July 1965 [15]p incl. diagrs. refs. (AFOSR-65-1482) (AF AFOSR-63-114) AD 623341 Unclassified

Magnetic susceptibility studies on small crystal (112A - 500A) palladium blacks and studies of the interaction of adsorbed nitric oxide with palladium surfaces through magnetic susceptibility and standard adsorption techniques have been made. The observed dependence of the magnetic susceptibility of palladium on particle size is consistent with a postulate of a band of electronic surface states lying slightly above the bulk 4-d band. Sorption studies indicate that nitric oxide is adsorbed at room temperatures to slightly more than monolayer coverage in both a physisorbed and a weakly energetic chemisorbed state. In addition, a complex cooperative electronic rearrangement apparently occurs over a small temperature range around room temperature and at monolayer coverage. (Contractor's abstract)

1384

Lehigh U. Center for the Information Sciences, Bethlehem, Pa.

COMPUTATIONAL, PHONOLOGICAL AND MORPHOLOGICAL LINGUISTICS AND RETRIEVAL STUDIES. GRAMMARS AND TEXT ANALYSIS, by D. J. Hillman. Aug. 23, 1965, 20p incl. refs. (Rept no. 1) (AFOSR-65-1892) (AF AFOSR-65-724) AD 621128 Unclassified

The role of grammatical analysis in processing text for document and message retrieval is explored and certain requirements are formulated. The utility of transformational grammars in text analysis is examined by considering whether transformations are (a) meaning-preserving, (b) truth preserving, and (c) information preserving. The inquiry reveals that transformations themselves do not preserve meaning, truth, or information content. Such grammars provoke methodological irrelevancies, leading to a strong negative recommendation concerning their use in text processing. It is suggested that questions of structure for document and message retrieval be explored from a different point of view which combines approaches from statistics, syntax, and semantics. Criteria for measuring the simplicity of a grammatical model are discussed (Contractor's abstract)

1385

Lehigh U. [Dept. of Mathematics] Bethlehem, Pa.

VECTOR FIELDS AND INFINITESIMAL TRANSFORMATIONS ON ALMOST-HERMITIAN MANIFOLDS WITH BOUNDARY, by A. L. Hilt and C.-C Hsiung. [1965] [26]p. incl. refs. (AFOSR-65-1035) (AF 49(638)1009) AD 619352 Unclassified

Also published in Canad. Jour. Math., v. 17: 213-238, Mar.-Apr. 1965.

An investigation is made of vector fields and infinitesimal transformations on almost-Hermitian manifolds with boundary. Riemannian manifolds are considered, as well as Lie derivatives over the manifolds, local boundary geodesic co-ordinates, and integral formulas. A Killing vector field on a compact orientable Riemannian manifold is discussed, and almost-Hermitian, almost-semi-Kählerian, and almost-Kählerian structures are defined. Contravariant analytic vector fields are given consideration on an almost-Hermitian manifold M^n with boundary B^{n-1}, together with their relations to Killing, projective Killing, and conformal Killing vector fields. Covariant analytic vector fields on an almost-Hermitian manifold with boundary are studied as well as vector fields on an almost-Kählerian manifold with boundary.

1386

Leicester U. Dept. of Biochemistry (Gt. Brit.).

THE METABOLISM OF SIMPLE CARBON COMPOUNDS IN MICRO-ORGANISMS, by H. L. Kornberg. Final rept. Jan. 1, 1965, 22p. incl. refs. (AFOSR-65-0665) (AF EOAR-63-17) AD 614479 Unclassified

This report summarizes the evidence for the views that (a) the structural gene for citrate synthase adjoins that for galactokinase on the chromosone of E. coli; (b) the anaplerotic carboxylation of C3-acids in E. coli is effected via phosphopyruvate carboxylase; this reaction is regulated by acetyl-coenzyme A, (c) the functioning of isocitrate lyase is causally related to growth on acetate; (d) the activation of an L-serine dehydratase by its substrate is associated with a change in the molecular weight of the enzyme; (e) erythro beta-Hydroxyaspartate dehydratase, highly purified, differs from other hydroxyaminoacid dehydratases; (f) P. ovalis Chester contains a highly active oxaloacetate 4-carboxylyase, which is inhibited by acetyl-coenzyme A derivatives; (g) Cl. kluyveri extracts catalyse the ferredoxin-dependent carboxylation of acetyl-coenzyme A In addition, a number of matters relevant to these major areas of work are discussed.

1387

Leicester U. Dept of Biochemistry (Gt. Brit.)

FINE CONTROL OF PHOSPHOPYRUVATE CARBOXYLASE ACTIVITY IN ESCHERICHIA COLI, by J. L Cánovas and H. L. Kornberg. [1965] [4]p incl. diagrs table, refs (AFOSR-65-0957) (AF EOAR-63-17) AD 617990 Unclassified

Also published in Biochim. et Biophys. Acta, v. 94: 169-172, Jan. 1965.

Studies with mutants of S typhimurium and E coli which fail to grow on glucose-salts media unless such media are supplemented with intermediates of the tricarboxylic acid cycle have shown that the carboxylation of phosphoenolpyruvate (PEP) is necessarily involved

in the maintance of the cycle. However, the quantities of phosphoenolpyruvate carboxylase, detected were in insufficient quantities to maintain the reaction. A considerably higher efficiency of isotope incorporation was observed when E. coli were incubated with acetate, ATP, and CoASH in addition to PEP, $H^{14}CO_3^-$ and Mg^{2+}. It is pointed out that PEP is an essential for the reaction and that the enzyme activity needed for the carboxylation of PEP is enhanced by the presence of CoASAc This compound is in return a product of PEP catabolism and is completely combusted in the scheme. The result is that a control system is established based on the particular needs of the orgamsm for oxaloacetate to enter the tricarboxylic acid cycle.

1388

Leicester U. Dept. of Biochemistry (Gt Brit.).

THE UTILIZATION OF ACONATE AND ITACONATE BY MICROCOCCUS SP., by R A. Cooper, K Ihaba, and H. L. Kornberg. [1965] [7]p. incl. diagrs. tables. refs. (AFOSR-65-2516) (AF EOAR-63-17) AD 627825 Unclassified

Also published in Biochem. Jour., v. 94: 25-31, Jan. 1965.

An organism, identified as Micrococcus sp., was isolated by elective culture on aconate, it also grew on itaconate. Washed suspensions of the aconate-grown organism readily oxidized intermediates of the tricarboxylic acid cycle, aconate and succinic semialdehyde, but not itaconate. Itaconate-grown cells oxidized tricarboxylic acid-cycle intermediates, succinic semialdehyde and itaconate, but not aconate. Succinate-grown cells oxidized neither itaconate nor aconate Extracts of aconate-grown cells catalyzed the formation of succinic semialdehyde and carbon dioxide, in equimolar amounts, from aconate. In the presence of NAD or NADP, succinic semialdehyde was oxidized to succinate with concomitant reduction of the coenzyme. Extracts of itaconate-grown cells catalyzed the formation of pyruvate and acetyl-CoA from itaconyl-CoA. Key enzymes involved in the formation of succinate from aconate, and of pyruvate and acetyl-CoA from itaconate, were distinct and inducible; their formation preceded growth on the appropriate substrate.

1389

Leicester U. Dept. of Biochemistry (Gt Brit)

THE BIOSYNTHESIS OF ALANINE BY CLOSTRIDIUM KLUYVERI, by I G. Andrew and J. G. Morris. [1965] [4]p. incl. diagr. tables, refs. (AF EOAR-63-17) Unclassified

Published in Biochim et Biophys. Acta, v. 97: 176-179, Jan. 1965.

This communication reports the operation of the pyruvate synthase system in clostridium kluyveri, an anaerobic organism which grows on a medium containing only acetate and ethanol as organic carbon sources despite the absence of isocitrate lyase and hence of the glyoxylate cycle. The strain of C. kluyveri used, was isolated from canal mud by anaerobic enrichment culture on the synthetic medium, without yeast extract and with acetate, ethanol and carbonate as sole carbon sources It was maintained by frequent subculture at 37° in this medium Results indicate the operation in C. kluyveri of a ferredoxin-dependent mechanism for the carboxylation of acetyl-coenzyme A, which results in the rapid production of alanine in the growing organism.

1390

Leicester U Dept of Biochemistry (Gt Brit.)

L-SERINE DEHYDRATASE OF ARTHROBACTER GLOBIFORMIS, by E S Bridgeland and K M Jones [1965] [1]p (AF EOAR-63-17) Unclassified

Published in Biochem Jour., v 94: 29P, Feb 1965

When studied in toluene-treated cells the enzyme L-serine dehydratase showed the following properties: pyruvate production proceeded linearly with time, no requirement for cations was observed, and the L serine saturation curve deviated only very slightly from the usual Michaelis-Menten form However, when extracts were prepared, either from toluenized cells by lysozyme treatment or from fresh cells by lysozyme treatment or ultrasonic vibrations, the enzyme exhibited markedly different properties.

1391

Leicester U. Dept. of Biochemistry (Gt. Brit)

THE ROLE OF PHOSPHOPYRUVATE CARBOXYLASE IN ESCHERICHIA COLI, by J M Ashworth, H L. Kornberg. and R. L Ward. [1965] [1]p (AF EOAR-63-17) Unclassified

Published in Biochem. Jour., v. 94: 28P, Feb. 1965

At least 4 enzymes, theoretically capable of effecting the net formation of C_4 acids by carboxylation of C_3 acids, have been shown to be present in micro-organisms In order to determine whether one of these enzymes uniquely effects the formation of C_4-acids necessary for growth, suspensions of a thiamin-requiring strain were treated with N-methyl-N-nitroso-N'-nitroguanidine A mutant (designated AB 1622) was selected which did not grow on a glucose-salts-thiamine medium but grew if this medium was supplemented with glutamate, aspartate or succinate The mutant also grew on acetate, glutamate, aspartate or succinate, but not on glycerol or lactate, when these compounds were provided as sole carbon source

1392

Leicester U Dept of Biochemistry (Gt Brit.)

THE UTILIZATION OF GLYCOLLATE BY

MICROCOCCUS DENITRIFICANS: THE β-HYDROXYASPARTATE PATHWAY, by H. L. Kornberg and J. G. Morris [1965] [10]p. incl. diagrs. tables, refs. (AF EOAR-63-17) Unclassified

Published in Biochem. Jour., v. 95, 577-586, June 1965.

Micrococcus denitrificans utilized glycollate as sole carbon source for aerobic growth. Glyoxylate was utilized less well, and though glycine alone did not support growth it enhanced growth on glyoxylate. During growth on glycollate, ^{14}C was incorporated from [2-^{14}C]glycollate into glycine and thence into aspartate, malate and glutamate. No phosphoglycerate was labelled at the earliest times. Glyoxylate was the first product of glycollate utilization, and glycollate oxidase was inducibly formed on transfer of the organism to glycollate-containing media. Extracts of glycollate-grown M. denitrificans contained negligible glyoxylate-carboligase activity and only low tartronate semialdehyde-reductase activity. erythro-β-Hydroxyaspartate is a key intermediate in glyoxylate utilization by this organism. Enzymes catalyzing (a) the synthesis of erythro-β-hydroxyaspartate from glyoxylate and glycine, and (b) the conversion of erythro-β-hydroxyaspartate into oxaloacetate, were inducibly formed during growth on glycollate and on other substrates yielding glyoxylate. Methods for the assay of these enzymes were developed. It is concluded that in M. denitrificans the biosynthesis of cell materials from glycollate is accomplished by the "β-hydroxyaspartate pathway," a novel metabolic route that may also perform a catabolic role in glyoxylate oxidation.

1393

Leicester U. Dept. of Chemistry (Gt. Brit.).

THE EFFECT OF ADDED ELECTROLYTES ON THE E.S.R. AND OPTICAL ABSORPTION OF METAL-AMMONIA SOLUTIONS, by M. C. R. Symons. Final rept. Jan. 1965, 12p. (AFOSR-65-1938) (AF EOAR-62-64) AD 627274 Unclassified

The electron spin resonance of solutions of alkali metals in liquid ammonia was studied as a function of the concentration of metal and of added alkali metal halides. When the concentration of metals is small ($< 10^{-2}$m) there are small negative deviations in the g-factor for added chlorides and bromides but very large negative deviations for added iodides, the shifts for a given salt molality being then a function of the cation. These shifts are enhanced at higher metal concentration and higher temperatures, and are accompanied by a marked increase in line-width. The visible and near IR absorption spectra of some of these solutions was measured and the appearance of a shoulder in the 12,500 cm^{-1} region was confirmed. These results are discussed in terms of a specific interaction between unpaired electrons and iodide ions. Evidence that solvated electrons are quite strongly confined to cavities in the solvent is summarized, and a simple model is suggested which links the optical properties of solvated electrons to those of F centers in alkali-halide crystals and to those of solvated halide ions.

1394

[Leyden U.] Lorentz Inst. (Netherlands)

DERIVATION OF MAXWELL'S EQUATIONS. THE ATOMIC FIELD EQUATIONS, by S. R. de Groot and J. Vlieger. [1965] [16]p. (AFOSR-65-1084) (AF EOAR-62-99) AD 619607 Unclassified

Also published in Physica, v. 31, 125-140, Feb. 1965.

From the electromagnetic equations for fields produced by point particles, the field equations, taking into account the existence of stable atoms, are derived in covariant form. These atomic field equations involve, besides the field tensor (e, b), an atomic polarization tensor (p, m) or alternatively the field tensor (d, h) = (e + p, b - m). The atomic polarization tensor is given as a function of atomic positions and velocities of proper electric dipole, quadrupole, and magnetic dipole moments, and of time derivatives of these quantities. The proper atomic multipole moments are defined in Lorentz frames in which the atoms are momentarily at rest.

1395

Leyden U. Lorentz Inst. (Netherlands)

DERIVATION OF MAXWELL'S EQUATIONS. THE STATISTICAL THEORY OF THE MACROSCOPIC EQUATIONS, by S. R. de Groot and J. Vlieger. [1965] [14]p. incl. refs. (AFOSR-66-1541) (AF EOAR-62-19) AD 638071 Unclassified

Also published in Physica, v. 31, 254-268, Mar. 1965.

The macroscopic Maxwell equations are derived in covariant way from the "atomic field equations." The latter were themselves obtained previously from the field equations of electron theory for point particles, by means of a covariant multipole expansion. In the statistical derivation an appropriate averaging procedure is used in a so-called "fluxion space," i.e., the space spanned by the atomic positions, the atomic multipole moments and the first and higher time derivatives of these variables, on which the fields may depend. Retardation of the fields is also taken into account.

1396

Library of Congress. Science and Technology Div., Washington, D. C.

AIR FORCE SCIENTIFIC RESEARCH BIBLIOGRAPHY. VOL. III, 1959, by G. V. Hooker, D. C. Yates and others. 1965, 693p. incl. refs. (AFOSR-700-5) (CSO-680-66-4) AD 626600 Unclassified

This bibliography includes abstracts of all technical reports, journal articles, books, symposium proceedings, and monographs produced and published by scientists supported in whole or in part by the Air Force Office of Scientific Research during the calendar year 1959. The Air Force Office of Scientific Research supports fundamental research in the five major scientific disciplines: physics, chemistry, engineering

sciences (subsuming mechanics and propulsion), life sciences (both biological and behavioral, but not medical), and mathematics (including during the period of this bibliography, the information sciences). Thus, these abstracts are multi-disciplinary, their common link being their support by AFOSR. References, reports, and clues to the existence of reports were found by searching the indexes and report collection of the Air Force Office of Scientific Research Technical Library, and the collection of the Defense Documentation Center. Detailed searches were made of each contract file in the several AFOSR Directorates. In addition, cover-to-cover searches were made of over 200 scientific journals issued mostly in the time period 1959-1962. This volume of the bibliography consists of approximately 2300 references. A detailed subject index, arranged alphabetically, and a special subject classification for mathematics, are provided. In addition, there are a contract index, AFOSR control number index, and a personal author index.

Libre U., Brussels (Belgium).
see Free U. of Brussels (Belgium).

1397

Lille U. (France).

DERIVATION AND SOLUTION OF THE EQUATIONS OF COMPATIBILITY OF A GAS, by R. Berker. Final rept. May 3, 1965, 129p. incl. refs. (AFOSR-65-1227) (AF 61(052)710) AD 621251 Unclassified

A gas is considered which has no viscosity and which is thermally nonconducting. By eliminating all unknown quantities, other than the velocity, which govern the motion of the gas, equations of motion are obtained which contain only the velocity and the known external force. The particular cases of steady motion, plane motion, and rotationally symmetric motion are examined. The inverse method is then applied in order to obtain new solutions of the equations of motion. The gas of Prim and the perfect gas are considered; and finally the methods developed are applied to steady plane motion, the streamlines of which are isometric curves, and rotational Prandtl-Meyer flows around a corner, performed by a gas which is neither perfect nor a gas of Prim.

1398

Little, Arthur D., Inc., Cambridge, Mass.

THE THERMODYNAMICS OF VAPORIZATION IN THE BERYLLIUM OXIDE-BORON OXIDE SYSTEM, by P. E. Blackburn and A. Büchler. [1965] [6]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1171, Advanced Research Projects Agency, and Army Research Office (Durham)) Unclassified

Published in Jour. Phys. Chem., v. 69, 4250-4255, Dec. 1965.

Vaporization and the phase relationships in the beryllium oxide-boron oxide system were studied by Knudsen effusion using a vacuum balance and a mass spectrometer and by differential thermal analysis. Gaseous beryllium metaborate, $Be(BO_2)_2$, was identified mass spectrometrically in the vapor above the system. Solid $Be_3B_2O_6$ (mp 1495 ± 5°) was found to be the only condensed mixed oxide. The following thermodynamic values were obtained for the formation of gaseous metaborate from beryllium oxide and gaseous boron oxide $BeO(c) + B_2O_3(g) = Be(BO_2)_2(g)$ (ΔH_{1500} - 22 ± 5 kcal/mol; ΔS_{1500} - 6 ± eu/mol). For the formation of solid $Be_3B_2O_6$ from the condensed oxides, $3BeO(c) + B_2O_3(l) = Be_3B_2O_6(c)$ (ΔH_{1500} - 23 ± 5 kcal/mol; ΔS_{1500} -13 ± 3 eu/mol). The metal-anion bond strengths in the gaseous lithium and beryllium metaborates show the same relation to each other as the bond strengths in the corresponding chlorides, thus further confirming the pseudohalide character of the gaseous metaborates. (Contractor's abstract)

1399

Litton Systems, Inc., Beverly Hills, Calif.

RESEARCH ON ELECTROMAGNETIC PLASMA ACCELERATION (Abstract), by A. S. Penfold and R. M. Rosen. [1965] [1]p. (Bound with AFOSR-65-1266, AD 622527) (AF 49(638)1251) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

This research is concerned with the behavior of plasma produced by electrodeless discharges in magnetic fields of the traveling-wave type. The plasma is highly ionized and relatively tenuous, and an attempt is made to attain acceleration with no slip between the plasma and the field. The desired result is a series of pinched plasma toroids moving at speeds which equal or exceed the speed of the traveling wave. The entire process of production and acceleration is nonsteady. A 10-phase traveling-wave machine consisting of an outer coil and an inner (ferrite loaded) coil, which together define an annular region for acceleration, has been constructed. Because of the hazards accompanying the use of mercury, initial operation of the accelerator was accomplished using argon gas. Significant amounts of thrust were observed when, and only when, the electrical tuning of the accelerator was close to ideal. The speed of the beam, measured at a point about 25 cm downstream from the accelerating channel, was observed to be about one-sixth of the field speed. No evidence of plasma pinching was seen. Following these tests the mercury feed system was assembled and installed. The behavior of the plasma in the fringing region of the field is of particular interest since undesirable effects occur there. A method for nearly all the undesirable effects has been discovered.

1400

Lockheed Missile and Space Co., Palo Alto, Calif.

FLUID MECHANICS AND HEAT TRANSFER UNDER LOW GRAVITY, PROCEEDINGS OF A SYMPOSIUM, Palo Alto, Calif., June 24-25, 1965, ed. by H. Cohan and M. Rogers. [1965] [477]p. incl. refs. (AFOSR-65-1841) [AF 49(638)1496] AD 633580 Unclassified

The proceedings contain 16 papers presented at the Symposium. These papers are concerned with analytical and experimental work covering a wide spectrum of the present state of knowledge and the art in fluid mechanical containment, fluid transfer, and fluid behavior under low gravitational conditions. The volume therefore serves not only as a useful reference for the workers in the field but should prove a useful tool in charting the paths for future research and development in the field of fluid mechanics and heat transfer under low gravitational conditions.

1401

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

U(12) AND VECTOR MESON DECAYS, by F. Hussain. [1965] [2]p. (AFOSR-65-1349) (AF EOAR-62-87) AD 622900 Unclassified

Also published in Phys. Ltrs., v. 15, 78-79, Mar. 1, 1965.

The group U(12) has recently been suggested as the covariant generalization of the SU(6) group structure. Using a unique expression for the 3 meson vertex, it was found that the decay of $\omega \to \rho\pi$ is forbidden. In the present note the following ratios for decay rates are found: $\frac{R(\omega \to K\bar{K})}{R(\omega \to 2\pi)} \frac{3}{57} \frac{R(\rho \to 2\pi)}{R(K^* \to K\pi)} 3.3$. The selection rule $\omega \not\to \rho\pi$ was obtained in SU(6) by λ' quark spin conservation. Relations obtained by total quark spin conservation in SU(6) were not always easily interpreted because of the presence of orbital angular momentum. In U(12) this difficulty does not occur.

1402

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

SU(6) IN A BARYON BOOTSTRAP MODEL, by R. H. Capps. [1965] [3]p. incl. refs. (AFOSR-65-1350) (AF EOAR-62-87) AD 621599 Unclassified

Also published in Phys. Rev. Ltrs., v. 14, 31-33, Jan. 4, 1965.

In the SU(3)-invariant, reciprocal bootstrap model, it is difficult to treat the B_8 and B_{10} multiplets on equal footing by including scattering states of the type P_8B_8. The purpose of this note is to construct a simpler baryon bootstrap model. The standard model is first complicated by adding to it a vector meson singlet and octet, and then simplified by neglecting the $B_8 - B_{10}$ mass difference and taking all the mesons to have a common mass small enough for the static model to be used. Certain properties of SU(6) can then be used to find a solution to the bootstrap problem.

1403

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

U-SPIN AND THE MASS SPLITTING OF UNITARY MULTIPLETS, by G. Feldman and P. T. Matthews. [1965] [12]p. incl. diagrs. (AFOSR-65-1780) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-87 and National Science Foundation) AD 626334 Unclassified

Also published in Ann. Phys., v. 31, 469-480, Feb. 24, 1965.

The relations between the masses in a unitary multiplet are derived from the U- and I-spin properties of the mass splitting interactions. Various simple rules—the Parallelogram Law and the nth Difference Rule—are derived. It is shown that the Gell-Mann-Okubo formula is just an equal spacing rule for particles within a U-multiplet.

1404

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

WEAK INTERACTIONS, by P. T. Matthews. [1965] [15]p. incl. refs. (AFOSR-65-1781) [AF EOAR-62-87] AD 626333 Unclassified

Also published in Proc. Roy. Soc. (London), v. 285A: 214-228, Apr. 1965.

The present status of weak interactions is review with particular reference to the implications of a current-current interactions, the $\Delta Y/\Delta Q$ rule for currents, and the $\Delta I = 1/2$ rule for non-leptonic transitions. The properties of leptons and the exchange of intermediate charged vector bosons are considered. With regard to semi-leptonic processes, hypercharge conserving reactions and hypercharge changing semi-leptonic decays are reviewed. Problems are discussed as a result of the equation $\Delta Y = 1$ for non-leptonic decays. In the paper it is assumed that intermediate bosons exist but $\Delta Y = \Delta Q$ semi-leptonic transitions do not.

1405

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

MASS SPLITTING IN A BOOTSTRAP MODEL OF FOUR MULTIPLETS, by R. H. Capps. [1965] [8]p. incl. tables, refs. (AFOSR-65-1852) (AF EOAR-64-46) AD 626343 Unclassified

Also published in Phys. Rev., v. 137, B1545-B1552, Mar. 22, 1965.

A bootstrap model of the pseudoscalar meson octet (P), vector meson octet (V), baryon octet (B), and baryon $J^P = 3/2^+$ decuplet (B*) is considered. A simple dynamical equation, used previously to predict the mass-splitting of the P and V multiplets, is applied to the B and B* multiplets. The approximations used are crude, but the calculated results agree closely with the experimental baryon masses. The main reasons for this agreement are expressed simply in terms of various Clebsch-Gordan coefficients of SU_3. The terms in the equation that are not linear in the mass splitting lead to an appreciable violation of the Gell-Mann-Okubo formula for the V mesons, and to negligible violations of the corresponding formulas for the B and B* multiplets. Matrix ND^{-1} dispersion relations are used to clarify the basic physical assumptions involved in the dynamical equation.

1406

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

ON THE COVARIANT EXTENSION OF SU(6), by J. M. Charap and P. T. Matthews. [1965] [13]p. incl. refs. (AFOSR-65-1853) (AF EOAR-64-46) AD 626341 Unclassified

Also published in Proc. Roy. Soc. (London), v. 286A, 300-312, July 1965.

The covariant generalizations of SU(6) invariant interactions are considered within the framework of $U(6) \otimes U(6)$. This group, in general, appears to lead to parity doubling for the mesons, but not the baryons. However, the parity doubling interpretation implies indefinite metric, which can be avoided by using the Bargmann-Wigner equations to eliminate the offending terms. These equations relate sets of terms, which would together make multiplets of U(12), and the multiplets correspond physically to those of SU(6). Five different Yukawa interactions are derived, invariant with respect to $U(6) \otimes U(6)$, all of which have the SU(6) static limit. The linear combination of these is found which is invariant for U(12).

1407

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.)

ITERATED CROSSED BOX DIAGRAM IN THE COMPLEX ANGULAR MOMENTUM PLANE AND BETHE-SALPETER EQUATION, by [illegible]. [1965] [15]p. incl. diagrs., refs. (AFOSR-65-1554) [AF EOAR-64-46] AD 626345 Unclassified

Also published in Commun. Math. Phys., v. 1, 112-126, 1965.

The analytic properties of the iterated crossed box diagram are considered in the complex angular momentum plane by using the partial wave Bethe-Salpeter equation. It is shown that the kernel of the Bethe-Salpeter equation is of the Hilbert-Schmidt type in the domain $\Delta(1, s)$: $1 \le s$, $\mathrm{Re}\, l > -3/2$, $\mathrm{Im}\, s \ne 0$ having a simple pole at $l = -1$. This pole produces in the whole amplitude a singularity found by Gribov and Pomeranchuk since the kernel is not of finite rank.

1408

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

INELASTIC BOUND-STATE SCATTERING IN SEPARABLE APPROXIMATION, by J. T. Cushing. [1965] [11]p. (AFOSR-65-1855) [AF EOAR-64-46] AD 626335 Unclassified

Also published in Nuovo Cimento, Series X, v. 36, 905-915, Apr. 1, 1965.

The inelastic contributions to the scattering amplitude describing the scattering of an elementary particle from a bound state are calculated explicitly from the Fadeev equations for separable interactions. The inelastic terms are then combined with the previously calculated elastic amplitude and the analytic properties of the complete amplitude are investigated in the static limit. The trajectories of the singularities of the partial-wave amplitude are shown to be bounded in the right-half plane of the total angular momentum. The model is applied to the scattering of a spinless elementary particle from a spinless compound one. The resulting amplitude is bounded by a finite power of $\cos\theta_1$ and independent of $\cos\theta_2$, where θ_1 and θ_2 are the scattering angles of the scattered elementary particle and ejected bound particle, respectively. The possible applicability of the separable approximation used is discussed.

1409

[London U.] Imperial Coll. of Science and Tech. (Gt. Brit.).

ELECTROMAGNETIC INTERACTION OF MESONS RESULTING FROM A BROKEN SYMMETRY, by G. S. Guralnik. [1965] [14]p. incl. diagrs. (AFOSR-65-1856) [AF AFOSR-64-46] AD 626498 Unclassified

Also published in Nuovo Cimento, Series X, v. 36, 1002-1015, Apr. 1, 1965.

The Nambu, Jona-Lasinio broken symmetry theory restated in terms of Green's functions in the presence of an external current source. Using these Green's functions, it is possible to calculate the lowest-order effects of electromagnetic interactions on the initially massless pseudoscalar mesons induced by the broken symmetry. It is found that the uncharged meson acquires no mass and hence the results are consistent with the Goldstone theorem applied to the fully interacting system.

1410

[London U.] Imperial Coll. [of Science and Tech.] (Gt Brit.).

A MODEL FOR THE CONNECTED PART OF THE THREE-BODY AMPLITUDE, by J. T. Cushing. [1965] [20]p. incl. diagrs. refs. (AFOSR-65-1857) (AF EOAR-64-46) AD 626037 Unclassified

Also published in Nuovo Cimento, Series X, v. 38 463-482, July 1, 1965

A model involving separable interactions is proposed for the scattering of 3 free particles into 3 free particles. The analyticity in the total angular momentum j and total energy s of the scattering amplitude is investigated. It is found that a Sommerfeld-Watson transformation cannot be used to yield information on the asymptotic behavior of the complete amplitude as a momentum transfer becomes infinite. On the basis of this and previous work on the same model for the bound-state parts of the 3-body amplitude, the analytic properties of all the 3-body amplitudes are summarized. The Regge mechanism of asymptotic dominance appears valid only for the elastic bound-state scattering amplitude and even here there is competition between a pole and a cut

1411

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

FORM FACTORS AND POLARIZATION EFFECTS IN NEUTRINO-INDUCED INTERACTIONS, by I. J. Ketley [1965] [14]p. incl. refs. (AFOSR-65-1858) [AF EOAR-64-46] AD 626338 Unclassified

Also published in Nuovo Cimento, Series X, v. 38 302-315, July 1, 1965.

Form factors analogous to F_C and F_M in nucleon electromagnetic interactions are suggested for the vector and axial-vector currents at the strong vertex in a current-current theory of weak interactions. They are used to compute the cross-section and expressions for the covariant polarization 4-vectors for the 2 final particles in the process $\nu(\bar{\nu}) + N \cdot 1 + b$ with a view to determining the form factors and testing time-reversal invariance.

1412

[London U.] Imperial Coll. [of Science and Tech.] (Gt Brit.).

VECTOR MESONS AND COMPLEX ANGULAR MOMENTUM, by M. Martinis and K. Ahmed. [1965] [19]p. incl. diagrs. refs. (AFOSR-65-1859) [AF EOAR-64-46] AD 626342 Unclassified

Also published in Nuovo Cimento, Series X, v. 38 1021-1039, July 1, 1965

The analytic behavior in the complex angular momentum plane of the amplitude for a vector meson coupled to a scalar nucleon through a conserved current is examined. The graph with the exchange of two vector mesons is considered. This graph is iterated in the vector meson or s channel. The partial wave projection of the lowest order graph, 4th order, has a simple pole at $\ell = 1$, which is obtained after an analytical continuation from higher ℓ. When the singular part of the graph at $\ell = 1$ is taken as the kernel of the Bethe-Salpeter equation it is found that for $s \geq 6\mu^2$ its solution has two simple moving poles in the neighborhood of $\ell = 1$ in the ℓ-plane. However, the Regge trajectory has two branches which intersect each other at the branch point $s = 6\mu^2$.

1413

[London U.] Imperial Coll [of Science and Tech.] (Gt. Brit.).

U(12) SYMMETRY AND THE JOHNSON-TREIMAN RELATIONS, by J. M. Charap and P. T. Matthews. [1965] [2]p. incl. refs. (AFOSR-65-1860) [AF EOAR-64-46] AD 626339 Unclassified

Also published in Phys. Ltrs., v. 16 95-96, May 1, 1965

It has been shown by Johnson and Treiman on the basis of SU(6) that $\sigma(K^+) - \sigma(K^-) = \sigma(K^0) - \sigma(\bar{K}^0) + \sigma(\pi^+) - \sigma(\pi^-)$ and $\sigma(\gamma^+) - \sigma(\pi^-) = \sigma(K^0) - \sigma(\bar{K}^0)$, where $\sigma(M)$ stands for the total cross section of mesons M on protons. Though these relations were shown valid in the covariant U(12) theory when the forward scattering amplitudes were restricted to the four regular ones, the same assumption implied zero polarization in several processes where the polarization was known to be large. In this paper irregular forward scattering amplitudes are considered in U(12) theory as well as the regular. There are thirty different possibilities of which twelve contribute to $\sigma(M) - \sigma(\bar{M})$. The relevant parts of each of these has the form of pure F-type baryon current coupled to the pure F meson current. Thus each term separately satisfies the Johnson-Treiman relations, which therefore remains valid in general in this theory.

1414

[London U.] Imperial Coll [of Science and Tech.] (Gt Brit.).

U(12) IRREGULAR COUPLING FOR $p\bar{p}$ ANNIHILATION, by F. Hussain and P. Rotelli. [1965] [2]p. incl. refs. (AFOSR-65-1861) (AF EOAR-64-46) AD 626336 Unclassified

Also published in Phys. Ltrs., v. 16 183-184, May 15, 1965.

Using irregular couplings, $p\bar{p}$ annihilation at rest into two pseudoscalar particles is considered in the U(12) symmetry scheme. Under the assumption the ratio of annihilation rates, $\frac{\sigma(K^+K^-)}{\sigma(\bar{K}^0K^0)}$, is calculated to be $\neq 1$

It is observed that the meson exchange mechanism proposed by Sawyer leads to the Johnson-Treiman relations

and hence in the model to the result 4 1 since the annihilation process is just the crosschannel Since the Johnson-Treiman relations were shown to hold in U(12) for all couplings, the result is independent of a model and appears as evidence for the validity of the approximate invariance of strong interactions in the $\tilde{U}(12)$ theory.

1415

[London U.] Imperi Coll. [of Science and Tech.] (Gt. Brit.).

NEUTRINO-INDUCED INTERACTIONS AND $\tilde{U}(12)$ SYMMETRY, by I. J. Ketley. [1965] [3]p. incl. diagrs tables, refs. (AFOSR-65-1862) (AF EOAR-64-46) AD 626340 Unclassified

Also published in Phys. Ltrs., v. 16 340-342, June 1, 1965.

In $\tilde{U}(12)$ theory, the for . factors associated with baryon-baryon and baryon-baryon resonance currents have been shown uniquely related. Using a current x current formulation for the weak interactions of leptons and hadrons, this relationship is used to obtain form factors applicable to neutrino interactions, and in particular to the processes $\nu(\nu) + N \to 1^-(1^+) + N$ and $\nu(\bar{\nu}) + N \to 1^-(1^+) + N^*$. Equations for the vector and axial-vector currents are solved and used to compute cross sections for the above interactions. The elastic cross sections have a maximum near s - 5 as usual computation gives with similar form factors, but for very high energies there is a logarithmic behavior. The results for the inelastic process are similar to those using SU(6) to find the relative magnitude of the form factors. Again for high energies the cross sections increase logarithmically.

1416

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

SPONTANEOUS BREAKDOWN OF SYMMETRY IN AXIOMATIC THEORY, by R. F. Streater. [1965] [9]p. incl. diagr. refs. (AFOSR-65-2694) (AF AFOSR-64-46) AD 628739 Unclassified

Also published in Proc. Roy. Soc. (London), v. 287A 510-518, 1965.

Two results are proved the first is that it is possible to prove Goldstone's theorem in a Wightman theory in which there is a conserved current with a meaning for a sharp time and which generates a broken symmetry. The second is that for such theories there exist infinitely many positive linear functionals on the algebra of quasi-local operators, that are Lorentz invariant and lead to a theory with positive energy. That is, the vacuum functional is non-unique. These 2 results are illustrated in the theory of the free massless neutral scalar field

1417

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

ON THE NONLINEAR PROPERTIES OF RETARDED PRODUCTS, by R. F. Streater. [1965] [17]p. incl refs. (AFOSR-65-2799) [AF EOAR-64-46] AD 628343 Unclassified

Also published in Ann. Phys., v. 33 311-327, July 1965

A set of functions t is given that satisfies the unitarity equations appropriate for time-ordered functions of n current operators, n 4, 5, . . . In terms of functions t, r is defined for each order n which correspond to the generalized retarded functions of axiomatic local quantum field theory Using the technique of generating functionals, the corresponding 'products of operators' T and R are defined. The t and r are well defined as distributions in momentum space, possibly not tempered, and the time-ordered and retarded operators are also distributions in momentum space, and as operators in Fock space have reasonable domains of definition It is found that the commutator between any two retarded operators can be expressed as sums and differences between retarded operators of order n + m. The various r-functions coincide in some region of momentum space, and any given r coincides with the t-function in the region of momentum space appropriate to the function r. The R-operators trivially satisfy the Steinmann relations. Thus many of the 'linear' properties of the retarded operators that follow from causality and Lorentz invariance also follow from unitarity, when no locality is assumed.

1418

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

A FIELD-THEORETIC PROOF OF A MODIFIED VERSION OF LEVINSON'S THEOREM, by J M. Charap [1965] [17]p. (AFOSR-65-2958) [AF EOAR-64-46] AD 628342 Unclassified

Also published in Nuovo Cimento, Series X, v. 36 419-435, Mar. 16, 1965.

A consideration of the integral equation for the vertex function derived from field theory leads to a proof of a new form of Levinson's theorem. The number of CDD poles, which occur at first-sheet zeros of the vertex function, must be supplemented by the number of second-sheet zeros of the vertex function, at which points occur the poles of the amplitude associated with particles for which the wave-function renormalization constant vanishes (Contractor's abstract)

1419

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

GENERALIZED GOLDSTONE THEOREM, by R. F. Streater. [1965] [2]p. (AFOSR-66-0102) (AF EOAR-64-46) AD 630140 Unclassified

Also published in Phys. Rev. Ltrs., v. 15, 475-476, Sept. 13, 1965.

The paper of Goldstone, Salam, and Weinberg (Phys. Rev., v. 127, 965, 1962) gave a very simple proof of an important theorem on broken symmetry. If $\varphi_1(\cdot) \to \varphi_2(\cdot)$ is a transformation of fields such that $\varphi_1(\ ) \cdot 0 \neq 0$ and such that the transformation is generated by a conserved current, then there must be zero mass particles in the theory with the quantum numbers of φ_1. (The proof depends on the absence of states of negative norm.) In this paper it is shown that a significant generalization, along the same lines, can be proved: namely, if a local conserved current generates a transformation $\varphi_1(\cdot) \to \varphi_1(\cdot)$ between fields corresponding to particles of different mass, then there must be states in the theory with arbitrarily small mass (again in the absence of states of negative norm). The theorem is applied to the proton-neutron mass difference.

1420

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

VECTOR MESONS AND COMPLEX ANGULAR MOMENTUM-II, by K. Ahmed and M. Martinis. [1965] [6]p. (AFOSR-66-0103) [AF EOAR-64-46] AD 630138 Unclassified

Also published in Nuovo Cimento, Series X, v. 39, 246-251, Sept. 1, 1965.

It is shown that the leading singularities in the complex angular momentum plane for the process $\pi^+\pi^- \to \pi^+\pi^-$ mediated by the vector mesons occur near $j = 1$. Only sixth-order Feynman graphs have been considered. One then finds that the analytic part of the sixth-order continued partial-wave amplitude has a purely imaginary contribution near $j = 1$. Singular part of the amplitude when iterated, gives two Regge poles in the neighborhood of $j = 1$.

1421

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

UNITARITY AND THE BOUND-STATE PROBLEM IN ALMOST LOCAL FIELD THEORY, by M. Martinis. [1965] [18]p. incl. refs. (AFOSR 66-1544) [AF EOAR-64-46] AD 639822 Unclassified

Also published in Nuovo Cimento, Series X, v. 40, 132-149, Nov. 1965.

The results of this study are divided into 3 sections. The first one demonstrates the possibility of imposing the condition of almost locality on a 4-point matrix element. This is done in order to obtain certain restrictions on the functions appearing in the Haag expansion of an almost local field. Disregarding possible end-point singularities it is possible to show that in a certain finite energy region these functions satisfy equations similar to physical unitarity. Assuming that the F-functions appearing in the Haag expansion possess analytic properties it is possible to find a model (given in the second section) which explicitly shows how the end-point singularity can be cancelled by the threshold behavior if the energy region is restricted to the elastic region. In the last section it is shown how the bound-state problem may be incorporated into the spirit of almost local field theory. The problem is analyzed in the case of AB elastic scattering where B represents a 2-particle bound state of A.

1422

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

U(12) ABSORPTION MODEL FOR $P\bar{P} \to \Lambda\bar{\Lambda}$, by H. D. Watson and J. H. Migneron. [1965] [3]p. incl. diagr. table, refs. (AFOSR-66-1545) (AF EOAR-64-46) AD 639821 Unclassified

Also published in Phys. Ltrs., v. 14, 424-426, Nov. 1965.

Brief details are presented of a calculation of the reaction $p+\bar{p} \to \Lambda+\bar{\Lambda}$ at 3.7 gev/c, in which the U(12) symmetry scheme is used to write down peripheral amplitudes on which the requirements of unitarity are then approximately enforced by the inclusion of absorptive effects in the initial and final states.

1423

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

MASS SPLITTING AND UNITARITY, by G. Fraser. [1965] [3]p. (AFOSR-66-1544) [AF EOAR-64-46] AD 639818 Unclassified

Also published in Phys. Ltrs., v. 19, 521-531, Dec. 1965.

Recently several authors have calculated ratios of amplitudes for various proton-antiproton annihilation modes at rest on the basis of a broken inhomogeneous U(12) symmetry scheme. Their calculations neglect mass splitting within the baryon octet. Although the mass-splitting between the observed particles is small, the splitting within the baryon octet is large. For stopped proton-anti proton reactions, this suppresses intermediate states composed of behavior baryon-anti-baryon pairs. This will have an effect on the observed process because of unitarity. This note presents a method for estimating these effects using the inverse reaction matrix formalism of Matthews and Salam.

1424

[London U] Imperial Coll. [of Science and Tech.] (Gt. Brit.)

CLEBSCH-GORDON COEFFICIENTS FOR THE GROUP SU_6, by C L Cook and G. Murtaza. [1965] [20]p incl. tables. [AF EOAR-64-46] Unclassified

Published in Nuovo Cimento, Series X, v. 39 531-550, Sept. 16, 1965.

Presented are tables of reduction coefficients for the direct products $35 \otimes 35$, $56 \otimes 35$, $56 \otimes \overline{56}$ of irreducible representations of SU_6 and a brief outline of the method of calculation. (Contractor's abstract)

1425

London U. Imperial Coll. [of Science and Tech.] (Gt. Brit.).

COMPLETE HIGH-ENERGY BEHAVIOR FOR CERTAIN PLANAR GRAPHS, by M. Martinis. [1965] [6]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF EOAR-64-46] and National Science Foundation) Unclassified

Published in Jour. Math. Phys , v. 6 136-141, Jan. 1965.

The results obtained by Polkinghorne for the set of ladder diagrams is generalized to a certain set of planar graphs. The leading asymptotic term behaves as $s^{-1}(\ln s)^p$, and then the complete set of terms $s^{-1}(\ln s)^m$ is summed over m. The final result allows the writing of an equation for the Regge trajectory function. (Contractor's abstract)

1426

[London U.] Imperial Coll [of Science and Tech.] (Gt. Brit.).

CONSERVATION LAWS FOR FREE FIELDS, by T W B Kibble [1965] [5]p. [AF EOAR-64-46] Unclassified

Published in Jour. Math. Phys , v 6 1022-1026, July 1965

The recently discovered conservation laws for the "zilch" of the electromagnetic field (of which a simple derivation is presented) are examined in the context of a general discussion of bilinear conserved quantities in free-field theories. It is shown that there is always an infinite set of these quantities, and a method of finding them all is presented and illustrated by applications to simple theories The existence of these conserved quantities is shown to be a consequence of the fact that the momentum-space density is constant in time (Contractor's abstract)

1427

[London U Imperial Coll of Science and Tech.] (Gt Brit.)

FREQUENCY SHIFT IN HIGH-INTENSITY COMPTON SCATTERING, by T W. B Kibble [1965] [14]p incl. diagrs. refs (AF EOAR-62-87)and AF EOAR-64-46) Unclassified

Presented at Conf. on Quantum Electrodynamics of High-Intensity Photon Beams, Durham, N C , Aug. 26-27, 1965.

Published in Phys. Rev., v 138 B740-B753 May 10, 1965.

The frequency shift predicted by Brown and Kibble, and by Goldman, for a photon scattered out of an intense beam by a free electron is re-examined. It is shown that the effect has a very simple classical interpretation, as a Doppler shift arising from the nonzero average velocity of the electron in the beam. The discrepancy between this prediction and the recent perturbation calculation of Fried and Eberly is shown to arise from the use, in the latter, of a pure monochromatic beam rather than a wave train of finite length. It is shown that the effect should arise for a quantized photon beam as well as for a classical one. The question of energy-momentum conservation is discussed. With the help of a one-dimensional model which exhibits all the essential features of the effect, it is shown that the extra energy and momentum which are generated in the scattering process are taken up by the beam itself in the form of an extremely small shift in the average momentum of a photon in the beam The possibility of experimental detection of the effect is briefly discussed. (Contractor's abstract)

1428

[London U] Imperial Coll [of Science and Tech] (Gt. Brit).

REDUCTION OF REPRESENTATIONS OF SU_{mn} WITH RESPECT TO THE SUBGROUP $SU_m \otimes SU_n$, by C R. Hagen and A J Macfarlane. [1965] [11]p incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-46 and Atomic Energy Commission) Unclassified

Published in Jour Math. Phys , v 6 1355-1371, Sept 1965.

With a view to application to theories such as the Wigner supermultiplet theory of nuclear structure and its recent extension into the domain of particle physics, the reduction of representations of the special unitary group SU_{mn} into representations of its $SU_m \otimes SU_n$ subgroup is considered Proof is given of the result, that, in the case of a representation of SU_{mn} of plurality type p_{mn}, this reduction yields only those irreducible representations of $SU_m \otimes SU_n$, whose SU_m and SU_n parts have plurality types p_m and p_n equal to p_{mn} modulo m and modulo n, respectively A practical method of obtaining reductions is described and a tabulation of results in the case of SU_6 and $SU_2 \otimes SU_3$ is made The

method depends on the use of a very concise version of the Weyl character formula for unitary groups which does not seem to have been used elsewhere. (Contractor's abstract)

1429

London U. Imperial Coll. of Science and Tech. (Gt. Brit.)

SCIENCE AND TECHNOLOGY IN THE EMERGING NATIONS, by A. Salam [1965] [10]p. [AF EOAR-64-46] Unclassified

Published in Science in the Sixties, Tenth Anniversary AFOSR Scientific Seminar, Cloudcroft, N. M. (June 14-25, 1965), ed. by D. L. Arm. Alburquerque, Mexico U. Office of Publications, 1965, p. 32-41.

An historical background of science and technology is presented and the fact is pointed out that the history of science has gone through cycles in which many cultures and lands have played a part. Scientific and technological development in emerging nations is discussed, using the author's native Pakistan as an example. Pakistan presents the picture of an ancient civilization, not too distantly in a scientific and a cultural lead. After military submission, its defeat was followed by an introduction of newer technological ideas and the harnessing of its rivers for agricultural growth. The importation of technology was beneficial only in part, however, for it was not accompanied by an educational system that would enable the further mastery of newer technologies. After initial prosperity, there was inevitable over-population and resultant hunger and poverty. This pattern repeated itself around the world. A foremost necessity for developing countries is the acquiring of basic skills for the operation of a technological economy with priority on the exploitation of natural resources, and the creation of a more and more productive agriculture.

1430

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

SU_3 AND THREE-PARTICLE STATES, by G. Murtaza. [1965] [11]p. incl refs. [AF EOAR-64-46] Unclassified

Published in Nuovo Cimento, Series X, v. 39, 195-205, Sept. 1, 1965

Some relations between the crossing matrices and 6j-symbols are derived. The SU_3 symmetry scheme is then applied to the N π system and, by inspecting the relevant (generalized) 6j-symbols, some qualitative conclusions concerning the potentials in the various channels are reached

1431

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

VECTOR MESONS AND REGGE TRAJECTORIES, by K Ahmed. [1965] [4]p. incl. diagrs. refs. [AF EOAR-64-46] Unclassified

Published in Phys. Rev., v. 138, B1470-B-1473, June 21, 1965.

Freund and Ochme's note concerning Reggeization of massive vector mesons in field theory is re-examined in the light of Polkinghorne's work, it is found that the Regge-pole approximation for the vector meson is not entirely justified. (Contractor's abstract)

1432

[London U.] Imperial Coll. [of Science and Tech.] (Gt. Brit.).

PHOTOSYNTHETIC MECHANISMS UNDER SUB-OPTIMAL CONDITIONS, by C. P. Whittingham. Final rept. Oct 1965 [28]p. incl. diagrs. tables, refs. (AFOSR-65-2649) (AF EOAR-65-2) AD 625495 Unclassified

Investigations have been made with Chlorella on the conditions which optimize the formation of glycollic acid as a product of photosynthesis in Chlorella. Maximum production is observed at low partial pressures of carbon dioxide, high light intensities or high pressures of oxygen. The influence of oxygen partial pressure, as well as carbon dioxide partial pressure has been studied in detail. A transition from 20%-100% oxygen resulted in increased formation of glycollate and an associated decrease in the size of the sugar phosphate pools of the photosynthetic cycle. With respect to steady state photosynthesis, the percentage incorporation of carbon dioxide into glycollate is greater at higher partial pressures of oxygen, again associated with a smaller pool size of sugar phosphate intermediates. Suggestions have been made that the sucrose formed in photosynthesis is derived through a pathway in which glycollic acid or some related compound is an intermediate. Glycollic acid has been shown to be approximately equally labelled in its 2 carbon atoms. Thus sucrose derived from triose phosphate (predominantly labelled in the 1C atom) or alternatively derived from glycollate would be expected to have different labelling patterns. Hence the labelling pattern of sucrose formed in Chlorella has been investigated under a wide range of conditions. It has been shown that under high partial pressures of oxygen the labelling pattern of sucrose is such that in part it may be derived from a pathway involving glycollate. In the presence of 20% oxygen it was not possible to establish whether sucrose was formed.

1433

[London U.] Inst. of Laryngology and Otology (Gt. Brit.).

THE AUDITORY APPARATUS OF THE HETEROMYIDAE (RODENTIA, SCIUROMORPHA), by A. Pye. [1965] [14]p. incl. illus. diagrs. refs. (AFOSR-65-2519) (AF EOAR-63-30) AD 627624 Unclassified

Also published in Jour. Anat. (London), v 99, 161-174, 1965.

The structure of the ears of the family Heteromyidae is discussed in relation to the phylogeny and classification of the family. A successful histological technique for the intra-vitam fixation and processing of the ears is described The results indicate that, in the more advanced members of the family, the middle ear and especially the cochlea of the inner ear have become extremely modified. The supposed phylogenetic line can thus be followed in the structure of the ears alone. The possible functions of these special modifications cannot be assessed until more is known of the general cochlear physiology.

1434

London U., Inst. of Laryngology and Otology (Gt. Brit.).

ENERGY TRANSFORMATION WITHIN THE INNER EAR, by D. F. N. Harrison. Final rept. June 1965 [3]p (AFOSR-65-1603) (AF EOAR-64-47) AD 623791 Unclassified

A review is presented of comparative anatomical studies of the mammalian inner ear Emphasis is continuing on the cochlea and larynx of Chiroptera and Rodentia, and work has been started on examinations of the avian syrinx. Computer facilities are being used for the best possible correlation between anatomical structure variations and function.

1435

[London U. Coll.] Dept. of Anatomy (Gt. Brit.).

[ANATOMICAL LOCALIZATION OF TARGET LEARNING AND MEMORY] by J. Z Young Final rept Nov. 17, 1965 [4]p. (AFOSR-65-2654) (AF EOAR-62-37) AD 628237 Unclassified

The work showed how the octopus may be prepared and kept for electrical recording. It made a beginning with the study of afferent impulses in the optic nerves the presence of efferent impulses in the optic nerves and their influence on the electroretinogram Impulses were shown for the first time in nerve fibers of the statocyst. Individual fibers of the lateral crista have been shown to respond both to low-frequency vibration and to angular acceleration. The latter response varied with the direction of rotation.

1436

London U. Coll Dept. of Anatomy (Gt Brit.)

THE DIAMETERS OF THE FIBRES OF THE PERIPHERAL NERVES OF OCTOPUS, by J Z. Young [1965] [37]p. incl. illus. diagrs. tables. refs (AFOSR-65-1788) (AF EOAR-63-2) AD 625707 Unclassified

Also published in Proc. Roy. Soc. (London), v. 162B· 47-79, Mar. 1965.

The diameters and numbers of fibers have been measured throughout the peripheral nervous system. The nerves of the muscles that act upon the outside world contain few fibers, having very large medium-sized fibers but no very small ones. Thus the muscles of the head receive 6000 fibers, the largest of 30 μm diam The eye muscles receive 3300 fibers, reaching 24 μm The stellar nerve fibers are more numerous (150,000), but smaller (20 μm) The preganglionic fibers joining the c. n. s. to the stellate ganglia are fewer than the postganglionic ones (4000, ~ 16 um) The fibers to the chromatophores are numerous (30,000) and of medium diam (~ 12 μm). The visceral motor and vasomotor nerves, however, contain hundreds of thousands of minute fibers (< 3 um). The significance of these numerous small fibers can hardly be to obtain great resolution of movement in such acts as secretion of saliva. Presumably the great number has a special significance. The fibers to the muscles of the buccal mass are more numerous and smaller than the somatic motor fibers, but fewer and larger than those for the viscera The muscles of the arms and suckers have 3,000,000 fibers, all < 6 μm, originating from neurons within the arms

1437

[London U Coll.] Dept. of Anatomy (Gt. Brit.)

TWO MEMORY STORES IN ONE BRAIN, by J Z Young [1965] [8]p. incl. illus diagrs. refs (AFOSR-65-2514) (AF EOAR-63-2) AD 627754 Unclassified

Also published in Endeavour, v 24, 13-20, Jan. 1965

The octopus brain has 2 almost separate stores, one for visual and the other for tactile information. Besides the lobes that carry the actual record, there are others concerned with reading-in or reading-out from the stores The work is part of a broader study of learning

1438

London U. Coll. Dept of Anatomy (Gt. Brit.).

SOME OBSERVATIONS ON THE FOOD INTAKE AND LEARNING IN OCTOPUS VULGARIS, by M. Nixon. [1965] 11p. incl. diagrs. tables (AFOSR-65-2841) (AF EOAR-63-2) AD 628370 Unclassified

Also published in Pubbl Staz Zool Napoli, v 34 329-339, 1965

Octopus vulgaris seems able to learn to attack a rectangular shape when the correct response is rewarded

by actual food (1.6 g of fish a day for animals weighing 200-350 g) whereas animals given a taste of fish at each trial only responded initially to the shape and did not maintain their attacks. Octopuses that were completely starved only attacked the shape infrequently. However, the 'attack system' of the animals was not impaired after starvation and virtual starvation lasting 12 1 2 days in the laboratory, for when shown a live crab it was attacked by the octopuses All of the animals that were starved or virtually starved lost weight but the animals given 1.6 g of fish a day all gained weight

1439

[London U. Coll Dept of Anatomy (Gt Brit.)]

[ANATOMICAL LOCALIZATION OF TARGET LEARNING AND MEMORY] by [J Z Young] Final rept [1965] [7]p. (AFOSR-65-1368) (AF EOAR-64-42) AD 621129 Unclassified

The 2 memory systems of the Octopus were investigated. The work and results for 7 studies are reported. These are (1) The experimental analysis of the functions of the centers that regulate attack. (2) The neuronal connections in the optimizing system. (3) The tactile memory system. (4) The mnemon unit of memory storage: (5) The feeding pathway. (6) The normal behavior in the sea. and (7) The diameters and conduction velocities of nerve fibers

1440

[London U Coll Dept. of Anatomy (Gt Brit.)]

OCTOPUS OPTIC RESPONSES, by B B. Boycott, J Y. Lettvin and others. [1965] [10]p incl illus. refs. (AFOSR-65-2525) (AF EOAR-64-42) AD 628743 Unclassified

Also published in Exper Neurol., v. 12: 247-256, July 1965.

A study of responses in Octopus vulgaris visual system was carried out. Gross recordings were made in the free swimming animal responding to brief flashes of light A simple negative electroretinogram was recorded within the eye beginning at 8 msec peaking at 20-25 msec With the animal resting, the amplitude of the ERG could be increased by gentle tactile stimuli which produce no movement or pupil change. Immediately behind the retina, an oscillating potential was recorded beginning 15 msec after the flash and lasting for about 40 msec with a frequency of about 150 per sec This was believed to be produced by synchronized volleys in the optic nerve fibers travelling at about 1 m per sec In the optic lobe, one could record the ERG. the arriving oscillatory volley and a gross response starting at 30 msec after the flash and peaking 20 msec later

1441

[London U. Coll] Dept. of Anatomy (Gt. Brit).

FURTHER OBSERVATIONS ON FORCES EXERTED BY OCTOPUS VULGARIS, by N. Dilly and M. Nixon. [1965] [6]p incl diagrs table. (AFOSR-65-2526) (AF EOAR-64-42) AD 629299 Unclassified

Also published in Pubbl. Staz. Zool. Napoli, v. 34: 340-345, 1965.

Octopuses kept isolated in tanks with heavy lids, for learning and other experiments, may escape, especially when recently arrived in the aquarium (Taki, 1941; Boycott, 1954, Dilly, Nixon and Packard, 1964). During training experiments octopuses can sometimes be seen to move the building bricks of their home. A further impression of the force they are capable of exerting is appreciated when an octopus is placed in a straight sided jar with a wooden lid for induction with urethane anesthetic solution. Two observations of the pushing force of small animals (Dilly, Nixon and Packard, 1964) suggested that this was approximately half of the pulling force of animals of similar weight

1442

London U Coll. Dept. of Anatomy (Gt. Brit.).

THE NERVOUS PATHWAYS FOR POISONING, EATING, AND LEARNING IN OCTOPUS, by J. Z. Young. [1965] [15]p. incl. illus. diagrs. tables. (AFOSR-66-1884) [AF EOAR-64-42] AD 643909 Unclassified

Also published in Jour Exper. Biol., v. 43: 581-593, Aug. 1965.

Octopuses, after removal of the lip, kill and eat crabs apparently normally They learn to attack a strange figure moving in the visual field The pair of nerves that originates from cells at the back of the superior buccal lobe is shown to be responsible for the discharge of secretion from the posterior salivary glands. If this pair of nerves in interrupted the octopus does not poison a crab after catching it. It still eats, however, and learns to attack a strange figure. If both interbuccal connectives have been severed the octopus does not remove the flesh properly from crabs. It does not learn to attack a strange figure. Any operation on the central nervous system that interrupts the pathway from the interbuccal connectives to the lateral superior frontal and optic lobes prevents learning to attack a figure that has been seen. If such cuts pass through the middle of the superior buccal lobe the octopus does not poison crabs but may tear them open and then clean and eat them. With cuts still farther back the animal poisons, cleans, and eats crabs, but still does not learn to attack.

1443

London U Coll Dept of Anatomy (Gt Brit).

INFLUENCE OF PREVIOUS PREFERENCES ON THE

MEMORY OF OCTOPUS VULGARIS AFTER REMOVAL OF THE VERTICAL LOBE, by J. Z. Young. [1965] [9]p. incl. diagrs. refs. (AFOSR-66-1885) (AF EOAR-64-42) AD 644131 Unclassified

Also published in Jour. Exper. Biol., v. 43: 595-603, Aug. 1965.

Octopuses from which the vertical lobe had been removed attacked a vertical rectangle more readily than a horizontal one when both shapes were moved vertically. During discrimination training the results differed markedly according to which figure was rewarded with food. When a vertical rectangle was positive the excess of attacks at this figure increased both within and between sessions, the animals showing considerable ability to learn. When a horizontal rectangle was the positive figure the responses to it were at first 'paradoxical', the negative shape being attacked more often. There was then improvement within each session, but little if any between the sessions. Octopuses without the vertical lobe quickly ceased to attack crabs shown at 4 min intervals when shocks were given for attacks, and the effect could still be detected 4 hr later. When crabs were shown at 8 min intervals, and shocks given for attacks, there was no decline in attacks over 14 trials. Fifteen hr later, however, some residual signs of the shocks were evident when trials were resumed at 8 min intervals. Although all of the animals at first attacked they soon stopped doing so. After a further 15 hr all attacked again but soon ceased to do so after receiving shocks. Normal animals, by contrast, all ceased to attack the crabs shown at 8 min intervals after receiving 4 or 5 shocks. The memory is much more retentive in normal animals, so that 2 days after receiving shocks the octopuses seldom attacked the crabs.

1444

London U. Coll. Dept. of Anatomy (Gt. Brit.).

SPLIT-BRAIN PREPARATIONS AND TOUCH LEARNING IN THE OCTOPUS, by M. J. Wells and J. Z. Young. [1965] [16]p. incl. illus. diagrs. tables. (AFOSR-66-1887) (AF EOAR-64-42) AD 643910 Unclassified

Also published in Jour. Exper. Biol., v. 43: 565-579, Aug. 1965.

A vertical longitudinal cut through the supraoesophageal part of the brain does not prevent discrimination between rough and smooth cylinders. It does prevent correct response by the opposite side after training on one side of the animal. Octopuses with intact supraoesophageal lobes, trained on one side, discriminate when tested with the same objects of the other side, split-brain animals do not. In this situation, the performance of one side of the octopus can be used as a control for the effect of a brain lesion in the other. Removal of large parts from the supraoesophageal brain does not prevent touch-learning. Octopuses with the brain intact or with the vertical lobes removed do not show marked rough/smooth preferences. In animals with large lesions to the inferior frontal system there is a preference for rough, so that rough+/smooth- is an easier discrimination than vice versa.

1445

[London U. Coll. Dept. of Anatomy (Gt. Brit.)]

THE POSITIVE AND NEGATIVE LEARNING PROCESS IN OCTOPUS VULGARIS LAMARCK. INFLUENCE OF THE VERTICAL AND MEDIAN SUPERIOR FRONTAL LOBES, by H. Maldonado. [1965] [19]p. incl. diagrs. tables, refs. (AFOSP-66-2006) (AF EOAR-64-42) AD 643913 Unclassified

Also published in Zeitschr. Vergleich. Physiol., v. 51: 185-203, 1965.

A block diagram was constructed, in order to clarify the functions of the vertical and median superior frontal lobes of the brain, for the process by which Octopus vulgaris builds up to the values of a command to attack an object in its visual field. This model incorporates Young's idea of a balanced action of the median superior frontal-vertical lobe system and attributes precise functions to these lobes. Animals trained for some days to attack a given figure (positive) and not to attack another one (negative) underwent operative procedures to remove either the vertical or the median superior frontal lobe. According to the hypothesis animals without the vertical lobe should have a better post-operative performance with positive complexes than those without the median superior frontal lobe. With a negative figure the animals without the vertical lobe should show a poorer post-operative performance than the animals lacking the median superior frontal lobe. The animals' performance both before and after operation was studied in order to compare the effects of removing the vertical or median superior frontal lobe.

1446

London U. Coll. Dept. of Anatomy, London (Gt. Brit.).

A UNIT OF MEMORY, by J. Z. Young. [1965] [3]p. incl. diagrs. (AFOSR-66-2007) (AF EOAR-64-42) Unclassified

Also published in New Scientist, v. 28: 861-863, Dec. 1965.

In the author's view, memory is localized in small combinations of brain cells, which he calls "mnemons". Each contains alternative nerve pathways, which are either preserved or blocked in the light of experience. In this hypothesis, memory can be seen as a straightforward extension of reflex mechanisms.

1447

London U. Coll. Dept. of Anatomy (Gt. Brit.).

CONDUCTION VELOCITY AND DIAMETER OF NERVE FIBERS OF CEPHALOPODS, by T. M. O. Burrows, I. A. Campbell and others. [1965] [2]p. (AFOSR-66-2009) (AF EOAR-64-42) AD 643512 Unclassified

Presented at meeting of the Physiological Society, London U. Coll. (Gt. Brit.), Mar. 26-27, 1965.

Also published in Jour. Physiol., v. 179: 39-40, July 1965.

This relationship has been tested in Octopus, Sepia and Loligo, including fibers of a range of diameters in each species. Velocity was measured at 20°C on nerves kept at their natural lengths. Estimates were from the passage of impulses past at least 2 points. The smallest fibers were from the salivary duct nerves of Octopus, medium sized fibers were from arm, fin and mantle nerves of all 3 species, and the largest, from giant fibers of the stellar nerves of Sepia and Loligo. For the small and medium fibers, measurements were made from the foot of the compound action potential and the diameters of the largest fibers in the nerves were estimated from measurements of fresh and fixed nerves. The action potentials and diameters of the giant fibers were recorded individually.

1448

London U Coll. Dept. of Anatomy (Gt. Brit.).

THE BUCCAL NERVOUS SYSTEM OF OCTOPUS, by J. Z. Young [1965] [17]p. incl. illus. diagrs. refs. (AF EOAR-64-42) Unclassified

Published in Philos. Trans. Roy. Soc., London, v. 249B: 27-44, 1965.

The operations of killing and eating food by an octopus are under the control of a series of nervous centers. The poison center lies most posteriorly and is probably activated first, since it lies close to endings of fibers from the arms. The fibers of the nerves to the posterior salivary gland run without synapse from the superior buccal lobe to the glands, passing first far forward and then back along the duct. There is thus no peripheral synapse on this path, perhaps because no continuing rhythmic operations are involved in the secretion, and no reflex guidance is needed. The actual injection of the poison by the salivary papilla is controlled through the subradular ganglia. The cerebro-subradular connectives arise from the front of the superior buccal ganglia, near the entrance of the labial nerves, and run direct to the subradular ganglia, bypassing the inferior buccal ganglion. The interbuccal connectives also arise from the front of the superior buccal lobe and run to the inferior buccal ganglion. The inferior buccal ganglion sends nerves to the muscles of the jaws and radula and to the anterior salivary glands, buccal palps and oesophagus. Through the sympathetic nerve it communicates with the gastric ganglion. The inferior buccal ganglion has a complicated internal structure. From its outer surface arise numerous strands of the juxtaganglionic tissue, which end at the surfaces of the buccal sinus. The proportion of large cells decreases in the sequence posterior buccal, superior buccal, inferior buccal, subradular and gastric ganglia.

1449

London U Coll. Dept. of Anatomy (Gt. Brit.)

THE CENTRES FOR TOUCH DISCRIMINATION IN OCTOPUS, by J. Z. Young [1965] [23]p. incl. illus. diagrs. table, refs. (AF EOAR-64-42) Unclassified

Published in Philos. Trans. Roy. Soc. London, v. 249B: 44-67, 1965.

The inferior frontal system, concerned with learning chemotactile discriminations, shows 4 distinct regions. The posterior buccal lobes contain both large and small cells and are the center of the system. They receive fibers from the arms (without interweaving), from the lips, and from the buccal mass. They send fibers downwards to the arm centers and backwards to the optic and superior frontal vertical systems. This is therefore probably both a reflex center for response to some simple chemotactile stimuli and also the main output pathway for the whole system. In the lateral inferior frontal lobes the fibers from the arms interweave and mix with those from other sources. Their efferent fibers pass to the posterior buccal lobes and to the same destinations as the efferent fibers of the posterior buccal lobes. The organization of the lateral inferior frontal thus allows responses to combinations of chemotactile inputs. The median inferior frontal lobe receives the same input as the lateral inferior frontals, and its interweaving bundles allow for further spreading and combination between efferents. Its efferent axons pass only to the subfrontal lobes. The subfrontal lobes, besides the input from the median inferior frontal lobe, receive fibers from below. Their cells are mostly very small, with axons ending within the lobe. A few larger cells with axons running to the posterior buccal lobes carry the output. The tactile system is thus essentially similar to the visual one, with a pair of lower centers (posterior buccal and lateral inferior frontal) and a pair of upper ones (median inferior frontal and subfrontal). Embryologically these all differentiate from a single lobe, and the small cells of the upper lobes form a continuous layer with the relatively fewer small cells of the lower lobes. The main difference between the visual and tactile systems is the absence from the latter of a differentiated region corresponding to the optic lobe. From the evidence of Wells the change that constitutes a memory record occurs in the region of the posterior buccal lobe that contains both large and small cells. This region is under the influence of the circuit through lateral and median inferior frontal and subfrontal lobes.

1450

[London U Coll. Dept. of Anatomy (Gt. Brit.)]

LESIONS IN THE DORSAL BASAL LOBES OF OCTOPUS (Abstract), by J. R. Parriss [1965] [1]p. (AF EOAR-64-42) Unclassified

Published in Jour. Compar. Neurol., v. 125: 1-10, 1965.

Lesions were made in the dorsal basal lobe of the octopus. The size and the region of these lesions were

related to the animal's capacity to learn a simple visual discrimination and to the level of attack maintained during training. No significant relationship was found between the discrimination scores and the size of the lesion but there was evidence that the position of the lesion influenced discrimination.

1451

London U. Coll. Dept. of Anatomy (Gt. Brit.).

THE ORGANIZATION OF A MEMORY SYSTEM, by J. Z. Young. [1965] [38]p. incl. illus. diagrs. refs. (AFOSR-66-2366) (AF EOAR-66-53) AD 643417 Unclassified

Also published in Proc. Roy. Soc. (London), v. 163B: 285-320, 1965.

The report consists of the Croonian Lecture of 1965 in which Prof. Young summarizes his work on learning in the octopus and presents general theoretical ideas on the neural basis of memory.

1452

[London U. Coll.] Dept. of Physics (Gt. Brit.).

ON INVARIANT AMPLITUDES FOR SCATTERING PROCESSES, by G. Rasche and W. S. Woolcock. [1965] [9]p. (AFOSR-66-1314) (AF EOAR-64-62) AD 639521 Unclassified

Also published in Nuclear Phys., v. 68: 582-590, July 1965.

It is shown that to obtain the partial wave expansion of the invariant reaction amplitudes $\pi + N \rightarrow \pi + N$ and $\pi + \pi \rightarrow N + \bar{N}$, it is not necessary to use the low energy representation of the Dirac matrices. (Contractor's abstract)

1453

[London U. Coll.] Dept. of Physics (Gt. Brit.).

VERY SHORT-RANGE INTERACTION IN PION-NUCLEON SCATTERING, by A. Donnachie and J. Hamilton. [1965] [11]p. incl. diagrs. tables, refs. [AF EOAR-64-62] Unclassified

Published in Phys. Rev., v. 138: B678-B688, May 10, 1965.

The dispersion relations for $F_l(s) = f_l(s)/q^{2l}$, where $f_l(s)$ is the usual partial-wave amplitude, are required by unitarity to obey a high-energy boundary condition. It is shown that this gives rise to a unitary sum rule. This sum rule can be used to estimate the short-range parts of the pion-nucleon interaction, and that makes it possible to give accurate predictions of the non-resonant P-, D-, and F-wave π-N amplitudes up to around 650 mev. The results are in good agreement with a recent analysis of the experimental data. (Contractor's abstract)

1454

Louvain U. Dept. of Applied Mechanics (Belgium).

ON THE SINGULAR CONFIGURATIONS OF STATICALLY DETERMINATE STRUCTURES, by F. Buckens. [1965] [14]p. incl. diagrs. (AFOSR-65-2427) (AF EOAR-62-107) AD 627553 Unclassified

Also published in Internat'l. Jour. Mech. Sci., v. 7: 301-314, May 1965

This paper shows how singular configurations of statically determinate plane structures can be determined. When the structure is a linkage, such configurations entail degrees of freedom 'in the small,' which make it act as a mechanism for infinitesimal motions. Their practical importance comes from the fact that large constraints are induced in the members of the linkage when external forces act upon such structures, if their configuration is very close to a singular one. Different degrees and orders of singularity are considered, which respectively correspond to the rank and stationarity of a given determinant, and a few examples are given.

1455

Louvain U. Dept. of Applied Mechanics (Belgium).

DYNAMIC BEHAVIOR OF SHELLS UNDER THERMAL STRESS, by F. Buckens. 1965, 109p. incl. diagrs. refs. (AFOSR-66-0898) (AF EOAR-63-49) AD 634109 Unclassified

The effect of initial stress and in particular of thermal stress on the dynamical behavior of thin shells (vibration and propagation of bending waves) is studied. The case of a circular cylindrical is considered in detail, and several effects of initial stress and distributed moment evaluated. Methods of determining initial thermal stress and deflection are given and their effects on natural frequencies and modes considered. Local effects on the velocity of propagation of bending waves are studied in detail and quantitative evaluations are obtained. Comparison with experimental results is given.

1456

Louvain U. [Dept. of Applied Mechanics] (Belgium).

ON THE INFLUENCE OF THE ELASTICITY OF COMPONENTS IN A SPINNING SATELLITE ON THE STABILITY OF ITS MOTION, by F. Buckens. [1965] [32]p. incl. diagrs. (AFOSR-65-2740) (AF EOAR-65-66) AD 628247 Unclassified

When a rigid body in free space is spinning around one of its principal axes, besides the three translational modes with zero frequency and one rotational mode of zero frequency around the spin axis, one may consider two rotational modes of small amplitudes of oscillations around the two remaining axes, which will be called nutational modes. Their frequencies do not vanish and are only real if the spinning motion is stable. If now the body is allowed to be slightly elastic, the frequencies of the nutational modes will be altered, but at the same

time there will appear new frequencies corresponding to the so-called elastic modes. Natural stability of such systems and stability of spinning motion in magnetic and gravitational fields are important questions and must be considered when designing spin stabilized satellites. This investigation is conceived on a general basis and brings up only the broad features of a rather complex problem.

1457

Louvain U. [Lab. for Inorganic and Analytical Chemistry] (Belgium).

AN EMPIRICAL METHOD FOR THE ESTIMATION OF BOND DISSOCIATION ENERGIES, by A. Van Tiggelen, J. Peeters, and P. Burke. [1965] [4]p. incl. tables. (AFOSR-65-2167) (AF EOAR-63-42) AD 629027 Unclassified

Also published in Chem. Eng. Sci., v. 20: 529-532, June 1965.

An empirical formula for the calculation of bond dissociation energies D(A-B) is suggested: $D(A\text{-}B) = (1/2\alpha)[\alpha_A D(A\text{-}A) + \alpha_B D(B\text{-}B)]$ where α_A and α_B are constants characteristic of radicals A· and B· while α is either α_A or α_B, whichever has the smaller value. Values of α for 34 organic and inorganic radicals have been determined and tabulated. From values of D(A-B), heats of reaction Q can be calculated. Activation energies E for substitution reactions can then be evaluated with the help of Polanyi's relation: $E = (\text{const})_1 - (\text{const})_2 \cdot Q$. (Contractor's abstract)

1458

Louvain U. Lab. for Inorganic and [Analytical] Chemistry (Belgium).

THEORETICAL AND EXPERIMENTAL STUDY ON REACTION KINETICS IN FLAMES, by A. Van Tiggelen. Final technical rept. Oct. 1965, 13p. (AFOSR-65-2240) (AF EOAR-63-42) AD 628144 Unclassified

The existence of fundamental flammability limits is discussed. In case of a chain reaction mechanism the latter are predicted theoretically but the experimental are probably different from the theoretical limits. Other considerations are related to the a priori evaluation of dissociation energies. A formula is proposed which is based on two empirical parameters which characterize any kind of radical. An experimental study of lifted turbulent flames is reported; it links the stability of such flames with the characteristic turbulence parameters: intensity and scale. The location of the anchoring place of the flame corresponds to the locus where a stoichiometric composition is attained. Burning velocities, flame temperatures and flame thickness have been measured for methane-oxygen flames, extending from very rich to very poor mixtures at different degrees of dilution with nitrogen. The kinetical parameters which can be derived from these data strongly suggest the following branching reaction: $H + O_2$ yields $OH + O$.

1459

Louvain U. [Lab. for Inorganic and Analytical Chemistry] (Belgium).

KINETICS OF LAMINAR PREMIXED METHANE-OXYGEN-NITROGEN FLAMES, by R. Burke and A. Van Tiggelen. [1965] [23]p. incl. diagrs. tables, refs. (AFOSR-66-0056) (AF EOAR-63-42) AD 631104 Unclassified

Also published in Bull. Soc. Chim. Belg., v. 74: 426-449, 1965.

The velocity of flame propagation, the combustion gas temperature, and the reaction zone thickness was measured for more than 300 mixtures of different combinations of methane-oxygen-nitrogen. This experimental study confirmed the results of investigations, made by other workers, on the structure of the reaction zone of flames propagated in these particular mixtures. It was possible to derive the apparent activation energy as well as the partial orders with respect to the fuel and to oxygen.

1460

Louvain U., Lab. for Inorganic [and Analytical] Chemistry (Belgium).

THE STABILIZATION MECHANISM OF LIFTED DIFFUSION FLAMES, by L. Vanquickenborne and A. Van Tiggelen. [1965] [11]p. incl. diagrs. tables, refs. (AFOSR-66-1800) (AF EOAR-63-42) AD 639573 Unclassified

Also published in Combustion and Flame, v. 9: 59-69, Dec. 1965.

Measurements on gas composition, gas flow velocity, intensity and Eulerian scale of turbulence have been made in a free jet of methane emerging from a conventional circular burner into an unconfined atmosphere. From the experimental data it appears that the base of a lifted diffusion flame anchors in a region where a stoichiometric composition is attained. Accepting the assumption that the turbulent burning velocity V_t equals the gas flow velocity in this region, an experimental relation is obtained between V_t and the parameters of turbulence. Finally the stabilization conditions are discussed; blow off and drop back of the flame are explained by the interaction between aerodynamic flow patterns and burning velocity.

1461

Lund U. Dept. of Pharmacology (Sweden).

CHEMICAL SENSITIVITY OF SKELETAL MUSCLE, by S. Thesleff. Final technical rept. May 31, 1965, 3p. (AFOSR-65-1367) (AF EOAR-63-12) AD 621167 Unclassified

The parameters of transmitter release from mammalian motor nerve terminals were evaluated by electrophysiological techniques. The amount of transmitter available

for immediate release, the rate of transmitter mobilization and synthesis have been determined under a variety of experimental conditions and in myasthenia gravis.

1462

Lund U. Dept. of Pharmacology (Sweden).

NEUROMUSCULAR TRANSMISSION WITH SPECIAL REFERENCE TO MYASTHENIA GRAVIS, by D. Elmqvist. [1965] [34]p. incl. table, refs. (AFOSR-65-1547) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-12; Muscular Dystrophy Association of America, Inc., Public Health Service, and Swedish Medical Research Council) AD 624010 Unclassified

Also published in Acta Physiol. Scand., v. 64, 3uppl. 249: 1-34. 1965.

Investigations with repetitive stimulation of the normal neuromuscular junction have shown several weak links in the chain of events leading to the release of acetylcholine quanta: (1) The pool from which acetylcholine quanta is directly released is only sufficient for a few impulses. (2) The fraction of this pool which is released by a nerve impulse is influenced by the ionic environment and by previous activity. (3) The rate at which transmitter release can continue with repetitive stimulation is governed by the mobilization of acetylcholine quanta into this pool. (4) The store of transmitter from which acetylcholine quanta are mobilized to become available for release has a limited size and is only slowly replenished, probably by the formation of new quantal units. Mobilization can therefore only keep up with intense release for a short period of continuous rapid stimulation. (5) The synthesis of acetylcholine in the nerve terminal can be insufficient due to the lack of substrate or due to the presence of inhibiting drugs such as hemicholinium, and acetylcholine content of the quantal packets may be reduced. Studies of the neuromuscular transmission in myasthenia gravis demonstrated that this series of events can be affected by pathological conditions. The results indicate that in myasthenia gravis there is a deficiency in the amount of acetylcholine in the transmitter quantum, probably brought about by a defect in the quantum formation mechanism or by the presence of a false transmitter.

1463

Lund U. Dept. of Pharmacology (Sweden).

PRESYNAPTIC ACTION OF HEMICHOLINIUM AT THE NEUROMUSCULAR JUNCTION, by D. Elmqvist and D. M. J. Quastel. [1965] [20]p. incl. diagrs. table, refs. (AFOSR-65-1581) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-12 and Swedish Medical Research Council) AD 623376 Unclassified

Also published in Jour. Physiol., v. 177: 463-482, Apr. 1965.

By the use of intracellular electrodes a presynaptic effect of HC-3, hemicholinium no. 3, was shown at the mammalian neuromuscular junction. This effect was demonstrable only when the transmitter was released from the motor nerve terminals at a high rate and consisted of a progressive decline in the size of the miniature end-plate potentials and in the quantal components of the end-plate potentials as the transmitter was released. Releasing the transmitter by nerve stimulation or by increased potassium ion concentration were equally effective in eliciting the phenomenon. Postsynaptic chemosensitivity as measured by bath application of carbachol was the same before and after the quantal units had become small as a consequence of stimulation of transmitter release in the presence of HC-3. The effect is attributed to an inhibition of ACh synthesis by HC-3, the quanta becoming smaller in size as the presynaptic stores of ACh become depleted. It is suggested that the amount of releasable ACh in the motor nerve terminals can be estimated from the sum of all end-plate potentials and/or miniature end-plate potentials that can be elicited after blockade of ACh synthesis.

1464

Lund U. Dept. of Pharmacology (Sweden).

POTASSIUM INDUCED RELEASE OF TRANSMITTER AT THE HUMAN NEUROMUSCULAR JUNCTION, by D. Elmqvist. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-2515) (AF EOAR-63-12) AD 627621 Unclassified

Also published in Acta Physiol. Scand., v. 64: 1-6, 1965.

When the release of ACh quanta from the human intercostal motor nerve terminals, recorded as miniature end-plate potentials (m. e. p. p. s), was enhanced by raising the potassium ion concentration, the increased rates were only sustained if release rates were limited to not more than 150 m. e. p. p. s/sec either by not using higher concentrations of KCl than 30 mM, or by reducing release with increased magnesium and lowered calcium concentrations when higher potassium ion concentrations were used. If higher rates of release were allowed to occur in the presence of 40 to 50 mM KCl, the release rates subsequently declined to very low levels. The total number of quanta released by 40 or 50 mM KCl corresponded to the amount of ACh estimated to be present in the motor nerve terminals.

1465

Lund U. Dept. of Pharmacology (Sweden).

SPONTANEOUS ACTIVITY AT A MAMMALIAN NEUROMUSCULAR JUNCTION IN TETRODOTOXIN. by D. Elmqvist and D. S. Feldman. [1965] [2]p. (AFOSR-66-1129) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-12, Public Health Service, and Swedish Medical Research Council) AD 639622 Unclassified

Also published in Acta Physiol. Scand., v. 64: 475-476, 1965.

The results indicate that although the nerve could not propagate an action potential and thus not release ACh in response to stimulation, the depolarization dependent transmitter release was still unimpared in the presence of tetrodotoxin. The ability of the muscle end-plate to respond to transmitter liberated from the nerve terminals was demonstrated even though the concentration of toxin used was 10^3—10^2 times greater than that necessary to block nerve and muscle conduction. The m. e. p. p. s. observed in the presence of the toxin were, as in the normal, mainly the result of an increase in the sodium conductance of the end-plate membrane. It therefore appears that the sodium conductance increase induced by the transmitter is unaffected by the toxin and does not require all the steps needed to produce the conductance increase during the action potential. It is also possible that the sodium pathways are entirely separate for chemically and electrically induced conductance changes.

1466

Lund U. Dept. of Pharmacology (Sweden).

NEUROMUSCULAR TRANSMISSION IN VIVO AND THE ACTIONS OF DECAMETHONIUM: A MICRO-ELECTRODE STUDY, by D. V. Roberts and S. Thesleff. [1965] [8]p. incl. illus. diagrs. tables. (AFOSR-66-1134) (AF EOAR-63-12) AD 639623 Unclassified

Also published in Acta Anaesth. Scand., v. 9: 165-172, 1965.

The lateral segmental tail muscles of the rat have been used successfully for micro-electrode studies of neuromuscular transmission and the effects of decamethonium in vivo. The values obtained for the resting membrane potential of single muscle fibers and of miniature end-plate potential amplitude and frequency were similar to those previously obtained in other rat muscles in vitro. Decamethonium given intravenously produced end-plate depolarization, desensitization of acetylcholine receptors and, at high frequencies of nerve stimulation, a presynaptic block of impulse transmission.

1467

Lund U. Dept. of Pharmacology (Sweden).

CALCIUM DEPENDENCE OF SPONTANEOUS ACETYLCHOLINE RELEASE AT MAMMALIAN MOTOR NERVE TERMINALS, by D. Elmqvist and D. S. Feldman. [1965] [11]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-12, Public Health Service, and Swedish Medical Research Council) Unclassified

Published in Jour. Physiol. (London), v. 181: 487-497, Dec. 1965.

Spontaneous release of ACh from the rat-diaphragm motor-nerve terminals, manifest as miniature end-plate potentials (m. e. p. p. s.), was greatly reduced below the resting rate by prolonged exposure to calcium-free solutions. The presence of a chelating agent (EDTA) made the decline in rate greater; after 6 hr m. e. p. p. s were often abolished. Micro-electrophoretic local application of calcium induced return of activity after a latency of 250 msec. Concentrations achieved were about 10^{-3}-10^{-4} m at the nerve terminals. Restoration of calcium to the bath in these concentrations also restored activity. In muscle exposed to EDTA, caffeine or ouabain caused a rapid further decline in m. e. p. p. frequency. When EDTA was not present, these agents induced a rate increase even though Ca^{2+} was absent. $BaCl_2$ and $SrCl_2$ were able to restore and maintain activity completely abolished by prolonged calcium deprivation with EDTA. It is concluded that calcium is a necessary co-factor for the spontaneous release of ACh at the motor nerve terminals. Intracellular strongly bound stores are capable of supplying sufficient calcium to maintain activity.

1468

Lund U. Dept. of Pharmacology (Sweden).

EFFECTS OF SODIUM PUMP INHIBITORS ON SPONTANEOUS ACETYLCHOLINE RELEASE AT THE NEUROMUSCULAR JUNCTION, by D. Elmqvist and D. S. Feldman. [1965] [8]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-12, Public Health Service, and Swedish Medical Research Council) Unclassified

Published in Jour. Physiol. (London), v. 181: 498-505, Dec. 1965.

The ability of G-strophanthin to influence neuromuscular transmission in voluntary strated muscle has been known since 1955 but the mechanism of this action is not clear. It was then observed that prolonged exposure to high concentrations of ouabain caused a rapid release of acetylcholine recorded as miniature end-plate potentials. The parameters of this effect were therefore investigated. Quabain and sodium azide induce after a latency of about 30 min a rapid release of acetylcholine packages from the motor-nerve terminals. Increased concentrations of calcium but not of magnesium block the ouabain-induced augmented release of ACh packages. The effects of ouabain on transmitter release are explained by its calcium mobilizing and sodium pump inhibiting effect.

1469

Lund U. Dept. of Physics (Sweden).

THE RELATIVE ABUNDANCE OF NUCLEI HEAVIER THAN HELIUM IN PRIMARY COSMIC RADIATION NEAR THE GEOMAGNETIC EQUATOR, by O. Mathiesen and A. Stenman. [1965] [21]p. incl. diagrs. tables, refs. (AFOSR-65-1844) (AF EOAR-64-35) AD 625702 Unclassified

Also published in Arkiv Fysik, v. 29: 145-165, Nov. 26, 1965.

Photometric measurements were made on 89 tracks of heavy primary particles ($Z > 2$), which were found in an

emulsion stack exposed at Guam near the geomagnetic equator. The measurements were corrected for different emulsion effects. The standard error in the charge determination was found to be about 0.25 units of charge. The charge calibration was made by measurements of δ-ray and blob densities and by studying suitable breakup events. The observed spectrum was divided into 3 groups: L($3 \leq Z \leq 5$), M ($6 \leq Z \leq 9$), and H ($Z \geq 10$). These were extrapolated to the top of the atmosphere. The following deductions were made: (1) The ratio $N_L(0)/N_M(0) = 0.05 \pm 0.08$. A comparison of this value with determinations of the ratio at other latitudes suggests that the energy spectrum of L nuclei may possibly be steeper than that of M nuclei. Some of the hypotheses proposed to explain the energy dependence of $N_L(0)/N_M(0)$ are discussed. Of these, the 3-dimensional diffusion model of particle propagation is found to be capable of accounting for the observed energy dependence, assuming that "soft" magnetic clouds are responsible for the diffusion mechanism. (2) The amounts of C and N nuclei relative to O nuclei at the top of the atmosphere are 1.4 ± 0.4 and 0.3 ± 0.1 respectively. (3) The ratio $N_H(0)/N_M(0) = 0.31 \pm 0.09$. This value is within the statistical limits of error consistent with determinations of the ratio at other latitudes.

1470

Lund U. Dept. of Physics (Sweden).

FLUX AND ENERGY SPECTRUM OF LOW-ENERGY COSMIC RAY PROTONS, by K. Kristiansson. [1965] [10]p. incl. diagrs. table. (AFOSR-65-1845) (AF EOAR-64-35) AD 625701 Unclassified

Also published in Arkiv Fysik, v. 29: 23-32, Nov. 24, 1965.

A spectrum of protons in the energy interval 25-150 mev is studied in a nuclear emulsion block which was exposed in a Nike-Cajun rocket launched from Kronogard in Northern Sweden. The exposure was made at a time of low solar activity. The integral momentum spectrum of the protons can approximately be expressed by the formula $J = K \exp(-p/q)$ where $K = 11,000$ protons/m-sq sec, and sterad and $Q = 75$ mv. The spectrum is discussed and compared with solar flare proton spectra.

1471

Lund U. Depts. of Histology and [Zoology] (Sweden).

A DETAILED METHODOLOGICAL DESCRIPTION OF THE FLUORESCENCE METHOD FOR THE CELLULAR DEMONSTRATION OF BIOGENIC MONOAMINES, by B. Falck and C. Owman. 1965, 23p. incl. illus. diagr. refs. (AFOSR-65-0959) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-5, Association for the Aid of Crippled Children, Public Health Service, and Swedish Medical Research Council) Unclassified

Also published in Acta Univ. Lund, Sect. II, No. 7: 5-23, 1965.

A methodological description gives detailed instructions for the preparation, freeze-drying, histochemical treatment, and sectioning of tissues for fluorescence microscopy of catecholamines, 5-hydroxytryptamine and their immediate precursors.

1472

Lund U. Depts. of Histology and Zoology (Sweden).

MONOAMINES IN THE SWIMBLADDER OF GADUS CALLARIAS AND SALMO IRIDEUS, by G. Fahlen, B. Falck, and E. Rosengren. [1965] [8]p. incl. illus. table, refs. (AFOSR-65-1554) (AF EOAR-64-5) AD 622909 Unclassified

Also published in Acta Physiol. Scand., v. 64: 119-126, 1965.

The noradrenaline in the swimbladder of the cod and the rainbow trout is stored in short adrenergic neurons whose perikarya are located in close relation to the swimbladder itself. In the cod, the noradrenergic neurons are innervated by noradrenergic neurons that arise from the coeliac ganglion of the sympathetic chain. A hitherto unknown system of epithelial cells storing 5-hydroxytryptamine was observed in the trout swimbladder. (Contractor's abstract)

1473

Lund U. Depts. of Histology and Zoology (Sweden).

CELLULAR LOCALIZATION OF MONOAMINES IN THE UPPER BRAIN STEM OF THE PIGEON, by K. Fuxe and L. Ljunggren. [1965] [27]p. incl. illus. tables, refs. (AFOSR-66-0736) (AF EOAR-64-5) AD 633571 Unclassified

Also published in Jour. Compar. Neurol., v. 125: 355-382, 1965.

With the help of a highly sensitive and specific fluorescence method developed by Falck and Hillarp, in combination with a pharmacological approach, it has been possible to demonstrate the presence in birds of specific neurons of 2 distinctly different types, which in all probability form and store a primary catcholamine and 5-hydroxytryptamine, respectively. The amines are in low concentrations in the cell bodies and axons but stored in very high concentrations in the terminals, especially in the abundant varicosities. At least three large ascending monoamine systems appear to be present within the upper brain stem. Many— if not most of the ascending fibers arise in all probability from cell bodies within the mesencephalon and run rostrally mainly in the medial forebrain bundle. Two of the neuron systems produce and store a primary catecholamine, one probably giving rise mainly to terminals within the hypothalamus and the preoptic area, the other within the corpus striatum. The remaining

system produces and stores 5-hydroxytryptamine. The modified ependyma seems to consist —at least partly— of 2 types of cells forming and storing either a primary catecholamine or 5-hydroxytryptamine.

1474

Lund U. Depts. of Histology [and Zoology] (Sweden).

NORADRENALINE AND CHOLINESTERASES IN CONCOMITANT NERVE FIBRES IN THE RAT IRIS, by B. Ehinger and B. Falck. [1965] [4]p. incl. refs. (AFOSR-66-1135) (AF EOAR-64-5) AD 639525 Unclassified

Also published in Life Sci., v. 4: 2097-2100, 1965.

Burn and Rand have suggested that the sympathetic nervous system operates by way of a cholinergic link in the liberation of nervous catecholamines (CA). The direct histochemical demonstration of high concentrations of CA in the terminal sympathetic neurons which can be liberated upon the stimulation of the sympathetic nerves and the rapid disappearance of noradrenaline in the tissues after sympathetic denervation demonstrate that the sympathetic nerve endings are the principal peripheral store of CA. Recently, Leaders advanced the hypothesis that there may be local peripheral interaction between adrenergic and cholinergic neurons. The arguments brought forward for this as well as the Burn and Rand hypotheses are however mainly circumstantial only. In order to obtain direct morphological evidence relevant to the two hypotheses, a combination of the fluorescence method of Falck and Hillarp for the demonstration of CA and the cholinesterase technique of Koelle has been worked out on whole amounts of the rat iris.

1475

Lund U. Depts. of Histology and Zoology (Sweden).

ON THE PRESENCE OF ADRENERGIC NERVES IN THE PARS INTERMEDIA OF THE FROG, RAN TEMPORARIA, by A. Enemar and B. Falck. [1965] [7]p. incl. tables, refs. (AFOSR-66-2030) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-5 and Swedish Natural Science Research Council) AD 645026 Unclassified

Also published in Gen. and Compar. Endocrinol., v. 5: 577-583, Oct. 1965.

By means of a highly specific and sensitive fluorescence method, a plexus of catecholamine-containing nerve terminals has been demonstrated in the pars intermedia of the frog, Rana temporaria L. This plexus, which synaptically encloses the intermedia cells, possesses the basic characteristics of an adrenergic ground-plexus. There is support for the hypothesis that these adrenergic fibers mediate the inhibitory control by the brain of the pars intermedia.

1476

Lund U. Depts. of [Histology and Zoology] (Sweden).

ON THE CONTROL OF VENTRICULAR FIBRILLATION DURING HYPOTHERMIA, by K. C. Nielsen and C. Owman. 1965, 13p. incl. diagrs. refs. (Communication no. 6) (AFOSR-65-1110) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-66-14 and Swedish Medical Research Council) AD 637482 Unclassified

Preliminary results are presented of studies on the possible role of adrenergic mechanisms in the production of ventricular fibrillation during hypothermia. The pattern of adrenergic innervation in the heart ventricles was investigated by means of a histochemical fluorescence method. In the hibernating animal studied (hedgehog) few, if any, adrenergic nerves were found in the ventricular muscle tissue, whereas the blood-vessels were supplied by a system of adrenergic nerve terminals. This contrasts with the cat ventricles, in which adrenergic nerves enclose both the muscle fibers and the vessels. One group of cats were pretreated with segontin (N-(3'-phenyl-propyl-(2'))-1, 1-diphenyl-propyl-(3)-amine), which causes a severe depletion of noradrenaline from the adrenergic nerves to the heart muscle, whereas noradrenaline more or less remains in the nerves to the heart vessels. The animals were then cooled to a rectal temperature of 17.8°—17.2°C and re-warmed to 24°C. None of these animals developed ventricular fibrillation. The same number of control cats died in ventricular fibrillation at 22° to 1[illegible]°C rectal temperature. Blockage of the adrenergic beta-receptor with INPEA (N-isopropyl-p-nitrophenyl ethanolamine) prevented ventricular fibrillation in cats cooled to 17.2°—17°C rectal temperature. These animals were returned to normothermia and kept for long-term survival.

1477

Lyon U. [Dept. of Physiology] (France).

[STUDY OF EYE MOVEMENT DURING THE PARADOXICAL PHASE OF SLEEP IN THE CAT] Etude de la motricite oculaire au cours de la phase paradoxale du sommeil chez le Chat, by M. Jeannerod, J. Mouret, and M. Jouvet. [1965] [13]p. incl. illus. diagrs. table, refs. (AFOSR-65-2672) (AF EOAR-62-67) AD 629218 Unclassified

Also published in Electroencephalog. and Clin. Neurophysiol. Jour., v. 18: 554-566, 1965.

The rapid eye movements (REM) occurring during the stage of sleep with fast cortical activity, or paradoxical stage of sleep (PP), have been studied by the electro-oculographic method in chronically implanted cats which were either normal or had brain lesions. In the normal cat, during the PP, the eye movements are either isolated, in small groups (like during visual observation) or in bursts (more than 5

movements); these bursts are specific to the PP. The sped of isolated movements during sleep is slightly slower than that of isolated movements during visual observation. Results suggest that an oculomotor system, triggered by the pons, is responsible for the eye movements during sleep. A schematic organization of such a system is proposed.

1478

Lyon U. [Dept. of Physiology] (France).

PARADOXICAL SLEEP--A STUDY OF ITS NATURE AND MECHANISMS, by M. Jouvet. [1965] [43]p. incl. illus. diagrs. refs. (AFOSR-65-2683) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-67, Direction General des Recherches et Moyens d'Essai, and Fonds de Developpement de la Recherche Scientifique)
AD 629202 Unclassified

Also published in Progress in Brain Research, v. 18: 20-62, 1965.

The EEG findings and behavioral, phylogenetic, ontogenetic, functional and structural criteria are presented, representing a number of concordant arguments in favor of the duality of the states of sleep and of the autonomy, at least relative, of paradoxical sleep (P.S) with respect to slow sleep. An attempt is made to delimit certain mechanisms regulating the appearance of P.S.

1479

[Lyon U. Dept. of Physiology (France)]

[SUPPRESSION OF IEFFERENT SLEEP STATES] La suppression des differents etats de sommeil, by P. Vimont-Vicary. 1965. 95p. incl. illus. diagrs. tables, refs. (AFOSR-66-0567) (AF EOAR-62-67)
AD 632874 Unclassified

Cats with chronically implanted electrodes were selectively deprived of paradoxical sleep for 1-26 days by the swimming pool and electric shock techniques. The "need for paradoxical sleep" was demonstrated by the progressive diminution of the intervals between attempts to enter this phase. Deprivation of this phase of sleep for more than a week produced somnolence, muscular hypotony, sexual excitement, tachycardia, and a picture resembling hallucinations. At the end of this deprivation there was a selective paradoxical sleep "rebound," and up to 60% of the first 6 hr was spent in this phase of sleep. Substances with an inhibitory effect on paradoxical sleep, such as atropine, monoamine oxidase inhibitors, and reserpine, were studied, and the results are discussed in light of a neurohumoral hypothesis of sleep.

1480

Lyon U. [Dept. of Physiology] (France).

THE EFFECTS OF CHRONIC BRAIN-STEM LESIONS ON CORTICAL AND MUSCULAR ACTIVITY DURING SLEEP AND WAKING IN THE CAT, by J. A. Hobson. [1965] [22]p. incl. illus. diagrs. tables, refs. (AFOSR-66-1113) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-67, Fonds de Developpement de la Recherche Scientifique, and National Institute of Mental Health) AD 639516 Unclassified

Also published in Electroencephalog. and Clin. Neurophysiol. Jour., v. 19: 1-15, July 1965.

The effects of total sections and lesions of the brain-stem on some aspects of cortical and muscular activity in relation to sleep and waking have been studied chronically in cats. The periodic muscular atonia of sleep is progressively inhibited as lesions are placed more caudally in the ponto-mesencephalic brain-stem. The pontine reticular formation is necessary and sufficient for its occurrence. Cortical desynchronization and waking are inhibited as lesions are placed more rostrally in the infrathalamic brain-stem, while desynchronized sleep appears normally. The posterior hypothalamus plays a particularly important role in the desynchronization of waking and the pontine brain-stem in the desynchronization of sleep, but their final common path may be the same. The coordination of tonic cortical and muscular activity, especially as manifested in desynchronized sleep, is disrupted by any total section and unaffected by any partial lesion of the brain-stem. The nervous structures involved are thus diffusely distributed in the ponto-mesencephalic brain-stem. The phasic electrical activity of desynchronized sleep disappears from structures anterior to the mid-brain after any lesion of the dorsal pons or mesencephalon. Such activity may be related to the difference in pattern of firing of brain-stem and cortical units that distinguishes desynchronized sleep and waking and underlies the difference in arousal thresholds between these two states by the mechanism of occlusion. (Contractor's abstract)

1481

Lyon U. [Dept. of Physiology] (France).

NEUROPHYSIOLOGICAL MECHANISMS OF THE STATES OF SLEEP, by M. Jouvet. Final rept. July 1964-Sept. 1965. Oct. 15, 1965 [11]p. incl. refs. (AFOSR-65-2655) (AF EOAR-64-66) AD 628246 Unclassified

The main findings are: (1) neuroanatomical evidence that 2 different systems are responsible for tonic and phasic phenomena during paradoxical sleep, and (2) neuropharmacological evidence that these 2 systems depend upon different mechanisms related with monoamines.

1482

Lyon U. [Dept. of Physiology] (France).

[DEVELOPMENT OF THE ELECTRICAL SIGNALS OF PARADOXICAL SLEEP DURING PHENOBARBITAL NARCOSIS] Evolution des signes électriques du sommeil paradoxal au cours de la narcose au pentobarbital, by D. Jouvet, F. Delorme and M. Jouvet. [1965] [4]p. incl. diagrs. (AFOSR-66-0731) (AF EOAR-64-66) AD 633324 Unclassified

Also published in Compt. Rend. Seances Soc. Biol., v. 159: 387-390, 1965.

Experiments with pentobarbital narcosis under normal conditions and following deprivation of paradoxical sleep show that the periods of monophasic spikes at the level of the lateral geniculate ganglion, which are specific to paradoxical sleep, may persist during narcosis without any other signs of paradoxical sleep and are facilitated by previous deprivation of paradoxical sleep.

1483

Lyon U. [Dept. of Physiology] (France).

[TRIGGERING THE OCULOMOTOR SYSTEM DURING SLEEP] Mise en jue du système oculomoteur pendant le sommeil, by J. Mouret, M. Jeannerod and M. Jouvet. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-0876) (AF EOAR-65-94) AD 633323 Unclassified

Also published in Confinia Neurologica, v. 25: 291-299, 1965.

Rapid eye movements during paradoxical sleep have been studied in the cat, and lesions have been made in various parts of the central nervous system to investigate their effects on oculomotor activity during both paradoxical sleep and arousal. Some observations on eye movements in normal human subjects and in patients with CNS pathology have been cited and compared with the findings from the experimental animal. The possible diagnostic use of oculographic recordings during sleep is suggested.

1484

McMaster U. Dept. of Chemistry, Hamilton, Ont. (Canada).

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY OF SOME SELENIUM COMPOUNDS, by T. Birchall, R. J. Gillespie, and S. L. Vekris. [1965] [8]p. incl. diagr. tables, refs: (AFOSR-65-1670) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-516 and National Research Council of [Canada]) AD 624331 Unclassified

Also published in Canad. Jour. Chem., v. 43: 1672-1679, June 1965.

Selenium nuclear magnetic resonance spectra have been observed for a number of selenium compounds. Chemical shifts and coupling constants with hydrogen and fluorine have been obtained. Various systems involving selenium compounds have been studied. It was found that a mixture of $SeOF_2$ and $SeOCl_2$ contains SeOClF and that rapid selenium exchange occurs between $SeOCl_2$ and $SeOBr_2$ presumably via the intermediate SeOClBr. The reactions of selenium tetrahalides with sulfur and selenium trioxides and with boron trifluoride were studied. It was observed that antimony pentachloride, tin tetrachloride, arsenic trichloride, quinoline, and potassium chloride produce considerable shifts in the resonance of selenium oxychloride. These shifts can be interpreted in terms of the acid-base behavior of the solutes.

1485

McMaster U. [Dept. of Chemistry] Hamilton, Ont. (Canada).

SOLUTIONS IN NON-AQUEOUS SOLVENTS, by R. J. Gillespie. Final rept. [1965] [8]p. incl. diagrs. refs. (AFOSR-66-0629) (AF AFOSR-64-516) AD 630795 Unclassified

The broad long-term objective of this work was to extend the knowledge of highly acidic non-aqueous solvent systems and to use such solvents for the study of the formation and reactions of new ionic and molecular species which are unstable in water and other more familiar solvents. Fluorosulfuric acid was studied in considerable detail. Some of the more important conclusions were: (1) Fluorosulfuric acid is more acidic than sulfuric acid and it is, therefore, the most highly acidic solvent that has been studied; (2) The autoprotolysis ions $H_2SO_3F^+$ and SO_3F^- conduct by a proton-transfer mechanism; (3) Iodine can be oxidized in this solvent to the hitherto unknown I_2^+ ion which gives the blue color formerly attributed to I^+, which does not appear to be stable; and (4) Phenol and anisole protonate on the aromatic ring and not on oxygen. A similar study of the HF solvent system has been initiated, but has not progressed so far. The behavior of the acid SbF_5 has been studied in some detail and evidence has been obtained for the formation of the new dimeric ion $Sb_2F_{11}^-$. This work has considerably extended our knowledge of highly acidic non-aqueous media and has shown the importance of these solvents in the study of new species, particularly positive ions, that are unstable in more basic media.

1486

McMaster U. Dept. of Chemistry, Hamilton, Ont. (Canada).

THE FLUOROSULFURIC ACID SOLVENT SYSTEM. II. SOLUTIONS OF ANTIMONY PENTAFLUORIDE, ANTIMONY TETRAFLUORIDE MONOFLUOROSULFATE, AND ANTIMONY PENTAFLUORIDE—SULFUR TRIOXIDE MIXTURES, by R. C. Thompson, J. Barr and others. [1965] [10]p. incl. diagrs. tables. (AFOSR-67-0545) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-516], Defence Research Board of Canada, and Petroleum Research Fund) AD 647880 Unclassified

Also published in Inorg. Chem., v. 4: 1641-1649, Nov. 1965.

Conductometric, cryoscopic, and nuclear magnetic resonance studies on solutions of SbF_5, SbF_4SO_3F, and SbF_5—SO_3 mixtures in fluorosulfuric acid show that there exists a series of acids with the general formula $H[SbF_{5-n}(SO_3F)_{1+n}]$ where n = 0, 1, 2, and 3 which increase in strength with increasing values of n. The acid $H[SbF_2(SO_3F)_4]$ is a strong acid of the fluorosulfuric acid solvent system. Dimeric and probably higher polymeric forms of these acids are also present in the solutions and nmr studies show that polymerization occurs through fluorosulfate bridges. The fluorosulfuric acidium ion, $H_2SO_3F^+$, has been shown to have an abnormally high conductivity in this solvent and it is concluded that it conducts by proton transfer. (Contractor's abstract)

1487

McMaster U. Dept. of Chemistry, Hamilton, Ont. (Canada).

CATIONS AND OXY CATIONS OF IODINE. III. THE +1 AND LOWER OXIDATION STATES OF IODINE IN SULFURIC ACID, by R. A. Garrett, R. J. Gillespie, and J. B. Senior. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-67-0546) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-516] and National Research Council of Canada) AD 647861 Unclassified

Also published in Inorg. Chem., v. 4: 563-566, Apr. 1965.

The results of measurements of the conductivities and freezing points of solutions formed by adding iodine and/or iodine monochloride or iodine monobromide to solutions of iodic acid in sulfuric acid are reported. The results provide evidence for the formation of the ions I_3^+, I_5^+, I_2Cl^+, I_2Br^+, and ICl_2^+ in these solutions and show that at the concentrations studied I^+ is essentially completely disproportionated into I_3^+ and IO^+.

1488

McMaster U. Dept. of Metallurgy and Metallurgical Engineering, Hamilton, Ont. (Canada).

THE PARABOLIC OXIDATION KINETICS OF BETA-ZIRCONIUM, by C. J. Rosa and W. W. Smeltzer. [1965] [6]p. incl. illus. diagrs. table. (AFOSR-65-0787) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-515] and Defence Research Board of Canada) AD 614556 Unclassified

Also published in Acta Metall., v. 13: 55-60, Feb. 1965.

An investigation is reported on the oxidation properties of β-zirconium at 950°C in oxygen for periods extending to 100 hr. The kinetics were determined by a volumetric technique and may be represented by a parabolic relationship after a period of rapid oxidation. The thickness of the zirconium dioxide scale and the underlying layer of α-zirconium-oxygen solid solution were determined by metallographic techniques. Parabolic diffusion relationships derived from a 3-phase oxide-metal model account for the kinetics of oxidation, scale growth and oxygen solution in the metal. (Contractor's abstract)

1489

McMaster U. Dept. of Metallurgy and Metallurgical Engineering, Hamilton, Ont. (Canada).

BREAKAWAY PHENOMENA IN THE OXIDATION OF ZIRCONIUM AT 850 AND 950°C, by G. R. Wallwork, C. J. Rosa, and W. W. Smeltzer. [1965] [14]p. incl. illus. diagrs. refs. (AFOSR-65-0788) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-515] and Atomic Energy of Canada, Ltd.) AD 616466 Unclassified

Also published in Corrosion Sci., v. 5: 113-120, Feb. 1965.

An investigation is reported on the deviations from parabolic oxidation kinetics to more rapid rates for zirconium at 850° and 950°C. Stresses in the oxide and in metal containing oxygen in solid solution induced cracks in both phases and permitted increased localized oxidation. Small voids were observed at the metal/oxide interface in metallographically prepared sections of oxidized specimens and a duplex scale was formed by cracking between these voids. A distinctly different type of scale was produced where the metal had cracked. Growth of this type of scale was induced by injecting small amounts of water vapor in the oxygen atmosphere and resulted in catastrophic failure of the specimens. (Contractor's abstract)

1490

McMaster U. Dept. of Metallurgy and Metallurgical Engineering, Hamilton, Ont. (Canada).

OXIDATION OF METALS AND ALLOYS, by W. W. Smeltzer. Final rept. Oct. 31, 1963-Oct 31, 1965, 1v. incl. illus. diagrs. tables, refs. (AFOSR-65-2236) (AF AFOSR-64-515) AD 629841 Unclassified

Research studies were conducted to obtain a more detailed understanding of the oxidation mechanism of zirconium and iron-nickel alloys, and the diffusion and thermodynamic properties of oxygen for the above systems. Emphasis was placed on precise measurements of reaction kinetics, and measurements of thermodynamic properties of oxides by the electromotive solid galvanic cell technique. Studies were initiated on the properties of ionic diffusion in metal oxides utilizing measurements of oxygen exchange by mass spectrometry and electrical conductivity. A brief summary of the completed investigations are presented; the full reports are appended.

1491

McMaster U. Dept. of Metallurgy and Metallurgical Engineering, Hamilton, Ont. (Canada).

THE REACTION OF ZIRCONIUM WITH CARBON DIOXIDE AND CARBON MONOXIDE AT 850°C, by R. J. Hussey and W. W. Smeltzer. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2543) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-515] and Defence Research Board of Canada) AD 622931 Unclassified

Also published in Jour. Electrochem. Soc., v. 112: 554-560, June 1965.

An investigation has been made of the kinetics, the chemistry, and the solid-state processes for the reaction of Zr with CO_2 and CO at 850°C. In CO_2 at 10 cm Hg pressure, the kinetic curve showed an initial decreasing rate, an intermediate increasing rate, and a final decreasing rate. The ratio of carbon to oxygen uptake by Zr in CO_2 was dependent on time and varied from 0.19 to 0.04 over a period 1-48 hr. Carbon produced in the early stages of reaction was incorporated into the oxide and led to formation of a needle-like phase of a ternary lower oxide or a solid solution at the metal/oxide interface. Due to a high ratio of carbon to oxygen uptake in CO this phase developed to a distinct intermediate layer between the oxide scale and metal substrate. The kinetic curves in this gas exhibited a continuously decreasing oxidation rate; eventually breakaway occurred, possibly due to the presence of the secondary phase at the metal-oxide interface. In the range of parabolic oxidation for both CO_2 and CO, the rates were similar in magnitude to that found in oxygen. Comparison of oxygen gradients demonstrated that the extent of oxygen solutions in the metal was the same for oxidation in these gases. (Contractor's abstract)

1492

McMaster U. Dept. of Physics, Hamilton, Ont. (Canada).

SOME LOW-ENERGY ATOMIC STOPPING CROSS SECTIONS, by J. H. Ormrod, J. R. MacDonald, and H. E. Duckworth. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-0482) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-159] and National Research Council of Canada) AD 613742 Unclassified

Also published in Canad. Jour. Phys., v. 43: 275-284, Feb. 1965.

The electronic stopping cross sections for photons in aluminum are reported in the energy interval $10 < E < 70$ kev. Stopping cross sections below 150 kev in carbon targets for projectiles with $13 \leq Z \leq 19$, and in aluminum targets for $Z \leq 11$ are reported also. The results are compared with theory and show reasonable agreement. The previously reported periodic dependence of S_ϵ on the atomic number of the projectile is also evident in the present results. (Contractor's abstract)

1493

McMaster U. Dept. of Physics, Hamilton, Ont. (Canada).

EFFECT OF MAGNETIC-FIELD NONUNIFORMITIES ON THE FOCUSING OF A SECOND-ORDER DOUBLE-FOCUSING MASS SPECTROMETER, by R. C. Barber. [1965] [6]p. incl. diagrs. (AFOSR-65-1067) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-159] and National Research Council of Canada) AD 620553 Unclassified

Also published in Canad. Jour. Phys., v. 43: 716-721, Apr. 1965.

The results of a numerical calculation investigating the effect of magnetic-field nonuniformities on the focusing of a second-order double-focusing mass spectrometer are reported. Because the image formed in previous experiments was so sharp, the aberrations were studied in the present investigation in finer detail than in former experiments. For each of the magnetic-field configurations considered, 9 ion trajectories were traced. Attention was confined to ions moving in the midplane of the magnetic field, and it was assumed that the field abruptly terminated at the boundaries.

1494

Madrid U. [Dept. of Crystallography] (Spain).

THERMAL EXPANSION OF β-SUCCINIC ACID AND α-ADIPIC ACID IN RELATION TO THEIR CRYSTAL STRUCTURES, by J. L. Amoros, M. L. Canut, and E. Neira. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR-66-1611) (AF EOAR-62-92) AD 639520 Unclassified

Also published in Proc. Roy. Soc. (London), v. 285A: 370-381, May 1965.

The thermal expansion quadrics of β-succinic acid and α-adipic acid have been determined by x-ray Weissenberg method. In adipic acid, x-ray measurements have been made between -100 and +100°C and in succinic acid between -150 and +130°C. In these monoclinic crystals, the minimum expansion corresponds to the c axis, which coincides with the direction of the hydrogen-bonded molecular columns. In other directions along which van der Waals forces prevail thermal expansion is greater, being maximum perpendicular to the (100) planes, the direction of the obtuse bisectrix of the molecular packing angle. The thermal expansion is quantitatively explained by assuming an increase in the angular vibration of the molecules. (Contractor's abstract)

1495

Maine U. Dept. of Physics, Orono.

INFLUENCE OF ELECTRIC AND MAGNETIC FIELDS ON THE MICROWAVE DIELECTRIC CONSTANT OF A LIQUID CRYSTAL WITH A POSITIVE DIELECTRIC ANISOTROPY, by E. F. Carr. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-0789) (AF AFOSR-64-605) AD 616472 Unclassified

Also published in Jour. Chem. Phys., v. 42: 738-742, Jan. 15, 1965.

The dielectric constant and loss in the anisotropic and normal liquid phases of anisal-p-aminoazobenzene were measured at frequencies of 6 and 24 kmc/sec. Measurements were made with an external magnetic field parallel and perpendicular to the microwave electric field at both frequencies while the measurements in the presence of an external electric field were made at only 6 kmc/sec with the external electric field parallel to the microwave electric field. Results in the presence of an external magnetic field were similar to those for p-azoxyanisole and anisaldazine which have a negative dielectric anisotropy. Measurements in the presence of an external electric field indicate that the alignment of the molecules due to low frequency ac fields is comparable to that produced by magnetic fields providing saturation is reached. Disturbances which were due to an electric field appeared to have an appreciable effect on the alignment when dc fields were applied, but this was not observed for ac fields with frequencies between 20 and 300,000 cps. (Contractor's abstract)

1496

Maine U. Dept. of Physics, Orono.

INFLUENCE OF ELECTRIC AND MAGNETIC FIELDS ON THE MOLECULAR ALIGNMENT IN THE LIQUID CRYSTAL ANISAL-p-AMINOAZOBENZENE, by E. F. Carr. [1965] [6]p. incl. diagrs. table. (AFOSR-66-1627) (AF AFOSR-64-605) AD 641784 Unclassified

Also published in Jour. Chem. Phys., v. 43: 3905-3910, Dec. 1, 1965.

The molecular alignment was studied for anisal-p-aminoazobenzene in the presence of external magnetic and ac electric fields. Measurements of the dielectric loss at a microwave frequency of 24 kmc/sec were used to indicate the extent of the molecular alignment. For the external fields parallel to each other, the degree of molecular alignment which could be obtained for a 370 kc/sec electric field was the same as that which could be produced by a magnetic field. For the magnetic and electric fields perpendicular to each other, the ratio of E/H corresponding to a random orientation of the molecules in the plane of E and H was obtained. As the magnetic field was changed from 500 to 3000 G the ratio of E/H remained constant within the limits of

experimental error. The value obtained for E/H could not be explained by assuming that the processes responsible for the molecular alignment were associated with only the anisotropy in the dielectric constant and the permeability. (Contractor's abstract)

1497

[Manchester U.] Dept. of Chemistry (Gt. Brit.).

INHIBITION OF THE THERMAL REACTION BETWEEN HYDROGEN AND OXYGEN, by D. R. Blackmore, D. R. Clark, and R. F Simmons. Final rept. Mar. 1, 1965 [28]p. incl. diagrs. refs. (AFOSR-65-1239) (AF EOAR-62-88) AD 621216 Unclassified

The kinetics of the inhibiting action of HBr and HCl on the thermal reaction between hydrogen and oxygen was investigated. HBr was found to be a very effective inhibitor of the reaction, while HCl was relatively inefficient. The kinetic characteristics of the inhibition were examined, and it was shown that in the case of HBr the primary inhibition step is: $H + HBr \rightarrow H_2 + Br$. Only a fraction of the bromine atoms produced in this reaction react to give chain termination, however, and the majority react to give chain propagation by: $Br + H_2 \rightarrow HBr + H$. It is suggested that chain termination occurs by: $Br + HO_2 \rightarrow HBr + O_2$. The corresponding mechanism is also operative when HCl is the inhibitor, but a second primary inhibition step is also important in this case: $OH + HCl \rightarrow H_2O + Cl$. The reason for the marked difference in efficiency of HBr and HCl is discussed.

1498

Manchester U. Dept. of Chemistry (Gt. Brit.).

INHIBITION OF THE SECOND LIMIT OF THE HYDROGEN-OXYGEN REACTION BY HYDROGEN BROMIDE AND HYDROGEN CHLORIDE, by D. R. Blackmore, G. O'Donnell, and R. F. Simmons. [1965] [8]p. incl. diagrs. refs. (AFOSR-66-1791) (AF EOAR-62-88) AD 639518 Unclassified

Also published in Tenth Symposium (Internat'l.) on Combustion, Cambridge (Gt. Brit.) (Aug. 17-21, 1964), Pittsburgh, Combustion Inst., 1965, p. 303-310.

The effect of hydrogen bromide and hydrogen chloride on the second limit of the hydrogen-oxygen reaction has been studied over a wide range of mixture composition and vessel diameter using barium bromide- and barium chloride-coated vessels, respectively. Hydrogen bromide has been found to be a very efficient inhibitor, and, in contrast, the same quantity of hydrogen chloride has only a small effect on the explosion limit; hydrogen bromide is approximately 400 times more effective as an inhibitor than hydrogen chloride. The mechanism of the inhibition is discussed, and with hydrogen bromide it is concluded that the primary termination reaction is a removal of hydrogen atoms by the hydrogen bromide. (Contractor's abstract, modified)

1499

Manchester U. Dept. of Mechanics of Fluids (Gt. Brit.).

RAREFIED GAS FLOWS BY MONTE CARLO METHODS AND UNSTEADY GAS FLOWS IN GRAVITATIONAL FIELDS, by G. A. Bird. Final rept. Mar. 15, 1965, 6p. (AFOSR-65-1013) (AF EOAR-64-65) AD 618309 Unclassified

Methods were developed for conducting numerical experiments with a model gas in a digital computer. The methods were used to investigate the structure of strong normal shock waves, and the aerodynamic properties of simple bodies in the hypersonic transition regime. The quasi-steady equilibrium state of a shock-heated atmosphere was studied with particular reference to the solar atmosphere. A method was also developed for the study of the unsteady behavior of a heated atmosphere. (Contractor's abstract)

1500

Manchester U. Dept. of Mechanics of Fluids (Gt. Brit.).

ONE-DIMENSIONAL COMPRESSION OF A COLLISIONLESS GAS, by G. A. Bird. [1965] [9]p. incl. diagrs. (AFOSR-65-2475) (AF EOAR-64-65) AD 629301 Unclassified

Also published in Jour. Fluid Mech., v. 21: Jan. 1965.

A highly rarefied gas, initially in equilibrium, is compressed by an infinite plane piston. The resulting flow is considered when the gas is unbounded and also when the gas is bounded by a second stationary wall. In the first case, the density ahead of the piston is specularly and diffusely reflecting surfaces. In the second case, the average temperature of the gas is found as a function of the wall separation for specularly reflecting surfaces. This (non-equilibrium) temperature is compared with that generated in the corresponding continuum flow which involves multiple shock wave reflexion. It is shown that, for a given average density gradient, the free molecule temperatures are very much higher than the continuum temperatures. (Contractor's abstract)

1501

Manchester U. Dept. of Mechanics of Fluids (Gt. Brit.).

THE EQUILIBRIUM STATE OF A SHOCK-HEATED ATMOSPHERE, by G. A. Bird. [1965] [8]p. incl. diagrs. (AFOSR-66-0101) (AF EOAR-64-65) AD 631162 Unclassified

Also published in Astrophys. Jour., v. 141: 1455-1462, May 15, 1965.

Equations are developed to describe an atmosphere heated by an arbitrary distribution of shock waves. Solutions are obtained for an atmosphere with a steady outward mass motion ("solar wind") in which the heat supplied by the shock waves is balanced by the convective heat loss due to this motion. The boundary conditions for the solution are those appropriate to the outer

solar atmosphere. It is found that there is a strong "self-regulating" property of shock-heated atmospheres, in that very large changes in the initial heat input are compensated by the subsequent changes in shock strength. This means that, for a very large range of shock strengths and frequencies, the temperature profile is similar to that predicted by the "constant shock strength hypothesis." The maximum coronal temperature varies by only a few per cent from 1,600,000°K while the initial heat input varies by a factor of thousands. However, the outward mass flux increases continuously with the initial heat input and, for very large initial inputs, the maximum temperature also rises appreciably. (Contractor's abstract)

1502

Manchester U. Dept. of Mechanics of Fluids (Gt. Brit.).

SHOCK-WAVE STRUCTURE IN A RIGID SPHERE GAS, by G. A. Bird. [1965] [8]p. incl. diagrs. (AFOSR-66-2063) (AF EOAR-64-65) AD 643479 Unclassified

Also published in Rarefied Gas Dynamics; Proc. of the Fourth International Symposium, Inst. for Aerospace Studies, Toronto (Canada), (July 14-17, 1964), ed. by J. H. de Leeuw. New York, Academic Press, v. 1: 216-222, 1965.

Consideration is given to a gas composed of rigid sphere molecules, initially in thermal equilibrium between 2 infinite, plane, parallel and specularly reflecting walls. A Monte Carlo approach is used to study the shock wave which is formed when one wall impulsively acquires a uniform velocity towards the other. The method essentially consists of carrying out a "numerical experiment" with a model gas on a very fast computer. Shock wave density profiles are presented for shock Mach numbers from 1.5 to 30. These are compared with the profiles predicted by various analytical methods.

1503

Manchester U. Dept. of Mechanics of Fluids (Gt. Brit.).

TRANSIENT BEHAVIOR OF A HEATED STELLAR ATMOSPHERE, by G. A. Bird. [1965] [3]p. incl. diagr. (AFOSR-66-2550) (AF EOAR-64-65) AD 644031 Unclassified

Also published in Phys. Fluids, v. 8: 2289-2291, Dec. 1965.

The note presents the results of a numerical investigation of the unsteady flow which follows the sudden application of heating to a region of a static atmosphere. The rate of heat addition did not depend directly on time but was related, in various ways, to the thermodynamic properties of the heated region. In all cases the flow settled down to a steady subsonic-supersonic expansion.

1504

Manitoba U., Winnipeg (Canada).

THE STRUCTURE OF POWERS OF NON-NEGATIVE MATRICES, by A. L. Dulmage and N. S. Mendelsohn. [1965] [13]p. incl. diagrs. refs. (AFOSR-65-1405) [AF AFOSR-62-235] AD 622856 Unclassified

Also published in Canad. Jour. Math., v. 17: 318-330, 1965.

The structure of powers of a reducible non-negative matrix is discussed in terms of properties of the directed graph of the matrix. The structure of the subdiagonal blocks in powers of reducible matrices is considered. The main theorem states: Let A be a reducible non-negative matrix with constituents $C_1, C_2, \ldots, C_m$ and let $F_1, F_2, \ldots, F_m$ be the row (or column) sets of these constituents. Let r and s be a pair of integers $1 \leq r < s \leq m$. Then exactly one of the following four alternative holds: (1) $C_{rs}^{(k)} = 0$ for all k; (2) for some k, $C_{rs}^{(k)} \neq 0$, but there exists N such that $C_{rs}^{(k)} = 0$ for $k > N$; (3) there exists N such that $C_{rs}^{(k)} > 0$ for $k > N$; and (4) corresponding to every integer N and to every pair i, j, with $i \in F_r$ and $j \in F_s$ there exists $k_1 > N$, $k_2 > N$ such that $a_{ij}^{(k_1)} = 0$ and $a_{ij}^{(k_2)} > 0$.

1505

Marburg U. Inst. for Theoretical Physics (Germany).

ONE-PARTICLE SINGULARITIES AND SU(3), by H. D. Doebner and G. C. Hegerfeldt. [1965] 4p. incl. diagrs. (AFOSR-65-0648) [AF 61(052)658] AD 614845 Unclassified

Also published in Ann. Physik, v. 15: 412-414, July 1965.

In an SU(3)-invariant Lagrangian field theory, it is easy to derive relations between coupling constants, which enter as numerical coefficients of certain field operator products. In an alternative way, based on the asymptotic formulation of field theory, it is possible to define products of coupling constants in terms of residues in the amplitude A(s, t) corresponding to known one-particle singularities. The equivalence of these definitions has not been proved, and it is therefore interesting to note that SU(3)-relations between coupling constants can be derived using SU(3)-predictions for the residues of one-particle poles in A(s, t).

1506

Marburg U. Inst. for Theoretical Physics (Germany).

APPROACH TO ELECTRON-PION SCATTERING, by H. D. Doebner and D. Simon. [1965] [23]p. incl. diagrs. refs. (AFOSR-65-0649) [AF 61(052)658] AD 614843 Unclassified

It is shown that a usual Mandelstam representation completed with a suitable choice for pole terms and single dispersion integrals, obtains straight-forward from unitarity using quantum electrodynamics and the resonance structure of the pion provides a method to discuss electron-pion scattering on the same lines as strong interaction theory. The double spectral functions are constructed from a system of integral equations in a strip approximation, and corrections are calculated to the one-photon exchange amplitude, expressed by integrals over the imaginary part of the form factor in the annihilation channel. To have results which are not available from second order perturbation theory at least the second step of the strip approximation or inelastic processes must be discussed. The first step strip approximation is not expected to give an essential correction to the one-photon exchange amplitude.

1507

Marburg U. Inst. for Theoretical Physics (Germany).

UNITARITY AND REDUCTION FORMULAS. [1965] 23p. incl. diagrs. refs. (AFOSR-65-0650) [AF 61(052)-658] AD 615151 Unclassified

A theorem is proved in the example of boson-fermion scattering, showing that the splitting of T in T_i^1, T_i^0 corresponds to a natural decomposition of the unitarity condition for T and that it can be deduced from unitarity alone. Reality conditions for T_i^1, T_i^0 are then derived from q-space properties without reference to x-space. Necessary and sufficient conditions for T, constructed from T_i^1, T_i^0 being unitary are given next. They are essential for iteration methods which are then developed which leads to a determination of elastic amplitudes starting with one-particle-exchange-contributions, i.e. pole terms and form factors, and the whole contribution from inelastic processes as input force.

1508

Marburg U. Inst. for Theoretical Physics (Germany).

FLUCTUATION IN GASES. MATHEMATICAL PROBLEMS IN QUANTUM FIELD THEORY, by G. Ludwig. Final rept. Jan. 1, 1965, 1v. incl. diagrs. refs. (AFOSR-65-0652) (AF 61(052)658) AD 616782 Unclassified

The investigations resulted in: (1) the completion of the derivation of the Boltzmann equation in μ-space including a study of the influence of binary correlations on the collision term; (2) a further improvement of the derivation of the master equation for binary collisions, the ζ-equation, by demonstrating that the macroscopic truncation of the time propagator U(t) can be replaced by exp ($V\tau$) for short times τ, and (3) a better understanding of the behavior of the solutions of the ζ-equation considering two simple boundary problems, one plate and two parallel plates, and taking the first two moments of ζ into account only.

1509

Maremont Corp. [Rocket Power Div.] Pasadena, Calif.

CHEMICAL SYNTHESIS WITH ION BEAMS, by S. Singer, N. G. Kim and others. [1965] [5]p. incl. diagr. refs. (AFOSR-65-1433) [AF 49(638)913] AD 622674 Unclassified

Also published in Jour. Phys. Chem., v. 69: 799-803 Mar. 1965.

A method of chemical synthesis by gas phase ion-molecule reactions analogous to known liquid phase reactions is described. The synthesis of nitrobenzene by the reaction of NO_2^+ and benzene is reported. The interaction of a beam of NO_2^+ ions, with maximum energies of 1 ev, with gaseous benzene gave nitrobenzene in high yield. A 1-ma ion current consisting of 99% NO_2^+ was formed by electron impact with nitrogen dioxide in a concentric dual-anode magnetron.

1510

Marseille U. Inst. of Statistical Mechanics of Turbulence (France).

THE EQUATIONS OF COMPRESSIBLE TURBULENT GASES, by A. J. Favre. Final rept. Jan. 1965, 78p. incl. diagrs. refs. (AFOSR-65-1229) (AF 61(052)772) AD 622097 Unclassified

The statistical equations for a compressible gas are developed in a general form. All the properties are considered to be turbulent and are separated into macroscopic quantities and fluctuations. First, a complete set of equations is derived from the general form, taking as the fundamental macroscopic quantities the mean values of the velocity, the temperature, the density and the pressure. Second the choice of the most convenient fundamental macroscopic quantities is discussed, which leads to the proposed use of the mean values of the mass-weighted velocity, the internal energy per unit volume, the density, and the pressure. The latter leads to much simpler and physically more significant equations. (Contractor's abstract, modified)

1511

[Martin-Marietta Corp.] Martin Co., Baltimore, Md.

VACUUM EFFECTS ON THE TENSILE AND CREEP PROPERTIES OF ALUMINUM, by H. Shen, S. E. Podlaseck, and I. R. Kramer. [1965] [6]p. incl. diagrs. tables. (AFOSR-65-2737) (AF 49(638)1455) AD 629019 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 233: 1933-1938, Nov. 1965.

The tensile and creep properties of aluminum in vacuum was investigated. It was found that the general effect of a vacuum environment was to reduce the rate of work hardening. Results obtained from creep tests showed that lowering the test pressure from 2×10^{-4} to 10^{-7} torr

produced a decrease in the activation energy as much as 500 cal/mole. An attempt is made to explain these effects in terms of how the surface-stress field of a specimen may be affected by a vacuum environment during plastic deformation. (Contractor's abstract)

1512

[Martin-Marietta Corp.] Martin Co., Baltimore, Md.

EFFECT OF VACUUM ON THE MECHANICAL BEHAVIOR OF METALS, by I. R. Kramer and H. Shen. Final scientific rept. Oct. 1, 1964-Oct. 1, 1965, 15p. incl. diagrs. (Rept. no. RR-70) (AFOSR-66-0007) (AF 49-(638)1455) AD 628794 Unclassified

The fatigue life of Aluminum 1100 has been studied as a function of pressure, stress, frequency, and temperature. The data indicate that the amount of fatigue improvement and the frequency effect observed in vacuum decrease with increasing stress amplitude. The results of resonant frequency measurements, showing the correlation of the fatigue improvement and the frequency effect with the rate of change in the resonant frequency, suggest a possible new method to detect the rate of damage formation for fatigue studies. Iron has been used for studying the various effects of vacuum on BCC metals. Results reveal that vacuum has greater effect on the fatigue life of iron than on the fatigue life of aluminum. As for the tensile studies, the stress-strain curves of iron and recrystallized molybdenum wire specimens have been studied in vacuum. It is found that in the case of iron, only the stress at the Luder's band region is subject to the effect of vacuum. However, the amount of change is dependent on the strain rate. When a very slow strain rate 9×10^{-7} sec^{-1}, is used, the decrease may amount to as much as 1200 psi. The effects of vacuum on the ultimate tensile stres and the total elongation of molybdenum at high temperatures are attributed to a decrease in the rate of oxidation. (Contractor's abstract)

1513

Maryland U. [Dept. of Physics and Astronomy] College Park.

VALIDITY OF MANY-BODY APPROXIMATION METHODS FOR A SOLVABLE MODEL. I. EXACT SOLUTIONS AND PERTURBATION THEORY, by H. J. Lipkin, N. Meshkov, and A. J. Glick. [1965] [11]p. incl. diagrs. tables. (AFOSR-65-0775) (In cooperation with Weizmann Inst. of Science, Rehovoth (Israel)) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-46 and Office of Naval Research) AD 616057 Unclassified

Also published in Nuclear Phys., v. 62: 188-198, Feb. 1965.

In order to test the validity of various techniques and formalisms developed for treating many-particle systems, a model is constructed which is simple enough to be solved exactly in some cases, but yet is nontrivial. The construction of such models is based on the observation that bilinear products of creation and annihilation operators can be considered as generators of Lie groups. Thus the problem of finding eigenvalues can be greatly simplified by the additional integrals of the motion which are present if the Hamiltonian is constructed so as to commute with invariants of the group. In the present case, the model consists of N fermions distributed in two N-fold degenerate levels and interacting via a monopole-monopole force. It is shown that the model Hamiltonian is easily expressed in terms of quasi-spin operators and exact eigenvalues are obtained. In addition, eigenvalues are calculated with ordinary perturbation theory using values for the number of particles and interaction strength which are appropriate to the more realistic problems of finite nuclei. In subsequent papers we consider the results obtained by various other approximation methods for comparison with the exact results presented here. (Contractor's abstract)

1514

Maryland U. [Dept. of Physics and Astronomy] College Park.

VALIDITY OF MANY-BODY APPROXIMATION METHODS FOR A SOLVABLE MODEL. II. LINEARIZATION PROCEDURES, by N. Meshkov, A. J. Glick, and H. J. Lipkin. Oct. 1963 [26]p. incl. diagrs. (Technical rept. no. 332) (AFOSR-65-0776) (In cooperation with Weizmann Inst. of Science, Rehovoth (Israel)) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-46 and Office of Naval Research) AD 601035; AD 640662 Unclassified

Also published in Nuclear Phys., v. 62: 199-210, Feb. 1965.

The validity of methods used in the study of many-particle systems is investigated by using the same approximation in treating a simple model for which exact solutions are available. The model consists of N fermions distributed in two N-fold degenerate levels and interacting via a monopole-monopole force. The excitation energy of the first collective state above the ground state is calculated using the following methods. the method of linearized equations of motion, linearization with the inclusion of renormalized single-particle energies, and a new self-consistent linearization method. The results of these approximation methods are then compared with exact results and with the results of ordinary perturbation theory found in a previous paper. It is found that renormalization of the single-particle energies leads to a considerable improvement of the results over that obtained with the ordinary linearization method, especially for small numbers of particles. Further improvement is obtained with self-consistent linearization method. The possibility of applying the latter method to more realistic problems is briefly discussed. (Contractor's abstract)

1515

Maryland U. [Dept. of Physics and Astronomy] College Park.

VALIDITY OF MANY-BODY APPROXIMATION METHODS FOR A SOLVABLE MODEL. III. DIAGRAM

SUMMATIONS, by A. J. Glick, H. J. Lipkin, and N. Meshkov. Oct. 1963, 32p. incl. diagrs. refs. (Technical rept. no. 334) (AFOSR-65-0777) (In cooperation with Weizmann Inst. of Science, Rehovoth (Israel)) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-46 and Office of Naval Research) AD 601260; AD 640817 Unclassified

Also published in Nuclear Phys., v. 62: 211-224, Feb. 1965.

The model N-fermion system studied in 2 previous papers is reconsidered in order to investigate the range of validity of diagrammatic many-body perturbation theory and various selective summations of higher order graphs. The familiar random phase approximation or bubble graph sum is shown to be the first term in an expansion in powers of 1/N for which the coefficients are arbitrary functions of NV/ϵ, where V is the interaction strength and ϵ is the level separation of the non-interacting system. However, the 1/N expansion converges very slowly (if at all) for $N \leq 40$. Other corrections to the bubble sum which do not fit into such an expansion are shown to be much more important than the 1/N corrections for small N. These are the exchange and self-energy graphs which correct for counting errors and violations of the exclusion principle when enumerating the states that a given particle can occupy. With these terms a rather good approximation to the excitation energy can be obtained, though the results are not quite as good as that obtained with fourth-order perturbation theory for small N, or for the whole range of N with the self-consistent linearization procedure described in a previous paper. (Contractor's abstract)

1516

Maryland U. [Dept. of Physics and Astronomy] College Park.

POSSIBILITY OF LONG-RANGE SPIN POLARIZATION IN A DEGENERATE ELECTRON GAS, by A. Bardasis, D. S. Falk and others. [1965] [3]p. (AFOSR-65-1760) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under [AF AFOSR-62-46], and National Science Foundation AD 625774 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 298-300, Mar. 1, 1965.

A conclusion of Dreyfus, et al that it is possible for an induced long-range spin-density distribution to exist in a nonferromagnetic metal is investigated as it contradicts the Ruderman-Kittel theory that the spin density generated at large distances from a localized spin perturbation is of an oscillatory nature. The 2 theories are reconciled by considering the spin density contribution by the nonevanescing waves. It is concluded that the nonevanescing waves contribute a long-range polarization which just cancels that coming from the evanescing waves, thereby leaving only the expected Ruderman-Kittel spatial dependence.

1517

Maryland U. Dept. of Physics and Astronomy, College Park.

SOFT X-RAY EMISSION SPECTRUM OF METALS, by A. J. Glick and P. Longe. [1965] [3]p. incl. diagrs. refs. (AFOSR-65-2931) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under AF AFOSR-62-46) AD 629149 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 589-591, Oct. 4, 1965.

The variation with frequency of the intensity of soft x-ray emission gives information on the width of the conduction band and on the conduction-electron density of states. There are however complications due to electron-electron interactions which produce a tail in the spectrum and give rise to collective behavior. Previous attempts to incorporate such interactions into the theory were not successful. It is shown here by application of the technique of diagrammatic many-body theory that these earlier treatments had overlooked important interference terms. When these are retained, agreement with experiment is excellent.

1518

Maryland U. Dept. of Physics and Astronomy, College Park.

ELECTRON-PHONON CONTRIBUTION TO ELECTRONIC SPECIFIC HEAT, by S. Maitra and R. E. Prange. June 1965, 8p. incl. diagr. (Technical rept. no. 266) (AFOSR-66-1230) (AF AFOSR-62-46) AD 641080 Unclassified

The electronic specific heat has been calculated as a function of temperature. Although the variation is an order of magnitude greater than would be anticipated on the most naive arguments, it still is very doubtful that a sufficiently accurate measurement can be made in the near future which could verify the predicted effect.

1519

Maryland U. Dept. of Physics and Astronomy, College Park.

TUNNELING DENSITY OF STATES FOR A SUPERCONDUCTOR CARRYING A CURRENT, by P. Fulde. July 1964 [20]p. incl. diagrs. refs. (Technical rept. no. 402) [AF AFOSR-62-46] AD 610500 Unclassified

Also published in part in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9 (Pt. A): 438-442, 1965.

Also published in Phys. Rev., v. 137: A783-A787, Feb. 1, 1965.

A current flowing in a superconducting film has a

tendency to break pairs similar to the effect of paramagnetic impurities in a superconductor. The effect of the current on the tunneling density of states for a normal-superconductor tunneling junction has been computed by the Green's function method of Abrikosov, Gorkov and Maki and found to be identical (for a short mean free path) to that of paramagnetic impurities. A simple relationship between the current parallel to the junction and the equivalent paramagnetic impurity concentration is derived. Passing various amounts of current through the sample in the one experiment gives the same information as is obtainable in the other experiment only by preparing different samples with various impurity concentrations. (Contractor's abstract)

1520

Maryland U. Dept. of Physics and Astronomy, College Park.

PARTICLE-MIXTURE THEORY AND APPARENT CP VIOLATION IN K-MESON DECAY, by H. Ezawa, Y. S. Kim and others. [1965] [4]p. incl. refs. (AFOSR-65-1345) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-500] and National Science Foundation) AD 622644 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 673-676, Apr. 19, 1965.

A model based on the idea of particle mixtures is proposed which is consistent with CP conservation and which leads to the 2-pion-decay mode of the $(K^\circ, \bar{K}^\circ)$ system. A set of partner particles is introduced with the requirement that the primed particles mix with the unprimed ones rather weakly, depending upon their mass difference, which is required to be much less than or of the order of 1 mev. Furthermore, the primed particles are inhibited from having very strong interactions with the usual strongly interacting particles so that not only their production cross section is very low, but also their decay to pions and leptons is much slower than that of the $(K^\circ, \bar{K}^\circ)$ system.

1521

Maryland U. Dept. of Physics and Astronomy, College Park.

QUANTUM MECHANICS OF A MANY-BOSON SYSTEM AND THE REPRESENTATION OF CANONICAL VARIABLES, by H. Ezawa. [1965] [25]p. incl. diagrs. refs. (AFOSR-65-1776) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-500 and National Science Foundation) AD 625571 Unclassified

Also published in Jour. Math. Phys., v. 6: 380-404, Mar. 1965.

A method is presented for treating the assembly of interacting bosons under Bose-Einstein condensation. The method is a quantum mechanical adaptation of the theory of small oscillation. The interaction between condensed particles determines the stability of this oscillation. When it is stable and its amplitude is not macroscopic, the Bogoliubov approximation is valid. In this way, the method provides a validity criterion for the Bogoliubov approximation as well as an estimation of the errors thereby committed. The method is applied to the Huang model, the assembly of bosons interacting through a hard core plus weak attractive potential, and it is concluded that Huang's treatment is well founded. The mathematical background of the approximation is discussed by invoking the representation theory of canonical variables of an infinitely large system. (Contractor's abstract, modified)

1522

Maryland U. Dept. of Physics and Astronomy, College Park.

SPECIAL CLASS OF FEYNMAN INTEGRALS IN TWO-DIMENSIONAL SPACE-TIME, by G. Källen and J. Toll. [1965] [5]p. (AFOSR-65-1816) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-500 and National Science Foundation) AD 626060 Unclassified

Also published in Jour. Math. Phys., v. 6: 299-303, Feb. 1965.

Contributions of Feynman diagrams consisting of a single loop with an arbitrary number of vertices are explicitly evaluated in 2-dimensional space-time. The result can be written as a sum of logarithms multiplied by algebraic expressions. Each logarithm is characteristic of a simple diagram of one loop with 2 external lines, while the coefficients can be obtained from rules analogous to the rules of residue calculus. (Contractor's abstract)

1523

Maryland U. Dept. of Physics and Astronomy, College Park.

PROOF THAT SCATTERING IMPLIES PRODUCTION IN QUANTUM FIELD THEORY, by S. Ø. Aks. [1965] [17]p. incl. diagrs. refs. (AFOSR-65-1817) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-500], National Aeronautics and Space Administration, and National Science Foundation) AD 625569 Unclassified

Also published in Jour. Math. Phys., v. 6: 516-532, Apr. 1965.

A proof of the necessity of production processes in quantum field theory is carried out in the axiomatic framework. It is shown that a field theory that is assumed to have a nontrivial scattering amplitude violates crossing symmetry, if production processes are absent. The proof is based on the rigorous analytic properties of the scattering amplitude, particularly the analyticity in the invariant-scattering variables s, t and u. In the course of the proof it is shown that the conclusion is valid for a scattering amplitude satisfying the requirements of an S-matrix theory embodied in the Mandelstam representation.

1524

Maryland U. Dept. of Physics and Astronomy, College Park.

SELECTION RULES FOR PARAFIELDS AND THE ABSENCE OF PARA PARTICLES IN NATURE, by O. W. Greenberg and A. M. L. Messiah. [1965] [13]p. incl. tables, refs. (AFOSR-65-1818) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-500 and National Science Foundation) AD 625572 Unclassified

Also published in Phys. Rev., v. 138: B1155-B1167, June 7, 1965.

Green's parafield quantization is reviewed. It is shown, both for a single field and for sets of fields, that all Fock-like representations of Green's trilinear commutation rules are realized by Green's ansatz with anticommuting (commuting) Bose (Fermi) component fields for para-Bose (para-Fermi) fields. Restrictions on the form of the interaction Hamiltonian density $H_I(x)$ are derived from the requirement that $H_I(x)$ be a paralocal operator. From these restrictions on H_I, selection rules on the S matrix are proved to all orders of perturbation theory. The most important such rule prohibits all reactions in which the total number of para particles of order $p > 1$ in the initial and final states is one. This last selection rule, together with experimental information, leads to the conclusion that no presently known particle can be para.

1525

Maryland U. Dept. of Physics and Astronomy, College Park.

ANALYTIC PROPERTY OF THREE-BODY UNITARITY INTEGRAL, by J. N. Islam and Y. S. Kim. [1965] [8]p. incl. diagrs. (AFOSR-65-1819) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-500 and National Science Foundation) AD 626484 Unclassified

Also published in Phys. Rev., v. 138: B1222-B1229, June 7, 1965.

Analytic properties of the 3-body unitarity integral are studied for the production amplitude corresponding to one-particle-exchange diagrams. The condition under which the absorptive part has singularities is discussed. For a simple degenerate case, it is shown that the singularity curve can be represented by an explicit elementary function. It is shown further that this singularity curve is identical to that from the conventional Landau-Bjorken analysis.

1526

Maryland U. Dept. of Physics and Astronomy, College Park.

"ABNORMAL" QUANTUM NUMBERS AND DECAY CHANNELS; J^{PG} ASSIGNMENT FOR EPSILON; A NORMAL SCALAR OCTET, by D. Loebbaka and J. C. Pati. Mar. 12, 1965, 17p. incl. table, refs. (Technical rept. no. 445) (AFOSR-65-1872) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-500 and National Science Foundation) AD 626?... Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 929-932, May 31, 1965.

An indication of an enhancement at about 730 mev was shown recently in the recoil spectrum of the proton in $\pi^- + p$ reactions (Bull. Amer. Phys. Soc., v. 9: 629, 1964). There has been no indication of such an enhancement in a direct 2 or 3 pion invariant mass plot. An investigation is made of the existence of such a resonance, which does not decay with a large branching ratio to a 2 or 3 pion system, but can be observed in a recoil system and is produced with an appreciable cross section. The possible decay modes of the resonance are studied for different assignments of its quantum numbers. The order of magnitude of corresponding partial widths are estimated by assuming dominance of low mass intermediate states. Four possible quantum numbers are assigned, 0^{+-}, 0^{-+}, 0^{++}, and 1^{++}.

1527

Maryland U. Dept. of Physics and Astronomy, College Park.

SOLUTION OF THE KÄLLEN-PAULI EQUATION, by A. Pagnamenta. [1965] [11]p. incl. refs. (AFOSR-65-1873) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-500 and National Science Foundation) AD 626782 Unclassified

Also published in Jour. Math. Phys., v. 6: 955-965, June 1965.

The relevant solution is given to the integral equation derived by Källén and Pauli for elastic Vθ-scattering in the Lee model. As an application of this result the exact Tamm-Dancoff solution for the entire Vθ-sector is obtained. This includes the amplitudes for Vθ- and N2θ elastic scattering and Vθ- N2θ production, as well as their extensions off the mass shell.

1528

Maryland U. Dept. of Physics and Astronomy, College Park.

HIGH-ORDER LIMIT OF PARA-BOSE AND PARA-FERMI FIELDS, by O. W. Greenberg and A. M. L. Messiah. [1965] [5]p. (AFOSR-65-2140) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-500 and National Science Foundation) AD 629041 Unclassified

Also published in Jour. Matn. Phys., v. 6: 500-504, Apr. 1965.

Para-Bose and para-Fermi quantization are schemes of second quantization which generalize the usual Bose and Fermi schemes. The different cases of para-Bose (para-Fermi) quantization are labeled by a positive

integer p, which is called the 'order'. For p = 1, the usual Bose (Fermi) quantization is recovered. The high-p limit of para-Bose (para-Fermi) quantization is studied, and it is shown that, to a large extent, the high-p limit of a para-Bose (para-Fermi) field is a Fermi (Bose) field. The nature of the limit is studied in detail, and a paradox relating to the connection of spin and statistics is resolved. (Contractor's abstract)

1529

Maryland U. Dept. of Physics and Astronomy, College Park.

BETA-DECAY COUPLING CONSTANTS, by Y. S. Kim. Aug. 1964, 14p. (Technical rept. no. 400) (AFOSR-65-2783) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-500] and National Science Foundation) AD 627852 Unclassified

Also published in Nuovo Cimento, Series X, v. 36: 523-532, Mar. 1965.

Dispersion relations are introduced which give the same asymptotic value for the vector and axial-vector form factors in the limit of high momentum transfer. The ratio gA/gV is related to the behavior of the vector form factor in the region of low momentum transfer. The numerical value gA/gV = 1.2 is obtained from the experimental curves for the electromagnetic form factors. (Contractor's abstract)

1530

Maryland U. Dept. of Physics and Astronomy, College Park.

PARTIAL WAVE DISPERSION RELATIONS FOR PIONIC DISINTEGRATION OF DEUTERON, by K. V. Vasavada. [1965] [47]p. incl. diagrs. tables, refs. (AFOSR-65-2793) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-500 and National Science Foundation) AD 627744 Unclassified

Also published in Ann. Phys., v. 34: 191-237, Sept. 1965.

A dispersion theoretic approach is made within the framework of partial wave dispersion relations to understand the pionic disintegration of the deuteron at low energies. The reaction amplitude is expressed in terms of 6 independent Lorentz invariant scalar functions which are free from kinematical singularities, and the partial wave helicity amplitudes are obtained. Dispersion relations are written after removing kinematical singularities. After some approximations, the dispersion relations become soluble integral equations of the Omnes-Muskhelishvilli type. The contribution of the left hand single nucleon exchange cuts is evaluated exactly. The left hand anomalous contribution is evaluated approximately by replacing the cuts by poles in the appropriate channels. Analytic continuation in the deuteron mass gives the contribution of the right hand anomalous cut. Part of the right hand cut due to the 2 protons intermediate state is taken into account by using the experimental energy dependent phase shift parameters for proton proton scattering. The intermediate state containing 2 nucleons and one pion is effectively replaced by one particle and a resonance, and model amplitudes are used to evaluate the contribution. The results of this calculation are numerically evaluated on an IBM 7090 computer. For the angular distribution and the total cross section, at a reasonable agreement is obtained with the results from low energy experiments. (Contractor's abstract)

1531

Maryland U. Dept. of Physics and Astronomy, College Park.

LONG-RANGE ELECTROMAGNETIC FORCES ON NEUTRAL PARTICLES, by G. Feinberg and J. Sucher. [1965] [15]p. incl. diagrs. (AFOSR-65-2794) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-500] and Atomic Energy Commission) AD 627679 Unclassified

Also published in Phys. Rev., v. 139: B1619-B1633, Sept. 20, 1965.

The long-range forces, i.e., those falling off as a power of the distance, which may act between pairs of particles, one of which is neutral and spinless are considered. It is shown that these forces may easily be calculated from the discontinuity function in the momentum transfer of the scattering amplitude for the 2 particles. The 2-photon exchange force between 2 neutral, spinless systems, and the 3-photon exchange force between a charged and a neutral, spinless system were investigated. In the former case, the potential behaves as r^{-7} for large r, in contradiction to the London expression for the Van der Waals force, and in agreement with the result of Casimir and Polder. For the latter case, the potential is odd under charge conjugation and hence can convert a K_2 meson to a K_1 meson. It is found that the potential behaves as r^{-7}. It is found that such long-range electromagnetic interactions are presently unobservable in particle physics. (Contractor's abstract)

1532

Maryland U. Dept. of Physics and Astronomy, College Park.

BROKEN SYMMETRIES AND MASS FORMULAE FOR VECTOR MESONS, by G. Segre and J. Sucher. [1965] 10p. (AFOSR-66 0439) [AF AFOSR-64-500] AD 630225 Unclassified

Also published in Nuovo Cimento, Series X, v. 38: 428-437, July 1, 1965.

The question of which kind of mass formulae [$(\text{mass})^2$ vs. $(\text{mass})^{-2}$] are correct for a multiplet of vector mesons is studied. It is shown that from a field theoretic point of view, one does not have a clear a priori preference for either kind of formulae. (Contractor's abstract)

1533

Maryland U. Dept. of Physics and Astronomy, College Park.

K_{e3} DECAY AND UNIVERSALITY IN CABIBBO'S THEORY OF LEPTONIC DECAYS, by S. Oneda and J. Sucher. [1965] [3]p. incl. table. (AFOSR-66-0444) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-500] and National Science Foundation) AD 630230 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 927-929, Dec. 13, 1965.

It is shown that the use of $|c^2-1| \lesssim 1\text{-}5\%$ where C is a renormalization factor, and the most recent 'best' va value' of the K_{e3} decay rate, together with the inclusion of hitherto neglected form-factor effects in the determination of Cabibbo's bare coupling constant for β decay (G cos θ) from this rate, may yield a value of cos θ which is in quite close agreement with that experimentally determined from β decay.

1534

Maryland U. Dept. of Physics and Astronomy, College Park.

FEYNMAN RULES AND FEYNMAN INTEGRALS FOR SYSTEM WITH HIGHER-SPIN FIELDS, by C. S. Lam. [1965] 10p. (AFOSR-66-0799) [AF AFOSR-64-500] AD 641617 Unclassified

Also published in Nuovo Cimento, Series X, v. 38: 1755-1764, Aug. 16, 1965.

It is known that Feynman rules for many systems may be expressed by replacing the interaction Hamiltonian in the Dyson formula by minus the interaction Lafrangian, provided we also make suitable covariant changes of the time-ordered functions between some fields. The general conditions for which this is valid are investigated and the result is stated. In case this is not valid, a general, straight-forward procedure for computing the extra vertices is given which is considerably simpler than the usual Dyson-Wick procedure. This procedure is illustrated by an explicit example dealing with charged vector electrodynamics. It also follows from these investigations that the integrand for the Feynman path integral is not always simply the exponential of i times the action. This simple prescription fails whenever an extra vertex for the Feynman rule occurs, and the correct expressions in these cases are given. (Contractor's abstract, modified)

1535

Maryland U. Dept. of Physics and Astronomy, College Park.

POLARIZATION OF A DECAY PARTICLE IN A TWO-STEP PROCESS: APPLICATION TO $K^- + p \rightarrow \pi^0 + \Sigma^0$, $\Sigma^0 \rightarrow \gamma + \Lambda$, by M. H. Cha and J. Sucher. [1965] [8]p. incl. diagrs. (AFOSR-66-0801) [AF AFOSR-64-500] AD 641626 Unclassified

The phenomenology of 2-step processes of the Type $A+B \rightarrow C + D$, $D \rightarrow E + F$ is studied for the particular case when among the final particles only F is observed. Formulas convenient for the computation of the polarization of F in terms of the parameters describing the production process are presented, and the connection between the polarization of F and that of D, when D is not observed, is clarified. Numerical results are obtained for the angular dependence of the Λ polarization in the process $K^- + \text{proton} \rightarrow \pi^0 + \Sigma^0$, $\Sigma^0 \rightarrow \gamma + \Lambda$ at a variety of incident energies.

1536

Maryland U. Dept. of Physics and Astronomy, College Park.

A USEFUL RELATION AMONG CASIMIR OPERATORS, by M. Resnikoff. [1965] [2]p. incl. refs. (AFOSR-66-0817) (AF AFOSR-64-500) AD 641618 Unclassified

Also published in Phys. Ltrs., v. 19: 596-597, Dec. 15, 1965.

The new extension of group theoretical methods, the 'dynamical' groups, now require a knowledge of the Casimir operators C_p for the group SU (n). It is the purpose of this note to point out a rather simple method of obtaining these numbers for the group SU (n), in general.

1537

Maryland U. Dept. of Physics and Astronomy, College Park.

MOMENTUM-SPACE ANALYTICITY PROPERTIES OF THE BERGMAN-WEIL INTEGRAL FOR THE THREE POINT FUNCTION, by G. Källen and J. S. Toll. [1965] [18]p. incl. refs. (AFOSR-67-1537) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-500 and National Science Foundation) AD 655166 Unclassified

Also published in Jour. Math. Phys., v. 6: 1885-1901, Dec. 1965.

The momentum-space analyticity domain of the Bergman-Weil integral representation of the vertex function or 3-point function is investigated using the assumption that thresholds can be introduced simply as lower limits of integration for the mass variables in the representation. It is shown that this assumption leads to a regularity domain which is larger than the domain following from general physical assumptions of Lorentz invariance, local commutativity and reasonable mass spectrum. To simplify the discussion it is assumed that the vertex function is regular when all 3 complex variables lie in the same half-plane. Standard techniques for the evaluation of Feynman diagrams have proved to be inconvenient for this investigation and new methods have been developed taking explicit advantage of the fact that there are only 2 external vectors and, hence, will work in a 2-dimensional Lorentz space.

Further, the vanishing of the masses for certain internal lines has also been exploited. The techniques used here might be of interest also in other connections. (Contractor's abstract)

1538

Maryland U. [Dept. of Physics and Astronomy] College Park.

SOME REMARKS ABOUT THE LOCALIZATION OF STATES IN A QUANTUM FIELD THEORY, by S. Schlieder. [1965] [16]p. incl. refs. (AFOSR-67-2613) (AF AFOSR-64-500) Unclassified

Also published in Commun. Math. Phys., v. 1: 265-280, 1965.

For the case of a field theory with a nuclear space of test functions (for instance, the space of strongly decreasing test functions) compact sets of states are constructed; these correspond to sets of localized states. Only such states are considered which are elements of a fixed subspace of the entire Hilbert space. This subspace belongs to the n-point functions of order less than a certain fixed 2n. (Contractor's abstract)

1539

Maryland U. Dept. of Physics and Astronomy, College Park.

A PROOF OF THE MEROMORPHY OF THE SCATTERING AMPLITUDE FOR THE HARD-SPHERE POTENTIAL, by S. Y. Shieh. Mar. 18, 1965, 7p. (Technical rept. no. 446) (AF AFOSR-64-500) Unclassified

For the amplitude of the hard-sphere potential, the author proves that (1) there are l poles from the l^{th} partial wave amplitude and (2) the l poles from l^{th} partial wave amplitude lie outside a circle of radius $\sqrt{2/3(2l-1)}$, with the center of the circle at the origin of the k-plane. These 2 facts establish that there is no accumulation point of these poles. Combining these results with a proof of the convergence of the expansion series, the meromorphy of the scattering amplitude as function of the momentum k is attained, the positions of these poles being independent of the angular variable cos θ.

1540

Maryland U. Dept. of Physics and Astronomy, College Park.

ELECTRON-PHONON RENORMALIZATION EFFECTS IN HIGH MAGNETIC FIELDS. THE DE HAAS-VAN ALPHEN EFFECT, by M. Fowler and R. E. Prange. Mar. 10, 1965, 25p. incl. diagrs. refs. (Technical rept. no. TR-443) (AFOSR-65-1192) (AF AFOSR-65-735) AD 620189 Unclassified

Also published in Physics, v. 1: 315-328, 1965. (AFOSR-66-1343; AD 641094)

When a metal is placed in a sufficiently strong magnetic field, it is to be expected that the effective mass of the electrons due to electron phonon interactions will be modified. The condition that the field will be strong enough to have an effect is that the cyclotron frequency be comparable to phonon frequencies. It is expected that such effects may be observable with experimentally realizable fields in some special cases. The amplitude dependence of the de Haas-van Alphen effect was calculated as a function of temperature and magnetic field. This amplitude can be interpreted as giving a field dependent effective mass. The amplitude was calculated numerically for several cases of interest. It is found that the field effects are rather smooth and depend most directly on the electron selfenergy function for pure imaginary values of the frequency. (Contractor's abstract)

1541

Maryland U. Dept. of Physics and Astronomy, College Park.

PHONONS IN CRYSTALLINE SOLIDS AND DILUTE BOSE GASES, by A. Bardasis, D. S. Falk, and D. A. Simkin. [1965] [7]p. incl. refs. (AFOSR-65-2108) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under [AF AFOSR-65-735] AD 627973 Unclassified

Also published in Jour. Phys. Chem. and Solids, v. 26: 1269-1275, Aug. 1965.

Phonons in a crystalline solid and a dilute Bose gas are treated from a uniform point of view. In each of the cases, the potential is expanded about ionic equilibrium positions, with the important difference that in the gaseous state these positions are allowed to move. This motion leads to an additional term in the kinetic energy part of the gas Hamiltonian, resulting in a dispersion relation for long wavelength density fluctuations identical to that obtained by Bogoliubov (JETP, v. 1: 83, 1955). The usual lattice phonon spectrum is also reproduced. The limitations of the viewpoint when applied to liquids and Fermi gases are discussed. (Contractor's abstract)

1542

Maryland U. Dept. of Physics and Astronomy, College Park.

EXCHANGE EFFECTS IN FERROMAGNETIC RESONANCE WITH NON-LOCAL CONDUCTIVITY, by L. L. Hirst and R. E. Prange. Jan. 12, 1965 [30]p. incl. diagrs. table, refs. (Technical rept. no. 429) (AFOSR-65-2109) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF AFOSR-65-735) AD 627971 Unclassified

Also published in Phys. Rev., v. 139: A892-A900, Aug. 2, 1965.

A solution is obtained for the surface impedance of a ferromagnetic metal with a wave-number-dependent

conductivity function, by an extension of the method of Reuter and Sondheimer. Computed curves are given for some specific cases. It is concluded that exchange effects are large under suitable low-temperature conditions, but there are too many unknown parameters to allow a very accurate value of the exchange constant to be deduced from resonance experiments. For extreme anomalous conductivity, exchange effects depend on the combination (exchange constant) X (conductivity)$^{2/3}$.

1543

Maryland U. Dept. of Physics and Astronomy, College Park.

THEORY OF INELASTIC SCATTERING OF ELECTRONS, by A. J. Glick. [1965] [10]p. incl. diagrs. refs. (AFOSR-66-1294) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under [AF AFOSR-65-735]) AD 641095 Unclassified

Presented at Symposium on Quantitative Electron Microscopy, Washington, D. C., Mar. 30-Apr. 3, 1964.

Also published in Lab. Invest., v. 14: 787-796, June 1965.

A brief summary of the theory of inelastic electron scattering by thin films is first presented. Then, it is shown that the scattering properties of the target material can be expressed in terms of the dynamic (frequency- and wave number-dependent) dielectric constant of the material. Thus, to determine the inelastic scattering theoretically, one must calculate the dielectric constant; an example of such a calculation is given for a model scattering medium. The resulting cross-section is analyzed and the features in the cross-section are discussed for various types of scattering materials. Surface and lattice effects and how they modify the cross-section are considered. Conversely, the feasibility of using the observed experimental cross-sections to work back and quantitatively explore the basic electron excitation spectrum of the target material is also discussed.

1544

Maryland U. [Dept. of Physics and Astronomy] College Park.

STRONG-COUPLED SUPERCONDUCTOR AT NONZERO TEMPERATURE, by D. J. Scalapino, Y. Wada, and J. C. Swihart. [1965] [4]p. incl. diagrs. (AFOSR-67-0373) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under [AF AFOSR-65-736], and National Science Foundation) AD 647638 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 102-105, Jan. 25, 1965.

The strong-coupling superconductors Pb and Hg have long been considered anomalous in the deviation of their superconducting properties from the law of corresponding states and from the predictions of the simplest form of the BCS theory. These calculations are extended to nonzero temperatures and (1) evaluate the effective electron-phonon coupling constant for Pb using an approximate form of the matrix element suggested by Harrison; (2) determine the frequency dependence of the gap function at nonzero temperature, and (3) discuss an anomaly in the effective tunneling density of states arising from recombination processes.

1545

Maryland U. [Dept. of Physics and Astronomy] College Park.

SOLUTION OF THE GAP EQUATION FOR Pb, Hg, AND Al, by J. C. Swihart, D. J. Scalapino, and Y. Wada. [1965] [3]p. incl. diagr. table, refs. (AFOSR-67-0438) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-735] and National Science Foundation) AD 647381 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 106-108, Jan. 25, 1965.

The solution of the gap equation for Pb, Hg and Al is discussed. The following thermodynamic properties of Pb, Hg and Al are presented: (1) the energy gap as a function of temperature, (2) the ratio $2\Delta_0/kT_c$ where Δ_0 is the gap at T = 0, (3) the condensation energy at T = 0 and the temperature dependence of the critical field, and (4) the contribution to the normal-state effective mass from the electron-phonon interaction.

1546

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A FINITE DIFFERENCE ANALOG OF THE NEUMANN PROBLEM FOR POISSON'S EQUATION, by J. H. Bramble and B. E. Hubbard. [1965] 14p. incl. refs. (AFOSR-65-2352) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-454 and National Science Foundation) AD 629528 Unclassified

Also published in SIAM Jour. Numer. Anal., v. 2: 1-14, 1965.

In a bounded connected plane region R with smooth boundary C, let u be the solution of (a) $\Delta u = -f$ in R, (b) $\partial u/\partial n = g$ on C. Introduce a square lattice of side h, and attempt to find a discrete approximation U to u on the lattice points in R and at the intersections of C with the sides of the squares. To determine U on this slightly irregular lattice, construct, as follows, a system of difference equations with diagonally-dominant coefficient matrix of positive type: (1) Assign the value of U at one interior point; (2) At the remaining interior lattice points, approximate (a) by standard 5 point formulas which may have O(h) errors at points adjacent to C, but $O(h^2)$ errors everywhere else; and (3) Approximate the boundary condition (a) by an $O(h^2)$ formula previously developed by the authors. Now let the error be e = u - U. By exploiting a discrete form of Green's theorem, a discrete Neumann's function, and the known

properties of a discrete Green's function for R, the authors prove that $|e| = O(h^2|\log h|)$ if $u \in C^4$ in R. An explicit example is used to prove that this estimate is sharp. The authors also discuss modifications of the proof to permit occurrence of corners on C.

1547

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

MATHEMATICAL RESEARCH IN FLUID DYNAMICS AND APPLIED MATHEMATICS. Final technical status rept Jan. 1965, 6p. (AFOSR-65-0200, (AF AFOSR-63-400) Unclassified

The status report lists the range of topics in which research was done during this project. A list of publications is also given.

1548

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SOME APPLICATIONS OF THE NEW MAXIMUM-MINIMUM THEORY OF EIGENVALUES, by A. Weinstein. [1965] [7]p. (AFOSR-66-0111) (AF AFOSR-63-400) AD 641532 Unclassified

Also published in Jour. Math. Anal. and Appl., v. 12: 58-64, Aug. 1965.

The object of the paper is to give some applications of an improved maximum-minimum theory of eigenvalues as recently developed by the present author. Among other applications he discusses problems which originated in the theory of the stability of solutions of the Navier-Stokes equations and the vibrations of an incompressible elastic body.

1549

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

REMARKS ON A GENERALIZATION OF BANACH'S PRINCIPLE OF CONTRACTION MAPPINGS, by S. C. Chu and J. B. Diaz. [1965] [7]p. incl. refs. (AFOSR-66-0561) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-400 and Naval Ordnance Laboratory) AD 641530 Unclassified

Also published in Jour. Math. Anal. and Appl., v. 11 440-446, July 1965.

A generalization of Banach's principle of contraction mappings appears in a book of Kolmogorov and Fomin. The purpose of this note is to simplify the proof of the generalization in the book, and to obtain, by proceeding along the lines of the simpler argument, several improvements to the above mentioned generalization (thereby showing that this generalization is merely a special case of an elementary fact).

1550

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON THE DIFFERENCE EQUATION $y(x+1) - y(x) = f(x)$, by S. C. Chu and J. B. Diaz. [1965] [4]p. (AFOSR-66-0562) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-400 and Naval Ordnance Laboratory) AD 641531 Unclassified

Also published in Jour. Math. Anal. and Appl., v. 11, 478-481, July 1965.

The following problem was considered by Euler to find a solution $y(x)$ of the difference equation $y(x+1) - y(x) = f(x)$. Euler derived a formula for a solution of the equation which may be valid when the function $f(x)$ has period one and is expandable in a Fourier series. The purpose of this note is to solve the equation in an extremely simple manner for all functions $f(x)$ of period one and to apply the basic idea involved to the solution of other difference equations. A brief resume of Euler's method of solution is given, for the purpose of comparison.

1551

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

COMPLEMENTARY INEQUALITIES III: INEQUALITIES COMPLEMENTARY TO SCHWARZ'S INEQUALITY IN HILBERT SPACE, by J. B. Diaz and F. T. Metcalf. [1965] [20]p. incl. refs. (AFOSR-66-0663) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSP-63-400 and Naval Ordnance Laboratory) AD 633544 Unclassified

Presented at Seventieth annual meeting of the Amer. Math. Soc., Miami, Fla., Jan. 23-27, 1964.

Abstract published in Notices of Amer. Math. Soc., v. 11: 92, Jan. 1964.

Also published in Math. Ann., v. 162: 120-139, 1965

The Schwarz inequality implies that $|(Ax, Bx)|^2 \leq (Ax, Ax)(Bx, Bx)$, where x is an arbitrary vector of the Hilbert space, A and B are operators on the Hilbert space itself. Under certain circumstances there exist complementary inequalities to the Schwarz inequality Previous papers have been concerned with complementary inequalities for finite sums of real numbers and for definite integrals. The purpose of this paper is to prove operator inequalities of this general "complementary" nature, which include as special cases several other complementary inequalities appearing in the literature Several complementary inequalities are discussed and further extensions involving several operators and vectors are presented. Variations and comparisons with many references are observed.

1552

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE TRANSPORTATION OF MAGNETIC LINES OF FORCE BY A HIGHLY CONDUCTING FLUID, by J. M. Burgers. [1965] [22]p. incl. diagrs. refs. (AFOSR-65-1471) (AF AFOSR-64-141) AD 622642 Unclassified

Presented at SIAM National Meeting, Washington, D. C., May 13-14, 1964.

Also published in Jour. Soc. Indus. and Appl. Math., v. 13. 184-205, Mar. 1965.

The transportation of magnetic lines of force by a moving medium of a high electrical conductivity can lead to the appearance of a boundary surface between moving fluid, devoid of a magnetic field, and a region with a strong magnetic field but without motion of the fluid. Equations describing the relation between particle motion and the magnetic field are developed, and some of the problems connected with the appearance of a separating surface are considered. The problem of how such a field arises when the motion is started from rest is treated, and simplification of the basic equations results in a model which illustrates the case when the gas is set in motion by a shock wave. Particle motion inside the Earth's magnetosphere is given special consideration as an example.

1553

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

NOZZLE FLOW OF A FULLY IONIZED PLASMA BASED ON TWO FLUID THEORY, by S. I. Pai and C. K. Tsao. [1965] [11]p. incl. diagrs. (AFOSR-65-2055) (AF AFOSR-64-141) AD 627742 Unclassified

Also published in Zeitschr. Angew. Math. und Phys., v. 16: 360-370, 1965.

Two fluid theory is used to analyze the 1-dimensional steady channel flow of a fully ionized plasma, and results are compared with those of single fluid theory. At a low rate of discharge, the 2 theories give very similar results, however the 2 fluid theory gives a more detailed picture of the flow-field of the plasma. It shows that the temperature of electrons is much larger than that of ions at high discharge rates. A special numerical example is presented of subsonic nozzle flow of a fully ionized gas. It is found that at the critical point where the local mach number of plasma reaches unity, the ion temperature and ion pressure both drop to zero, and ion velocity reaches its terminal value for a given initial pressure.

1554

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

ON SOLUTIONS OF THE GENERALIZED BI-AXIALLY SYMMETRIC HELMHOLTZ EQUATION GENERATED BY INTEGRAL OPERATORS, by R. P. Gilbert and H. C. Howard. [1965] [12]p. incl. refs. (AFOSR-65-2111) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-400 and National Science Foundation) AD 629791 Unclassified

Also published in Jour. Reine und Angew. Math., v. 218: 109-120, 1965.

Bergman's integral operator method is used to investigate solutions of the partial differential equation

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{2\mu}{x}\frac{\partial u}{\partial x} + \frac{2\nu}{y}\frac{\partial u}{\partial y} + k^2 u = 0, \quad \mu, \nu > 0.$$

This equation is referred to as the generalized bi-axially symmetric Helmholtz equation, following Weinstein who first considered fractional-dimensional space in potential theory. One is led to consider this equation initially by seeking "monochromatic" solutions $U(X, Y, t) \equiv U_1(X, Y)e^{\pm ikt}$ of the $(m+n = (2\mu+1) + (2\nu+1))$-dimensional wave equation $\frac{\partial^2 U}{\partial x_1^2} + \ldots + \frac{\partial^2 U}{\partial x_m^2} + \frac{\partial^2 U}{\partial y_1^2} + \ldots + \frac{\partial^2 U}{\partial y_n^2} = \frac{\partial^2 U}{\partial t^2}$ which depend solely on the variables $X^2 = (x_1^2 + \ldots + x_m^2)$, $Y^2 = (y_1^2 + \ldots + y_n^2)$. The generalized bi-axially symmetric Helmholtz equation and cases $\mu = 0$ and $k=\mu=0$ have been the object of many investigations; here, further properties of solutions to the generalized bi-axially symmetric Helmholtz equation with $k > 0$ are investigated by using Bergman's operator method. In particular, information concerning the location of singularities and the growth of solutions is obtained. (Math. Rev., abstract)

1555

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

SOME INEQUALITIES FOR GENERALIZED AXIALLY SYMMETRIC POTENTIALS WITH ENTIRE AND MEROMORPHIC ASSOCIATES, by R. P. Gilbert. [1965] [7]p. incl. refs. (AFOSR-65-2113) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-400, National Science Foundation, and Naval Ordnance Laboratory) AD 630585 Unclassified

Also published in Duke Math. Jour., v. 32: 239-246, June 1965.

Solutions to the partial differential equation of generalized axially potential theory (GASPT), $\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial y^2} + \frac{k}{y}\frac{\partial \varphi}{\partial y} = 0$, $k > 0$, may be generated by a given integral operator $A_k[f(\sigma)]$ maps analytic functions of the complex variable σ onto solutions of the GASPT equations $u(x, y)$.

The function $f(\sigma)$, which is mapped onto $u(x, y)$ is called the A_k-associate of $u(x, y)$. In this paper certain inequalities are obtained concerning entire and meromorphic GASPT functions that are independent of the associate function. This is done by making use of the inverse operator A_k^{-1}.

1556

[Maryland U. Inst. for Fluid Dynamics and Applied Mathematics College Park]

ON THE LOCATION OF SINGULARITIES OF A CLASS OF ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS IN FOUR VARIABLES, by R. P. Gilbert. [1965] [11]p. incl. refs. (AFOSR-65-2114) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-400 and National Science Foundation) AD 630208 Unclassified

Also published in Canad. Jour. Math., v. 17: 676-686, 1965.

The location of singularities is investigated for solutions to the elliptic equation $T_4[\Psi] \equiv \frac{\partial^2 \Psi}{\partial x_\mu \partial x_\mu} + A(r^2) x_\mu \frac{\partial \Psi}{\partial x_\mu} + C(r^2)\Psi = 0$, where $A(r^2)$, $C(r^2)$ are entire functions of the complex variable $r^2 = x_\mu x_\mu$ ($\mu = 1, 2, 3, 4$). The procedure makes use of an integral operator $B_4[f]$ which maps holomorphic functions of three complex variables onto harmonic functions of four variables. It is established that certain functions $H(X)$, generated by the operator $B_4[f]$ are regular provided that X is not contained in a given set of intersections.

1557

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A FIXED POINT THEOREM FOR 'IN THE LARGE' APPLICATION OF THE CONTRACTION PRINCIPLE, by S. C. Chu and J. B. Diaz. [1965] [13]p. (AFOSR-65-2235) (AF AFOSR-64-400) AD 639794 Unclassified

Also published in Atti Accad. Sci. Torino, Classe Sci. Fis. Mat. e Nat., v. 99: 351-363, 1964-1965.

In finding fixed points of functional transformations in normed function spaces, one often tries to apply the contracting mapping principle. Frequently this may be accomplished by suitably renorming the space or modifying the class of functions. A number of illustrations of this technique are presented for integral and functional equations.

1558

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SINGULARITIES OF ANALYTIC FUNCTIONS HAVING INTEGRAL REPRESENTATIONS, WITH A REMARK ABOUT THE ELASTIC UNITARITY INTEGRAL, by R. P. Gilbert, H. C. Howard, and S. Aks. [1965] [6]p. incl. refs. (AFOSR-65-2329) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-400 and National Science Foundation) AD 629790 Unclassified

Also published in Jour. Math. Phys., v. 6: 1157-1162, July 1965.

In this paper a survey is given of some results obtained recently concerning the singularities of holomorphic functions having integral representations. These results are all essentially extensions or modifications of those developed by Hadamard (for the proof of his multiplication of singularities theorem) to the case of several complex variables. In concluding, the authors consider the connection between the original Hadamard idea and the elastic unitarity integral of the quantum theory of fields. (Contractor's abstract)

1559

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON SOLUTIONS OF THE GENERALIZED AXIALLY SYMMETRIC WAVE EQUATION REPRESENTED BY BERGMAN OPERATORS, by R. P. Gilbert and H. C. Howard. [1965] [15]p. incl. refs. (AFOSR-65-2344) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-400, National Science Foundation, and Naval Ordnance Laboratory) AD 629792 Unclassified

Also published in Proc. London Math. Soc., v. 15: 346-360, Apr. 1965.

Bergman's integral-operator method is used to investigate solutions of the partial differential equation $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{2\nu}{y}\frac{\partial u}{\partial y} + k^2 u = 0$. This equation is referred to as the generalized axially symmetric wave equation, following Weinstein who first considered fractional-dimensional space in potential theory. One is led to consider this equation initially by considering "monochromatic" solutions, $U(X;t) = U(X)e^{\pm ikt}$, of the $(n=2\nu+2)$-dimensional wave-equation $\frac{\partial^2 U}{\partial x_1^2} + \cdots + \frac{\partial^2 U}{\partial x_n^2} - \frac{\partial^2 U}{\partial t^2} = 0$ which depend solely on the variables $x=x_1$, $y=(x_2^2+\cdots+x_n^2)$. The generalized axially symmetric wave equation and the particular case $k=0$ have been the object of many investigations, here, further

properties of solutions to the generalized axially symmetric wave equation with $k > 0$ are investigated by using Bergman's operator method. In particular, information concerning the location of singularities and the growth of solutions is obtained.

1560

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

INTEGRAL OPERATOR METHODS FOR GENERALIZED AXIALLY SYMMETRIC POTENTIALS IN (n+1) VARIABLES, by R. P. Gilbert and H. C. Howard. [1965] [18]p. incl. refs. (AFOSR-66-0200) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-400 and National Science Foundation) AD 633542 Unclassified

Also published in Jour. Australian Math. Soc., v. 5: 331-348, 1965.

The integral operator method of Bergman is used to investigate solutions of the partial differential equation $\frac{\partial^2 u}{\partial x_1^2} + \cdots + \frac{\partial^2 u}{\partial x_n^2} + \frac{\partial^2 u}{\partial \rho^2} + \frac{s}{\rho}\frac{\partial u}{\partial \rho} = 0$, where $s > -1$. In particular, information concerning the growth and location of singularities of solutions of the partial differential equation is obtained. Equations of the form (1.1) with $s=1, 2\ldots$ arise from the $(n+k+1)$-dimensional Laplace equation $\Delta_{n+k+1} u = 0$ in the "axially symmetric" coordinates $x_1, \ldots x_n, \rho$.

1561

[Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park]

SOME RESULTS IN INTERMEDIATE PROBLEMS FOR EIGENVALUES, by A. Weinstein. [1965] [19]p. incl. diagrs. tables, refs. (AFOSR-66-0212) (AF AFOSR-64-400) AD 641721 Unclassified

Also published in Proc. Internat'l. Symposium on Appl. Anal. Math. Phys., Cagliari-Sassari (Italy) (Sept. 28-Oct. 4, 1964), Rome, Edizioni Cremonese [1965] 218-234.

Considering a completely continuous symmetric operator T in a Hilbert space H, assume that T is negative definite so that the eigenvalues can be written in increasing order; this allows the eigenvalues to be defined by minimum rather than by maximum problems. In the numerical applications, T more often is positive definite instead of being negative. Usually the inverse operator is considered which in applications is a differential equation with appropriate boundary conditions. The problem of upper bounds is considered as solved by the Rayleigh-Ritz method; to find lower bounds, the method of intermediate problems is used. Tables of some numerical results obtained by the method of intermediate problems are presented, some of which can be found in the literature and some of which are published here for the first time. Included also are results which were obtained by various modifications and extensions of the basic theory of intermediate problems and which have already been published in various periodicals and reports.

1562

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ANALYTIC PROPERTIES OF THE ELASTIC UNITARITY INTEGRAL, by S. Ø. Aks, R. P. Gilbert, and H. C. Howard. [1965] [9]p. incl. refs. (AFOSR-66-0557) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-400 and National Science Foundation) AD 633543 Unclassified

Also published in Jour. Math. Phys., v. 6: 1626-1634, Nov. 1965.

In this paper, certain results concerning the singularities of holomorphic functions with integral representations are used to investigate the analytic properties of the elastic unitarity integral of the quantum theory of fields. In particular, it is shown that each of the Landau singularities of the scattering amplitude is an actual singularity. It is also shown that if the scattering amplitude is not identically zero it must have a natural boundary on the unphysical sheet.

1563

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A COMPLEMENTARY TRIANGLE INEQUALITY IN HILBERT AND BANACH SPACES, by J. B. Diaz and F. T. Metcalf. Jan. 1965, 15p. (Technical note no. BN-383) (AFOSR-66-2096) (AF AFOSR-64-400) Unclassified

Published in Proc. Amer. Math. Soc., v. 17: 88-97, Feb. 1966.

If non-zero vectors $x_1 \ldots, x_n$ of a Hilbert space satisfy $0 \le r \le (\mathrm{Re}(x_i, a))/\|x_i\|$ for a unit vector a, then $r(\|x_1\| + \cdots + \|x_n\|) \le \|x_1 + \cdots + x_n\|$, where the equality holds if and only if $x_1 + \cdots + x_n = r(\|x_1\| + \cdots + \|x_n\|)a$.

Consequently, it is obtained that $r(\|x_1\| \cdots \|x_n\|)^{1/n} \le \frac{1}{n}\|x_1 + \cdots + x_n\|$. This is a generalization of an inequality obtained by H. S. Wilf for complex numbers. The authors give elementary proofs and obtain similar inequalities for Banach spaces. (Math. Rev. abstract)

1564

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

MULTIVALUED HARMONIC FUNCTIONS IN FOUR VARIABLES, by R. P. Gilbert. [1965] 19p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of

Scientific Research under AF AFOSR-64-400, and Office of Naval Research) Unclassified

Also published in Jour. D'Anal. Math., v. 15: 305-323, 1965.

In the investigation of multivalued harmonic functions of 4 variables use was made of the theory of algebraic surfaces, and of rational and algebraic functions. The following theorem was proved: If H(X) is a harmonic function in 4 variables defined by integral representation, and $\sqrt{2}[X] \sim 0$ is a 2-cycle which meets each $D\mu[X]$ in just 2 points, then H(X) has a representation in terms of Weierstrass E-functions.

1565

[Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park]

A TRANSFORM RELATED TO THE POISSON INTEGRAL FOR A HALF-PLANE, by D. V. Widder. Mar. 1965, 16p. (Technical note no. BN-392) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-400 and National Science Foundation) Unclassified

Published in Duke Math. Jour., v. 33: 355-362, June 1966.

The author considers the inversion of the integral transform $f(x) = \int_0^\infty t\varphi(t)[z^2 + t^2]^{-1}\, dt$. By a simple change of variables this can be reduced to the Stieltjes transform. It then follows from a now classical formula of the author that $\varphi(t) = L_t f = \lim_{n\to\infty} L_{n,t} f$ almost everywhere if $L_{n,t} = -\theta \prod_{k=0}^{n} (1-\theta^2/4k^2)$. Here $\theta = t(d/dt)$. The main result of the paper is that if it happens that $f(x) = x^{-\alpha} \sum_0^\infty a_k x^k$, $0 < x < \rho$, then the inversion formula above reduces to the following: $\varphi(t) = \frac{2}{\pi} t^{-\alpha} \left\{ \sin\frac{\pi\alpha}{2} \sum_{k=0}^{\infty} (-1)^k a_{2k} t^{2k} - \cos\frac{\pi\alpha}{2} \sum_{k=0}^{\infty} (-1)^k a_{2k+1} t^{2k+1} \right\}$ for $0 < t < \delta$, where δ depends upon ρ. If $\rho = \infty$ then $\delta = \infty$. A parallel formula holds when $f(x) = x^{-\alpha} \sum_0^\infty a_k x^{-k}$, $\rho < x < \infty$. (Math. Rev. abstract)

1566

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

UNSTEADY THREE-DIMENSIONAL LAMINAR JET MIXING OF A COMPRESSIBLE FLUID, by S. I. Pai. [1965] [5]p. incl. diagrs. (AFOSR-65-1472) (AF AFOSR-65-141) AD 622924 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 24, Jan. 27, 1965.

Also published in AIAA Jour., v. 3: 617-621, Apr. 1965.

The fundamental equations of an unsteady 3-dimensional laminar jet mixing of a compressible fluid are discussed These equations are of continuity, motion, energy, and state; they are simplified by introducing 2 stream functions. Finally, the unsteady jet flow that deviates slightly from an unsteady uniform flow is studied in detail. It was found that, for arbitrary 3-dimensional jets, the velocity and temperature distributions tend to be axisymmetrical at large time-from-start and far downstream. Numerical examples are given. (Contractor's abstract, modified)

1567

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

NONLINEAR MECHANICS OF UNIVERSAL PLASMA INSTABILITIES, by H. Lashinsky. Aug. 1965 [18]p. incl. illus. diagrs. refs. (Technical note no. BN-411) (AFOSR-65-1737) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-141 and Atomic Energy Commission) AD 625033 Unclassified

Presented at Seventh Internat'l. Conf on Ionization Phenomena, Belgrade (Yugoslavia), Aug. 22-27, 1965.

Certain nonlinear mode-competition phenomena observed in experiments on the universal plasma instability in a thermal plasma device, the Q-machine, are analyzed by extending the usual phase-plane methods of nonlinear mechanics, the phase-plane coordinates in this case being the mode energies. Ion Landau damping of the universal instability provides an experimental means for selective control of the mode amplitudes. The results of mode-competition experiments using this technique are in agreement with the theoretical analysis, and the relevance of the results to similar phenomena in gas lasers and lumped-parameter vacuum-tube circuits is discussed. (Contractor's abstract)

1568

[Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park]

PHENOMENA AROUND HIGH SPEED FLOW, by J. M. Burgers and S. I. Pai. Final rept. Oct. 1, 1964-Sept. 30, 1965. Oct. 21, 1965, 10p. incl. refs. (AFOSR-65-2004) (AF AFOSR-65-141) AD 627262 Unclassified

A review is made of research on the properties of gases at high temperatures, the effects of these properties in high speed flows and around bodies, and problems of electro- and magnetogasdynamics. The investigation includes studies on (1) the transfer of magnetic lines of force by a gas flow, (2) the nonequilibrium effects on energy transfer in a plasma flow, using the three-fluid theory, (3) the effects of radiative heat transfer on flow properties, (4) unsteady laminar jet mixing of a compressible fluid, (5) the density dependence of thermal

transport coefficients, and (6) nonlinear phenomena in the universal plasma instability. Major experimental work has consisted of the construction of a thermal-plasma device (Q-machine) for use in the study of nonlinear mechanics of distributed systems.

1569

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

OPTICS OF THE INTEGRATING SCHLIEREN INSTRUMENT, by P. C. T. de Boer. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-2052) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-141] and Office of Naval Research) AD 627159
Unclassified

Also published in Rev. Scient. Instr., v. 36: 1135-1142, Aug. 1965.

An analysis is presented of the optics encountered in the integrating schleiren arrangement. Expressions were developed for the signal which will be received on the phototube, both for the instrumentation using an inclined knife edge and for that with a vertical knife edge. A simple method is described for calibrating the density scale; the method involves displacing the knife edge over a known distance and measuring the resulting signal. The influence of certain diffraction phenomena on the measurements is briefly discussed, and it is concluded that Fresnel diffraction occurring in the edges of the light beam is one of the factors determining the resolving power. Another factor important for the resolving power is the divergence of the incident light. The advantage of the vertical knife edge is the very high sensitivity which can be obtained. (Contractor's abstract, modified)

1570

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

INVESTIGATION OF THE UNIVERSAL INSTABILITY IN A THERMAL PLASMA DEVICE (Q-MACHINE), by H. Lashinsky. Sept. 1965 [20]p. incl. illus. diagrs. tables, refs. (Technical note no. BN-415) (AFOSR-65-2053) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-141 and Atomic Energy Commission) AD 627261 Unclassified

Also published in Plasma Physics and Controlled Nuclear Fusion Research; Proceedings of the Second Conf., Culham (Gt. Brit.), (Sept. 6-10, 1965), Vienna, International Atomic Energy Agency, v. 1: 499-514, 1966. (Title varies)

A Q-machine is used to study the universal instability due to the joint effect of the finite ion Larmor radius and the density gradient perpendicular to the magnetic confining field. A Q-machine is well suited for such an investigation since it produces a plasma that is essentially quiescent. The experimentally determined basic characteristics of the instability are found to be in good qualitative agreement with the linear theory of the universal instability. The effect of column length on the real part of the frequency and on the imaginary part is examined. The latter effect is due to ion Landau damping and the method is excellent for studying the Landau damping mechanism itself. A number of nonlinear effects are revealed in the experiments, which are analyzed by generalizing standard methods of nonlinear mechanics.

1571

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

NONLINEAR MODE INTERACTIONS IN UNIVERSAL PLASMA INSTABILITIES, by H. Lashinsky. [1965] [3]p. incl. illus. diagr. refs. (AFOSR-65-2054) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-141 and Atomic Energy Commission) AD 627477 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 508, Apr. 28, 1965.

Also published in Phys. Rev. Ltrs., v. 14: 1064-1066, June 28, 1965.

By regarding the plasma column of a thermal plasma device (Q-machine) as a bounded, spatially distributed oscillator with velocity-distributed constituent elements, the nonlinear behavior of the universal instability can be analyzed through an extension of the methods of nonlinear mechanics. Nonlinear mode interactions are considered in a 2-mode system with incommensurate mode frequencies. To investigate the stability of simultaneous oscillation in 2 modes, the phase-plane topology methods of nonlinear mechanics are used. In addition it is shown possible to set up an experimental situation in which only 2 modes oscillate by an appropriate adjustment of the sheath conditions and the column length. Results of such a 2-mode experiment are given.

1572

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

DIVERGENT TRANSPORT COEFFICIENTS AND THE BINARY COLLISION EXPANSION, by L. K. Haines, J. R. Dorfman, and M. H. Ernst. Oct. 1965, 38p. incl. diagrs. refs. (Technical note no. BN-419) (AFOSR-65-2741) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-141, Army Research Office (Durham), and Netherlands Organization for the Advancement of Pure Research) AD 631808
Unclassified

The binary collision expansion for the viscosity of a 2-dimensional gas of hard disks is discussed. A divergence appears in the first correction to the Boltzmann equation result. The calculations presented here are exact and free of the difficulties that appear in the earlier discussion of Kawasaki and Oppenheim. The coefficient of the divergence is computed and found to be

precisely the same as that found by Sengers by an entirely different method. The origin of the divergence is shown to be exactly the same as that found by Dorfman and Cohen. (Contractor's abstract)

1573

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

FUNCTIONS AND INTEGRALS CONNECTED WITH SOLUTIONS OF THE DIFFUSION OR HEAT FLOW EQUATION, by J. M. Burgers. May 1965, 96p. incl. diagrs. (Technical note no. BN-398) (AFOSR-66-1946) (AF AFOSR-65-141) AD 640445 Unclassified

The paper contains an investigation of the properties of certain functions connected with solutions of the ordinary diffusion or heat flow equation $\partial\psi/\partial x = J(\partial^2\psi/\partial y^2)$, when the function ψ must become zero on a boundary curve in the x, y-plane, the most important case being that where the boundary curve is a parabola $y = x^2/2t$ (J and t being constant parameters). In the first part of the paper, the functions of interest are defined, and various properties of these functions are derived from a study of the partial differential equation and the behavior of its solutions when the boundary curve is subjected to variations. In the second part, the boundary curve is always a parabola. A transformation of the field makes it possible to change this boundary into a straight line, the differential equation obtaining a slightly more complicated form. In the third part, certain multiple integrals are evaluated, depending upon these functions defined.

1574

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

TRANSPORT COEFFICIENTS FOR DENSE GASES, by J. R. Dorfman. [1965] [23]p. incl. diagrs. (AFOSR-66-0334) (AF AFOSR-66-1015) AD 630588 Unclassified

Presented at Fourth Eastern Theoretical Physics Conf., Stony Boook, N. Y., Nov. 26-27, 1965.

A convergent theory for the density dependence of transport coefficients for a moderately dense gas is discussed. Since the terms in the original density expansion depend upon the dynamics of successively higher numbers of particles, one can classify the divergences that appear in terms of the associated dynamical events. The most divergent terms are always determined by sequences of binary collisions. The summation of the most divergent terms produces a collision damping which keep the interval between successive binary collisions to within a few mean free times. The resummed expression for the viscosity due to Kawasaki and Oppenheim was partially evaluated. One can say that terms proportional to $n^{d-1} \log n$, where d is the number of dimensions, appear in the density expansion, however, the precise coefficients of the logarithm have not yet been established.

1575

Massachusetts Inst. of Tech., Cambridge.

THERMAL EFFECTS ON THE FLUORESCENCE LIFETIME AND SPECTRUM OF MgO:V^{2+}, by B. Di Bartolo and R. Peccei. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-65-2774) (Sponsored jointly by Air Force Materials Laboratory; and Air Force Office of Scientific Research under AF AFOSR-62-317) AD 629266 Unclassified

Also published in Phys. Rev., v. 137: A1770-A1776, Mar. 15, 1965.

The vibronic spectrum associated with the $^2E \rightarrow {}^4A_2$ transition at 8700A of MgO:V^{2+} has been investigated as a function of temperature. The position and the width of the purely radiative (R) line associated with this transition were measured from 4 to 460°K, and the total intensity of the fluorescence spectrum from 77 to 650°K. At low temperatures, vibrational satellites are observed only on the low-energy side of the pure electronic transition, corresponding to spontaneous phonon emission; at higher temperatures, they also appear on the high-energy side, corresponding to phonon abosrption. With increasing temperature the vibronic bands become more intense relative to the pure electronic transition, the peaks broaden, and multiphonon processes enter and form a fluorescence continuum extending from 7000 to 500A. The fluorescence lifetime of the ^2E level, which is 50 msec and nearly temperature-independent at 77°K, decreases rapidly above 200°K to ~ 0.03 msec at 800°K. The enhancement of the transition probability of the vibronic bands, determined from the relative increase in the integrated area after correction for the temperature dependence of the absorption strength, can account for the major temperature dependence of the fluorescence lifetime, without requiring the presence of any purely nonradiative transitions. (Contractor's abstract)

1576

Massachusetts Inst. of Tech., Cambridge.

EXPERIMENTAL ELECTRIC CURRENT DISTRIBUTIONS IN MGD CHANNEL FLOWS (Abstract), by M. A. Hoffman. [1965] [1]p. (Bound with AFOSR-65-1266; AD 622527) (AF AFOSR-64-306) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Experimental investigations of the distribution of currents to electrodes in linear MGD channels have been carried out. The experiments have been performed with 2 electrode configurations: (1) continuous electrodes and (2) segmented electrodes. In each case the electrodes were finely subdivided so that the current distribution to the electrodes could be determined. As expected, current concentrations were measured at the edges of the electrodes. However, the concentrations were less pronounced than the current density singularities predicted by theories assuming constant electrode potential (as well as uniform gas properties and gas velocity).

A semi-empirical theory including a current-dependent electrode potential shows reductions in the current concentrations similar to those in the experiments. Therefore it appears that electrode and sheath voltage drops will tend to limit the current concentrations on the electrodes in some current ranges. This implies that operation in the diffuse current mode without the arc breakdowns which would be expected from the predicted current singularities of the constant electrode potential theory should be possible in MGD generators.

1577

Massachusetts Inst. of Tech., Cambridge.

PROPERTIES OF NONEQUILIBRIUM PLASMA AT LARGE HALL PARAMETERS (Abstract), by J. L. Kerrebrock. [1965] [1]p. (Bound with AFOSR-65-1266; AD 622527) (AF AFOSR-64-306) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

The aim of this program is to determine the properties of nonequilibrium plasmas in strong magnetic fields. It appears from the experiments conducted to date that the effective Hall parameter and conductivity of the plasma may deviate considerably from the values which would be expected for a homogeneous plasma. Theory and the present experiments both indicate that this deviation may be due to the presence of wave-like disturbances which are amplified at large Hall parameters. Measurements of the root-mean amplitude of the electrical fluctuations in the plasma show a strong increase with increasing Hall parameter, while the effective conductivity and Hall parameter both decrease from their expected values. The measurements of Hall voltage have also lead to a direct determination of the electron density in the nonequilibrium plasma. From the electron density, the electron temperature can be inferred, and hence the electronic energy loss rate. The loss rates so determined agree reasonably well with those expected from elastic collisions and resonance radiation.

1578

Massachusetts Inst. of Tech. [Aeroelastic and Structures Research Lab.] Cambridge.

PLASTIC DEFORMATION AND FAILURE OF SILVER-STEEL FILAMENTARY COMPOSITES, by H. R. Piehler. [1965] [5]p. incl. illus. diagrs. (AFOSR-65-0916) (AF 49(638)775) AD 616803 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 233: 12-16, Jan. 1965.

Continuous 7- and 19-filament close-packed silver-steel filamentary composites were tested in tension. For purposes of comparison, the tensile behavior of the composite was predicted from the measured properties of the individual components. It was assumed that the axial strain is the same in both components and that the contribution of each component to the composite flow stress is proportional to its volume fraction. Good agreement was obtained between the observed and predicted tensile behavior. However, the composite elongation at fracture was about twice that observed when the individual steel wires were tested alone. Composites in which the filaments were widely spaced failed by the consecutive fracture of the filaments. In composite with closely spaced filaments, a composite instability preceded fracture. These effects are explained in terms of a lateral restraint to the necking of the filaments which develops in the deforming composite.

1579

Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge.

MECHANICAL BEHAVIOR OF COMPOSITE MATERIALS, by J. W. Mar and L. A. Shepart. Final summary rept. Sept. 1, 1965, 13p. (Rept. no. 94-6) (AFOSR-65-1936) (AF 49(638)775) AD 627173 Unclassified

This study was conducted to develop an understanding of the interaction of stronger and more ductile phases in determining the mechanical behavior and fracture of metallic composites. It was directed to composites in which the strong phase constituted the major volume fracture. The following aspects were particularly emphasized: (1) the relationship of the properties of individual phases to their behavior in a composite; (2) the effect of the shape, size and volume fraction, distribution, and spacing of the phases upon the properties; and (3) the thermodynamic properties, i.e., phase relationships solubilities, and interfacial tensions of the composites.

1580

Massachusetts Inst. of Tech. Aerophysics Lab., Cambridge.

EXPERIMENTAL INVESTIGATION OF THERMAL DIFFUSION EFFECTS IN LAMINAR AND TURBULENT SHEAR FLOW, by H. Thomann and J. R. Baron. [1965] [13]p. incl. illus. diagrs. (AFOSR-65-1151) (AF AFOSR-62-407) AD 618575 Unclassified

Also published in Internat'l. Jour. Heat and Mass Transfer, v. 8: 455-466, Mar. 1965.

An experimental investigation was conducted to determine the order of magnitude of thermal diffusion across a laminar and a turbulent shear layer. A short length of a cooled free jet was passed through stationary gas and subsequently recaptured into a continuous circulating system. Various mixtures of helium and nitrogen were investigated. With temperatures of 78°K in the jet and 310°K in the surrounding chamber, steady-state helium concentrations in the laminar jet were as much as 7% smaller than in the surroundings. The experimental results are in good agreement with a simplified analysis. With a turbulent shear layer between the jet and surroundings, the helium concentration inside the jet increases to within 0.1% higher than the chamber level. The thermal diffusion ratio (i.e. thermal to mass concentration diffusion coefficients) in the turbulent shear layer was thus at least 2 orders of magnitude

smaller than in the laminar case and of opposite sign. It is suggested that similar separation effects are to be expected for other steady flows with closed streamlines, such as base flows and flows past cavities. (Contractor's abstract)

1581

Massachusetts Inst. of Tech. Aerophysics Lab., Cambridge.

EXPERIMENTS ON BLUNT BODY FLOWS WITH CENTRAL INJECTION, by A. F. Gollnick, Jr. May 1965, 68p. incl. illus. diagrs. tables, refs. (Technical rept. no. 105) (AFOSR-65-1149) (AF AFOSR-64-641) AD 621525 Unclassified

Blunt nosed models incorporating axisymmetric contoured injection nozzles were tested at Mach numbers of 7.46 and 4.80. Nozzle contours were computed by means of an inviscid, incompressible analysis and designed to generate hemispherical and ellipsoidal interfaces between the injectant and external flow fields. Shock and interface displacement measurements were in substantial agreement with earlier data, provided a consistent definition of injection mass flow rate was used. Injection produced substantial reductions in equilibrium surface temperatures. Helium proved to be a more effective injectant in this respect than air. In the hypersonic range, Mach number appeared to have no effect on the results. It appeared that in most cases the injectant separated from the nozzle near the throat, producing considerable mixing within the injection cap, accompanied by unsteadiness and asymmetry of the bow shock and interface. It was found that separation data could be correlated on the basis of a previously developed throat flow rate parameter and that separation could be successfully postponed by increasing the throat area. (Contractor's abstract)

1582

Massachusetts Inst. of Tech. Aerophysics Lab., Cambridge.

RADIATION COUPLED WEDGE FLOW USING METHOD OF INTEGRAL RELATIONS, by M. C. Jischke. Apr. 1965, 34p. incl. diagrs. table, refs. (Technical rept. no. 112) (AFOSR-65-1727) (AF AFOSR-64-641) AD 624554 Unclassified

The radiation coupled supersonic flow past a wedge or cone is formulated using the first approximation of the method of integral relations. Solutions obtained for wedge flow of an optically thin, i.e., nonabsorbing, gas indicate a temperature decrease and density increase along the surface with a corresponding shock wave decay. Radiation effects on velocity and pressure are relatively small. Anomalous behavior of the transparent gas far downstream of the leading edge suggests a criterion for estimating the region of validity for the optically thin gas approximation. (Contractor's abstract)

1583

Massachusetts Inst. of Tech. Aerophysics Lab., Cambridge.

HIGH SPEED VISCOUS, REACTING AND RADIATING FLOWS, by J. R. Baron. Final rept. Nov. 1965, 31p. incl. diagrs. refs. (Technical rept. no. 127) (AFOSR-65-2713) (AF AFOSR-64-641) AD 628233 Unclassified

A description is given of investigations conducted during this project. Some of the work has already been reported and is not discussed in detail except where publication is pending. Major emphasis is on work in progress to indicate present status. The overall objective was a consideration of real gas and real fluid flows, the majority being analytical in nature. The individual studies fall within the general groupings of nonequilibrium flow, radiation coupled flow, boundary layer flow, shear layer flow, and injection flow.

1584

Massachusetts Inst. of Tech. Aerophysics Lab., Cambridge.

RADIATION EFFECTS IN THE STAGNATION REGION BOUNDARY LAYER, by J. Shwartz. Nov. 1965, 47p. incl. diagrs. tables, refs. (Technical rept. no. 119) (AFOSR-66-0129) (AF AFOSR-64-641) AD 628547 Unclassified

The radiation coupled boundary layer of an emitting and absorbing gas at the stagnation region of a blunt body is considered. Solutions are obtained for a wide range of optical thicknesses and radiation intensities, including the radiative effects of the adjoining shock layer. The solutions indicate the decrease in temperatures, their gradients, and the related conductive heat transfer to the wall as well as the net radiant energy contribution. The results are shown for a range of optical thicknesses from thin to effectively thick, with the major effects of radiation found to exist for the former extreme. (Contractor's abstract)

1585

Massachusetts Inst. of Tech. Aerophysics Lab., Cambridge.

AXISYMMETRIC, LAMINAR, BINARY SHEAR LAYER WITH THERMAL DIFFUSION AND DIFFUSION-THERMO EFFECTS, by K. Y. Chien. [1965] [7]p. incl. diagrs. (AFOSR-66-0570) (AF AFOSR-64-641) AD 631154 Unclassified

Also published in Internat'l. Jour. Heat and Mass Transfer, v. 8 1507-1513, 1965.

Consideration is given to the thermal separation of components across the shear layer between a cold jet mixture (of helium and nitrogen) and a hot ambient gas, both initially at the same concentration levels. An asymptotic steady state solution is obtained assuming the layer to be thin relative to the jet radius. As a consequence of

small inhomogeneity the momentum equation may be decoupled from energy considerations and a priori known velocity profiles result with the customary assumption of constant product of density and viscosity. Iterative integration of the concentration and energy relations is completed on the basis of the steady state condition of zero mass transport across the dividing streamline using similarity co-ordinates. Reasonable agreement with available experimental data results from use of the modified hard sphere model for the thermal diffusion ratio. (Contractor's abstract)

1586

Massachusetts Inst. of Tech. Center for International Studies, Cambridge.

RADIO AND TELEVISION IN THE SOVIET UNION, by F. G. Durham. June 1965, 122p. incl. illus. diagrs. refs. (Rept. no. C/64-10) (AFOSR-67-0955) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF 49(638)1237) AD 651556 Unclassified

This paper can be divided into 6 major sections. The first one deals with the broadcasting network within the Soviet Union. Here the author discusses radiobroadcasting, broadcasting stations, television broadcasting, number of television stations, and radio and television in rural localities. The next section covers production and repair of radio and television sets and also covers future radio and television sets and subscription fees. The third section treats the Administration of Soviet Radio and Television-the structural apparatus of the Broadcasting Administration and its functions. In the fourth chapter, the author discusses programs and hours of radio and television broadcasting. Here the author also goes into educational TV in the USSR, radio and television in Dnepropetrovsk, Ukrainian SSR, and recording of broadcasts. The fifth section pertains to Intervision which is the central network connecting the television broadcasting systems of the major socialist countries. In the final section, the author studies the size of the audience, the nature of the audience, and audience feedback and listening behavior.

1587

Massachusetts Inst. of Tech. Center for International Studies, Cambridge.

AMATEUR RADIO OPERATION IN THE SOVIET UNION, by F. G. Durham. June 1965, 71p. incl. illus. diagr. refs. (Rept. no. C/64-10A) (AFOSR-67-0956) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under [AF 49(638)1237]) AD 651559 Unclassified

A study was made of amateur radio operation in the Soviet Union. The importance of amateur radio activity in Soviet society is shown. The reader learns about the Administration of Soviet Amateur Radio Activity, and RADIO, the official journal of Soviet amateur radio activity. This leads to a discussion on the amateur radio operator and his technical training, call signs, and frequency allocations. A discussion is given of the types of amateur communications being encouraged in the Soviet Union such as short wave, vhf, and uhf, and single-sideband communications. Contests, titles and awards for Soviet amateur radio operators are noted. Other topics discussed include participation of amateur radio operators in such activities as tracking artificial earth satellites; the military significance of radio amateurism in the Soviet Union; radio equipment, exhibitions of amateur built equipment, and foreign contacts of Soviet amateur radio operators.

1588

Massachusetts Inst. of Tech. Center for International Studies, Cambridge.

NEWS BROADCASTING ON SOVIET RADIO AND TELEVISION, by F. G. Durham. June 1965, 63p. incl. diagrs. tables, refs. (Rept. no. C/64-10b) (AFOSR-67-0957) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF 49(638)1237) AD 651568 Unclassified

The paper specifically deals with news broadcasting on Soviet radio and television. It begins by discussing the Soviet conception of the functional role of broadcasting media and news. It emphasizes of what extreme importance is the position which news broadcasting occupies in the process of informing the individual Soviet citizen. This leads into a study of radio news broadcasting. The first part of this section deals with the mechanics of news broadcasting in the Soviet Union. The reader learns about schedules, planning, the news-gathering apparatus, and party influence. In the next section it turns to a study of the content of the news broadcasts; into their characteristics, forms, and the different types of news. After this it discusses television news broadcasting; on times of broadcasts, forms of news broadcasts on television and the preparation of news for television.

1589

Massachusetts Inst. of Tech. Center for International Studies, Cambridge.

THE FILM INDUSTRY IN COMMUNIST CHINA, by A. P. L. Liu. July 1, 1965, 92p. incl. diagr. tables, refs. (Rept. no. C/65-5) (AFOSR-67-0959) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF 49(638)-1237) AD 651567 Unclassified

The monograph deals with the development of a centralized movie industry in Communist China. A brief review is given of the state of movie industry in pre-Communist China. Then a detailed description of the Communist nationalization of the movie industry is given. A network of movie showing was quickly established under the Communist leadership. Movie attendance went up slowly over the years but most of the growth was due to organizational effort rather than voluntary attendance. The Communists selectively imported and censored foreign films. As to the domestic film industry the regime

still faces the problem of producing an adequate number of high-quality feature films. The problem of producing films appealing to the peasantry is especially serious.

1590

Massachusetts Inst. of Tech. Center for International Studies, Cambridge.

CHINESE ATTITUDINAL REACTIONS TO FORCED COMPLIANCE: A CROSS-CULTURAL EXPERIMENT IN THE THEORY OF COGNITIVE DISSONANCE, by P. Hiniker. May 1965, 66p. incl. tables, refs. (Rept. no. C/65-18) (AFOSR-67-0969) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF 49(638)1237) AD 651566 Unclassified

This paper is a report of experimental research on Chinese psychological reactions to forced compliance conducted by the author in Hong Kong between the months of January and October 1964. It represents an attempt to provide empirical answers to the questions posed by 2 mutually contradictory theories pertinent to Chinese reactions in a forced compliance situation, viz. the Theory of Cognitive Dissonance and a Characterological Theory about Chinese behavior. The former is about the tendency of people to maintain consistency between their cognitions, evaluations, and behaviors and how people react once this consistency is disrupted. The latter is about the behavior characteristics of Chinese resulting from their culture of Confucianism. The author finds that the experiment supports the Characterological Theory in general, but only part of the Dissonance Theory is supported. For example, for the Chinese and American subjects alike, increased inducement produces increased compliance. But unlike that of the American subjects, the internalized attitudes of the Chinese were affected neither by increased inducement nor by consequent increased compliance. However the author does not conclude that this experiment has large implications for dissonance theory as a whole but he does contend that the experiment has direct implications for the cross-cultural applicability of dissonance due to forced compliance.

1591

Massachusetts Inst. of Tech. Center for International Studies, Cambridge.

THE USE OF TRADITIONAL MEDIA FOR MODERNIZATION IN COMMUNIST CHINA, by A. P. L. Liu. Oct. 1965, 96p. incl. illus. diagr. tables, refs. (Rept. no. C/65-24) (AFOSR-67-0961) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under AF 49(638)1237) AD 651558 Unclassified

This is a very general description of how the Chinese Communist Government reforms 4 traditional entertainment media for the purpose of Communist propaganda. However, the author also discusses the general pattern of grass-root communication in traditional China in order to provide a historical perspective of the paper. The Communists made several serious efforts to reform the traditional theater but ended up in unsatisfactory results. Then the regime turned to the traditional art of story-telling and poems. To complement that, the regime also organized people for collective singing. The ironic result, as the author points out, is that the regime meant to exploit the effectiveness of these media as traditionally being "people's art" but the regime's exploitation destroys this unique quality of "people's art".

1592

Massachusetts Inst. of Tech. Center for International Studies, Cambridge.

BOOK PUBLISHING IN COMMUNIST CHINA, by A. P. L. Liu. Oct. 1965, 92p. incl. diagr. tables, refs. (Rept. no. C/65-25) (AFOSR-67-0962) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF 49(638)-1237) AD 651563 Unclassified

This is a general study of the organization of the book publishing industry in Communist China. First the paper reviews briefly the private industry of publishing in pre-Communist China. Next the Communist nationalization of the publishing enterprise is described. Then the author discusses the publishings of the following categories of books: works of Mao Tse-tung and other Chinese Communist leaders, belles lettres (modern and classical), history and economics, science and technology, dictionaries, popular reading materials, children's readers and specially designed books for the minority races in China. The author also discusses briefly China's translation of books from foreign countries, especially the Soviet Union and China's export of books to foreign lands. Finally the author discusses the general reading preferences among the Chinese public today and notes the popularity of classical literature.

1593

[Massachusetts Inst. of Tech. Computation Center, Cambridge]

RATIONAL APPROXIMATIONS ON FINITE POINT SETS, by P. Fox, A. A. Goldstein, and G. Lastman. [11]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-348 and General Motors Research Laboratories) Unclassified

Published in Approximation of Functions, Proc. of the [Eighth] Symposium, General Motors Research Laboratories, Warren, Mich., (Aug. 31-Sept. 2, 1964), ed. by H. L. Garabedian. Amsterdam, Elsevier, 1965, p. 57-67.

Two new algorithms are described for rational Cebysev approximation on finite point sets. It is assumed that both numerator and denominator depend linearly on the free coefficients. These algorithms differ from those previously given for the same problem in that they terminate in a finite number of cycles. The rational approximation obtained is constrained in the sense that the denominator is bounded below by, say, $\delta > 0$. With a

small additional effort other linear equalities can be imposed as additional constraints. To implement the algorithms, a method for solving systems of linear inequalities is required. (Math. Rev. abstract)

1594

Massachusetts Inst. of Tech. [Computation Center] Cambridge.

THE NUMERICAL SOLUTION OF BOUNDARY VALUE PROBLEMS, by J. W. Lucey. May 14, 1965, 114p. incl. diagrs. tables, refs. (AFOSR-65-1279) (A. AFOSR-63-341) AD 621201 Unclassified

The marchout method is extended to the numerical solution of second order 2-dimensional inhomogeneous problems and the one velocity neutron transport equation. In the method the solution is expanded in a full set of vectors which are used in an unstable difference equation. The error growth is controlled, however, by periodic matrix transformations which insure the completeness of the vector set. The error in the solution is determined by the frequency of these transformations and may be preset. The method has its greatest advantage in relation to the computational speed of conventional methods in elongated meshes, such as multigroup diffusion calculations or low order discrete ordinate or P_N calculations with many spatial mesh points. (Contractor's abstract)

1595

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

THE INTERIOR ELASTIC STRESS FIELD IN A CONTINUOUS CLOSE-PACKED FILAMENTARY COMPOSITE MATERIAL UNDER UNIAXIAL TENSION, by H. R. Piehler. June 1965, 33p. incl. diagrs. tables, refs. (Technical rept. no. 132-1) (AFOSR-65-1426) (AF 49(638)1463) AD 624572 Unclassified

Using symmetry arguments, boundary conditions are established which must hold on the lines of symmetry between neighboring filaments in an oriented filamentary composite. These conditions serve to set the problem as a special case of the mixed boundary value problem of elasticity. The composite is assumed to deform such that the normal strains in the direction of the filament axes are the same in both media. The equations of elasticity are then solved in polar coordinates so that the solution has the appropriate sixfold symmetry. The in-plane stresses are vanishingly small for the epoxy-fiberglass composite. For the silver-steel composite, the in-plane stresses reach about 3% of the average axial stress. When the filaments are close together, the periodic portions of the stress field are most important. As the filaments are more widely spaced, the stress field becomes more circularly symmetric. The phasing of the stress field is such that the radial stress is compressive at the point where the filaments are closest together and tensile at the point where the filaments are farthest apart. In all cases, the composite Young's modulus varies linearly with filament fraction. (Contractor's abstract)

1596

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

THE OPERATION OF BRITTLE FRACTURE MECHANISMS IN DUCTILE METAL COMPOSITES, by J. P. Kershaw and L. A. Shepard. Dec. 1965, 17p. incl. illus. diagrs. refs. (Rept. no. ASRL TR 132-3) (AFOSR-66-1669) (AF 49(638)1463) AD 638621 Unclassified

Experiments with W-Fe-Ni and Fe-Ag composites are described. The former consists of continuously bonded rounded tungsten grains in a FCC solid solution matrix of W-Fe-Ni, while the latter consists of a regular grain structure with silver dispersed in the grain boundaries and through the grains. Griffith cracks, concentrated slip, and the effects of twin intersection in these composites are described. It is concluded that the softer matrix phase provides a mechanism whereby the stress concentrations in the harder phase are relieved, thus leading to ductile behavior of the composite. (Contractor's abstract)

1597

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

EFFECT OF TUNGSTEN COMPOSITION ON THE MECHANICAL PROPERTIES ON THE W-Ni-Fe HEAVY ALLOY, by J. W. O'Neil and P. N. Salyer. Dec. 1965, 30p. incl. illus. diagrs. tables, refs. (Rept. no. ASRL TR 132-2) (AFOSR-66-1670) (AF 49(638)1463) AD 638620 Unclassified

The ductility and strength of W-Ni-Fe composites over a wide range of volume % W was investigated at room temperatures. A series of composites was prepared (40% W to 95% W), sintered in the presence of the liquid phase and tested in tension. The sources of strength and ductility of the W-Ni-Fe composite was determined as related to the measured dihedral angle, mean particle diameter, tungsten mean free path, tungsten contiguity and volume % W. Similar stress-strain curves were obtained for all specimens tested which showed liquid phase sintered microstructure. These test results indicate that the volume % has very little effect upon the composite strength. For W-Ni-Fe composites where the tungsten mean free path is greater than the measured particle diameter (approximately 85% to 96% W), the maximum strain and maximum stress at necking dropped off rapidly. (Contractor's abstract)

1598

Massachusetts Inst. of Tech. [Dept. of Aeronautics and Astronautics] Cambridge.

THEORETICAL CONSIDERATIONS OF PANEL FLUTTER AT HIGH SUPERSONIC MACH NUMBERS, by J.

Dugundji. Aug. 1965, 71p. incl. diagrs. refs. (Rept. no. ASRL TR 134-1) (AFOSR-65-1907) (AF 49(638)-1528) AD 624995 Unclassified

The general characteristics of panel flutter at high supersonic Mach numbers are examined theoretically. Linear plate theory and 2-dimensional first order aerodynamics are used. The report attempts to clarify the important role of damping, the relationship between traveling and standing wave theories of panel flutter, and the effects of edge conditions. The solution procedures and general mathematical behavior may be of interest in other stability problems characterized by the appearance of complex eigenvalues. (Contractor's abstract)

1599

Massachusetts Inst. of Tech. [Dept. of Aeronautics and Astronautics] Cambridge.

THE FLUTTER OF AN INFINITELY LONG CYLINDRICAL SHELL, by E. H. Dowell. Jan. 1965, 67p. incl. diagrs. refs. (Rept. no. ASRL TR 112-3) (AFOSR-65-0639) (AF AFOSR-62-363) AD 616321 Unclassified

The aeroelastic stability of an infinitely long, isotropic cylinder with the outer surface exposed to an inviscid flow is re-examined. The cylinder behavior is described by the shell equations of Goldenvieser, while the aerodynamic forces are described by the classical linearized potential theory. For a cylinder whose length is long compared to the critical wavelength, the model presented should adequately describe the stability boundary. Rather extensive numerical results for flutter velocity and dynamic pressure indicate the effects of Mach number, thickness, and density. An important consequence of the study is the indication that the aerodynamic loading on the cylinder is of the "slender body" type when the axial wavelength is large compared to the circumferential wavelength It may be expected that a similar result will hold for cylinders of finite length. (Contractor's abstract)

1600

Massachusetts Inst. of Tech. [Dept. of Aeronautics and Astronautics] Cambridge.

VIBRATIONS OF FREELY-SUPPORTED ORTHOTROPIC CYLINDRICAL SHELLS UNDER INTERNAL PRESSURE, by P. R. DiGiovanni and J. Dugundji. Feb. 1965, 70p. incl. diagrs. tables, refs. (Rept. no. ASRL TR 112-4) (AFOSR-65-0640) (AF AFOSR-62-363) AD 617269 Unclassified

The influence of orthotropicity and internal pressure on the natural frequencies of a thin cylindrical shell whose ends are freely supported is found using the shell equations of Washizu. Other common shell theories are also presented. Calculations are performed for 4 constant thickness orthotropic cylinders, 2 stiffened cylinders, and a basic isotropic cylinder. For these calculations, only the special cases of axial and circumferential stiffening were considered It is noted that there is a difference in the behavior of the frequencies for the n 0, n - 1, and n 2 modes. The effects of circumferential stiffening and axial stiffening on the frequencies for the different modes are discussed, as well as the effects of internal pressure on the frequency for cases of stiffening.

1601

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

THE STABILITY OF AN UNSTEADY KELVIN-HELMHOLTZ FLOW, by R. E. Kelly. [1965] [14]p. incl. diagrs. refs. (AFOSR-66-0329) (AF AFOSR-63 156) AD 631136 Unclassified

Also published in Jour. Fluid Mech., v 22· 547-560, July 1965.

The investigation concerns the stability of an interface between 2 inviscid fluids of different densities which flow parallel to each other in an oscillatory manner. When the difference in the mean speeds is below the steady, critical speed for instability but is large compared to the amplitude of the fluctuations, parametric amplification of waves at the interface occurs, and the interface exhibits a resonance of a subharmonic nature. The paper concludes with a discussion of the stability of unsteady shear layers on the basis of the results. (Contractor's abstract)

1602

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

STABILITY OF A PANEL IN INCOMPRESSIBLE, UNSTEADY FLOW, by R. E. Kelly. [1965] [6]p. incl. diagrs. refs. (AFOSR-66-0330) (AF AFOSR-63-156) AD 631135 Unclassified

Also published in AIAA Jour. v. 3· 1113-1118, June 1965.

The stability of an infinite panel is investigated when the panel is immersed in an airstream whose velocity is composed in part of an unsteady component that oscillates periodically with respect to time. The analysis indicates that neutrally stable waves in the panel can undergo parametric amplification due to the flow oscillation and therefore grow exponentially with time. It is also shown that the unsteadiness has a destabilizing effect on the mode of instability which is a result of dissipation in the panel. Finally, the possibility of stabilizing a membrane in a steady flow by varying its tension periodically with respect to time is discussed (Contractor's abstract)

1603

Massachusetts Inst. of Tech. [Dept. of Aeronautics and Astronautics] Cambridge.

MOLECULAR BEAM VELOCITY DISTRIBUTION MEASUREMENTS, by P B. Scott Feb. 1965 [169]p. incl.

illus. diagrs. tables, refs. (Fluid Dynamics Research Lab. rept. no. 65-1) (AFOSR-65-0192) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-131 and Office of Naval Research)
AD 614230 Unclassified

The energy accommodation of molecules during reflection from a solid surface can be measured as a function of angle of incidence, reflection angle, and incident velocity by molecular beam methods described in the report. The velocity distribution of the rebounding beam of molecules is measured, and compared to the velocity distribution of the incident molecular beam. The measurement is made by the time of flight method. A rotating thin disc with a notched edge acts as a shutter to allow a molecular beam to pass only for a short period. The molecular beam density at a distance L downstream of the shutter is sensed by electron beam ionization and ion collection. It is shown that the thermodynamic fluctuation effect limits the signal resolution of the instrument. Preliminary measurements of the incident molecular time of flight distributions show agreement with the Maxwellian theory in the case of a helium beam, and a deficiency of low velocity molecules for nitrogen and argon beams. Preliminary reflected beam measurements using a polycrystalline nickel surface show that at high target temperatures the thermal accommodation coefficient of air is 0 68 and of helium is 0. 06. (Contractor's abstract, modified)

1604

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

METHOD FOR DETERMINING ACCOMMODATION COEFFICIENTS FROM DATA IN THE TEMPERATURE-JUMP RANGE WITHOUT APPLYING TEMPERATURE-JUMP THEORY, by H. Y. Wachman. [1965] [2]p. incl. tables, refs. (AFOSR-65-1157) (AF AFOSR-64-131)
AD 620487 Unclassified

Also published in Jour. Chem. Phys., v. 42. 1850-1851, Mar. 1, 1965.

An alternative method to temperature-jump theory (TJ) is outlined for experimental determination of the thermal accommodation coefficient. It is based on Langmuir's theory of heat conduction from thin wires, and is designated the mean-free-path method. It has the advantage that it eliminates the need for the TJ method assumptions regarding extension of temperature gradients to solid boundaries and the questionable relation between the accommodation coefficient and the temperature discontinuity. Applicability of the method is demonstrated within the 0. 2 mm pressure range.

1605

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

THE FLOW FIELD INDUCED BY AN OSCILLATING SPHERE, by C. -Y. Wang. [1965] [13]p. incl. diagrs refs. (AFOSR-65-2471) (AF AFOSR-64-156)
AD 628452 Unclassified

Also published in Jour. Sound and Vibration, v. 2: 257-269, July 1965.

The method of inner and outer expansions is applied to the case of a sphere oscillating along a diameter with high Reynolds number and high Strouhal number. The entire velocity field is determined to the second order. It is found that the induced motion has a steady part, a harmonic part, and a subharmonic part. The secondary steady motion, or acoustic streaming, has a pair of toroidal cells in the boundary layer in addition to a steady streaming motion away along the axis in the outer flow. (Contractor's abstract)

1606

Massachusetts Inst. of Tech. [Dept. of Aeronautics and Astronautics] Cambridge.

ON THE TORSIONAL OSCILLATIONS OF A PLANE WITH LARGE SUCTION, by R. E. Kelly. [1965] [4]p. incl. diagr. (AFOSR-66-0328) (AF AFOSR-64-156)
AD 631156 Unclassified

Also published in Zeitschr. Angew. Math. und Phys., v. 16: 516-519, July 25, 1965.

It is well known that torsional oscillations of a disk induce an axial flow towards the surface of the disk. Due to centrifugal effects, this flow is composed of a steady as well as an unsteady component. This note concerns how suction applied at the disk surface affects the magnitude of this steady inflow. When suction is applied at the disk surface a balance is provided in the outer region between the vorticity and the inflow due to the wall suction and the inflow due to the non-linear terms becomes of secondary importance.

1607

Massachusetts Inst. of Tech. [Dept. of Aeronautics and Astronautics] Cambridge.

MEASUREMENT OF DRAG OF CYLINDERS AND SPHERES IN A COUETTE-FLOW CHANNEL, by D. L. Kohlman and E. Mollo-Christensen. [1965] [5]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-156] and National Science Foundation) Unclassified

Published in Phys. Fluids, v. 8: 1013-1017, June 1965.

An investigation was carried out to determine the range of Reynolds numbers for which flow shear does not affect drag in a Couette flow, and to measure the wall effects on the drag of cylinders and spheres. A moving belt Couette-flow apparatus is described, and observations of mean flow are given.

1608

Massachusetts Inst. of Tech. [Dept. of Aeronautics and Astronautics] Cambridge.

SYMMETRIC DEFORMATION OF A RADIALLY-

CONSTRAINED THIN CIRCULAR RING UNDER INERTIA LOADING, by L. L. Bucciarelli, Jr. and T. H. H. Pian. July 1965, 30p. incl. diagrs. (Rept. no. ASRL TR 127-1) (AFOSR-65-1619) (AF AFOSR-64-347) AD 622150 Unclassified

This paper presents a derivation of the equations governing the elastic deformation of a thin circular ring which is acted upon by inertia loading along a direction in the plane of the ring. The ring is constrained such that no radial outward displacements are permitted. The resulting nonlinear equations are reduced to a convenient form which enables the application of a systematic iterative scheme for its solution. Analysis of a ring of a thickness-radius ratio of 0.01 is made. The snap-buckling behavior of the ring is indicated by a load-deflective curve. The paper also provides a simple linear analysis which is applicable to the calculation of the initial portion of the load-deflection curve. (Contractor's abstract)

1609

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

ELEMENT STIFFNESS-MATRICES FOR BOUNDARY COMPATIBILITY AND FOR PRESCRIBED BOUNDARY STRESSES, by T. H. H. Pian. [1965] [21]p. incl. diagrs. tables, refs. (AFFDL TR 66-80) (AFOSR-67-1940) (AF AFOSR-64-347) Unclassified

Also published in Proc. Matrix Methods of Structural Mechanics, Wright-Patterson Air Force Base, Ohio, Oct. 26-28, 1965, p. 457-477.

A method for the derivation of element stiffness matrices based on the principle of minimum complementary energy employing assumed stress distribution is described. Two different types of elements are considered: (1) one which is constrained at the entire boundary, and (2) one which has prescribed stresses along the boundary. The result shows that by using sufficiently large number of terms for the assumed stress distribution, a converging stiffness matrix can be obtained. Example calculations for rectangular panels in plane stress condition and for square plates in bending indicate an improvement in structural analysis when the element stiffness matrices satisfy complete boundary compatibility and boundary stress conditions.

1610

Massachusetts Inst. of Tech. Dept. of Chemistry, Cambridge.

A NEW METHOD OF DIHALOCARBENE GENERATION BASED ON TRIHALOMETHYLMETAL COMPOUNDS, by D. Seyferth, J. Y.-P. Mui and others. [1965] [2]p. incl. diagrs. (AFOSR-65-0684) (AF AFOSR-64-502) AD 616469 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87 681-682, Feb. 1965.

A procedure is given which permits utilization of trimethyl (trifluoromethyl)-tin in CF_2 generation at 80° in a nonbasic medium to give, in the presence of olefins, gem-difluorocyclopropanes in very good yield. This procedure can be used to generate CCl_2 at room temperature from $C_6H_5HgCCl_2X$, when X-Cl and Br. Several examples are given to illustrate the value of this method.

1611

Massachusetts Inst. of Tech. Dept. of Chemistry, Cambridge.

SYNTHESIS OF MONOHALOCYCLOPROPANES AND 1-HALOOLEFINS VIA PHENYL-(DIHALOMETHYL)MERCURY COMPOUNDS, by D. Seyferth, H. D. Simmons, Jr., and G. Singh. [1965] [3]p. incl. diagr., table, refs. (AFOSR-65-1259) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-502 and Army Research Office (Durham)) AD 617596 Unclassified

Also published in Jour. Organometal. Chem., v. 3 337-339, Apr. 1965.

Previous studies of the synthesis of gem-dihalocyclopropanes using $C_6H_5HgCX_2Br$ compounds as CX_2 sources were extended to an investigation of the utility of $C_6H_5HgCHXBr$ compounds in the preparation of monohalocyclopropanes. It was found that both compounds (X=Cl and Br) serve excellently in the preparation of monohalocyclopropanes. A further similarity of $C_6H_5HgCHXBr$ reagents to $C_6H_5HgCX_2Br$ compounds is seen in their reactions with triethylsilane. A new, general synthesis of vinylic bromides and chlorides based on (dihalomethyl) mercurial chemistry was developed $C_6H_5HgCHXBr + (C_6H_5)_3P + RR'C{=}O$ yields $RR'C{=}CHX + C_6H_5HgBr + (C_6H_5)_3PO$. This general procedure also is applicable to the preparation of olefins of type $RR'C{-}CX_2$ from aldehydes and ketones. This method does not involve use or intervention of a strongly basic reagent as do previously available methods.

1612

Massachusetts Inst. of Tech. Dept. of Chemistry, Cambridge.

HALOMETHYL-METAL COMPOUNDS. II. THE PREPARATION OF GEM-DIHALOCYCLOPROPANES BY THE REACTION OF PHENYL(TRIHALOMETHYL)-MERCURY COMPOUNDS WITH OLEFINS, by D. Seyferth, J. M. Burlitch and others. [1965] [12]p. incl. diagrs. table, refs. (AFOSR-65-2388) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-502], Army Research Office (Durham), and Public Health Service) AD 623707 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87 4259-4270, Oct. 5, 1965

Phenyl(trihalomethyl)mercury compounds react with olefins to give gem-dihalocyclopropanes in high yield.

This new procedure does not involve trihalomethide ion as an intermediate, nor does it require basic reaction conditions. Thus the mercurial route allows the preparation of gem-dihalocyclopropanes from olefins which contain base-sensitivity functional groups, which react with trihalomethide ion, or which are only poor nucleophiles. A number of examples are given to illustrate these advantages of the mercurial route in these specific cases over the Doering-Hoffmann and Wagner routes. The conversion of cis and trans olefins to gem-dihalocyclopropanes by the mercurial route occurs with retention of configuration. (Contractor's abstract)

1613

Massachusetts Inst. of Tech. Dept. of Chemistry, Cambridge.

THE CHEMISTRY OF CARBANIONS. X. THE SELECTIVE ALKYLATION OF UNSYMMETRICAL KETONES, by H. O. House and B. M. Trost. [1965] [11]p incl. diagrs. tables, refs. (AFOSR-67-1423) (AF AFOSR-64-573) AD 654121 Unclassified

Also published in Jour. Org. Chem., v. 30: 2502-2512, Aug. 1965.

Solutions of enolate anions which retain their structural and stereochemical integrity can be prepared by reaction of the corresponding enol acetates with 2 equivalents of methyllithium in 1, 2-dimethoxyethane. By use of this procedure it is possible to effect the selective alkylation of unsymmetrical ketones at either the more or less highly substituted α-position, utilizing the appropriate enol acetate derivative of the ketone. Selective alkylations of 2-heptanone, 2-methylcyclopentanone, 2-methylcyclohexanone, and 1-decalone are described. The proportion of cis-fused 9-methyl-1-decalone obtained from alkylation of 1-decalone can be significantly enhanced by use of the very reactive alkylating agent, trimethyloxonium 2, 4, 6-trinitrobenzenesulfonate. (Contractor's abstract)

1614

Massachusetts Inst. of Tech. Dept. of Chemistry, Cambridge.

THE CHEMISTRY OF CARBANIONS. IX. THE POTASSIUM AND LITHIUM ENOLATES DERIVED FROM CYCLIC KETONES, by H. O. House and B. M. Trost. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-67-1427) (AF AFOSR-64-573) AD 654278 Unclassified

Also published in Jour. Org. Chem., v. 30 1341-1348, May 1965.

The compositions of the enolate anion mixtures derived from 2-methylcyclopentanone, 1-decalone, trans-2-decalone, and cis-2-decalone have been studied Equilibrium among the isomeric enolate anions derived from each ketone did not occur unless an excess of the free ketone was present. This was particularly true for the lithium enolate anions where a substantial excess of unionized ketone was required before rapid equilibration was observed. As a consequence, it is possible to prepare different enolate anion mixtures from an unsymmetrical ketone reflecting either kinetic or thermodynamic control by the appropriate choice of reaction conditions and quantities of reactants. (Contractor's abstract)

1615

Massachusetts Inst. of Tech. Dept. of Chemistry, Cambridge.

BY-PRODUCTS OF THE ROBINSON ANNELATION REACTION WITH CYCLOHEXANONE CYCLOPENTANONE, AND CYCLOPENTANE-1, 2-DIONE, by H. O. House, B. M. Trost and others. [1965] [7]p. incl. diagrs. refs. (AFOSR-67-1428) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-573 and National Institutes of Health) AD 654230 Unclassified

Also published in Jour. Org. Chem., v. 30: 2513-2519, Aug. 1965.

Reaction of the pyrrolidine enamine of cyclohexanone with methyl vinyl ketone was found to yield in addition to the expected enamines of $\Delta^{1,9}$-octal-2-one, the saturated diketone. Syntheses for 2, 6-bis(3-keto-1-butyl)-cyclohexanone, a precursor for the diketone, and 2, 5-bis(3-keto-1-butyl)cyclopentanone are described. The Robinson annelation reaction, which was successful with cyclopentanone, failed with cyclopentane-1, 2-dione and cyclohexane-1, 2-dione and the alternative products were isolated.

1616

Massachusetts Inst. of Tech. Dept. of Chemistry, Cambridge.

THE STANDARDIZATION OF SOLUTIONS OF METHYLLITHIUM AND METHYLMAGNESIUM DERIVATIVES, by H. O. House and W. L. Respess. [1965] [3]p. (AFOSR-67-1429) (AF AFOSR-64-573) AD 654261 Unclassified

Also published in Jour. Organometal. Chem., v. 4: 95-97, July 1965.

A method for the analysis of solutions of methyllithium and methylmagnesium reagents is described in which the reagent is treated with chlorodimethylphenylsilane to form phenyltrimethylsilane. The amount of the trimethylsilane is determined by gas chromatographic analysis.

1617

Massachusetts Inst. of Tech. Dept. of Chemistry, Cambridge

THE CHEMISTRY OF CARBANIONS. VIII. THE INTRAMOLECULAR ALKYLATION OF KETYL RADICAL ANIONS, by H. O. House, J.-J. Riehl, and C. G. Pitt. [1965] [4]p. incl. diagrs. refs. (AFOSR-67-1433) (AF AFOSR-64 573) AD 654253 Unclassified

Also published in Jour. Org. Chem., v. 30. 650-653, Feb. 1965.

The reactions of $Ac(CH_2)_4Cl$ and $Ac(CH_2)_5Cl$ with Li in liquid NH_3, sodium-phenanthrene, and sodium-naphthalene radical anions, and with Cr(II) ion were examined. Treatment of $Ac(CH_2)_4Cl$ with Cr(II) acetate yielded the starting material, but the other 2 reducing systems converted $Ac(CH_2)_4Cl$ and $Ac(CH_2)_5Cl$ to the desired cyclic carbinols (n=2 and 3), and to the corresponding saturated acyclic ketones, $Ac(CH_2)_3Me$ and $Ac(CH_2)_4Me$. The secondary alcohols corresponding to the saturated acyclic ketones were also formed in the reduction with Li in liquid NH. The yields of the desired cyclic carbinols were low with the corresponding saturated acyclic ketones being the major products. In an effort to suppress formation of the saturated acyclic ketones, the reductions of some quaternary ammonium salts were examined but only the corresponding amines were obtained. The results implied that the acyclic products were derived, in part, by opening of the intermediate alkoxy radical to form another radical followed by further reduction.

1618

Massachusetts Inst. of Tech. Dept. of Chemistry, Cambridge.

PERHYDROINDAN DERIVATIVES. VI. DERIVATIVES OF 1, 1a, 2, 3, 4, 4a-HEXAHYDROFLUORENE-2, 9-DIONE, by H. O. House and R. Darms. [1965] [4]p. incl. diagrs. (AFOSR-67-1434) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-573 and National Science Foundation) AD 649943 Unclassified

Also published in Jour. Org. Chem., v. 30: 2528-2531, Aug. 1965.

An improved synthetic route to 1a-carboxymethyl-2, 9-diketo-8-methyl-cis-1, 1a, 2, 3, 4, 4a-hexahydrofluorene is described. The monoethylene ketal of this acid as well as the corresponding methyl and t-butyl esters were prepared and the reduction of the two esters was studied. With sodium borohydride, the ester and 9-keto functions were reduced with approximately equal ease. (Contractor's abstract)

1619

Massachusetts Inst. of Tech. [Dept. of Mathematics] Cambridge.

PARALLELIZABILITY AND FLAT MANIFOLDS, by J. A. Thorpe. [1965] [5]p. incl. diagr. (AFOSR-65-1034) [AF 49(638)42] AD 619749 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 138-142, Feb. 1965.

The object of this paper is to improve upon the result that every simply connected flat Riemannian manifold is parallelizable by weakening the assumption of simple connectivity. An orientable flat Riemannian manifold X is considered, and a condition is found on the holonomy group of X sufficient to guarantee parallelizability. If the orientability assumption on X is omitted, the same condition is sufficient to insure (n-1)-parallelizability.

1620

[Massachusetts Inst. of Tech. Dept. of Mathematics, Cambridge]

DIFFERENTIAL OPERATORS IN THE MANIFOLD OF SOLUTIONS OF A NON-LINEAR DIFFERENTIAL EQUATION, by I. Segal. [1965] [61]p. [AF AFOSR-62-229] Unclassified

Published in Jour. Math. Pures et Appl., v. 44. 71-105, Jan.-Mar.; 107-132, Apr.-June, 1965.

The field quantization is carried out rigorously for nonlinear abstract differential equations in a Banach space. The contents of the paper may conveniently be divided into two parts. The first part is mostly analytical and deals with the abstract differential equation $du/dt = Au + K_t(u)$, or its integrated version, $u(t) = W(t-t_0)u_0 + \int_{t_0}^{t} W(t-s)K_s(u(s))ds$. The second part contains the construction of the quantized field associated with the integrated version, in which it is now assumed that $\{W(t)\}$ is a group defined for $-\infty < t < \infty$, $K_t(u) = K(u)$ is independent of t and smooth in u, and that all the solutions u of (1) exist for $-\infty < t < \infty$. Thus u(t) depends on u_0 smoothly.

1621

Massachusetts Inst. of Tech. Dept. of Mathematics, Cambridge.

ON THE SUBSPACE OF THE L^p INVARIANT UNDER MULTIPLICATION OF TRANSFORM BY BOUNDED CONTINUOUS FUNCTIONS, by A. Figa-Talamanca. [1965] [15]p. (AFOSR-66-0009) (AF AFOSR-63-335) AD 630396 Unclassified

Also published in Rend. Sem. Matem. Univ. Padova, v. 35: 176-189, 1965.

The author extends a result of Helgason (Ann. Math., v. 64: 240-254, 1956) from L^1 to L^p, $1 < p < 2$: the only subspace of $L^p(-\infty, \infty)$ which is invariant under multiplication of transforms by bounded continuous functions is the zero subspace. From this the author can obtain a result of Hormander on multipliers (Acta Math., v. 104: 93-140, 1960). He makes some remarks on the case $p > 2$ (which is quite different) and gives a negative answer to a problem of Helgason (op. cit.): for $p > 2$ it is false that the subspace of $L^p(-\pi, \pi)$, invariant under multiplication of the Fourier coefficients by bounded sequences is also invariant under permutation of Fourier coefficients. (Math. Rev. abstract)

1622

Massachusetts Inst. of Tech. [Dept. of Mathematics] Cambridge.

REGULAR BOUNDARY POINTS IN MARKOV CHAINS, by A. W. Knapp. [1965] [6]p. (AFOSR-66-1538) (AF AFOSR-63-335) AD 641465 Unclassified

Also published in Proc. Amer. Math. Soc., v. 17: 435-440, Apr. 1965.

In the present work the author studies the nature of the set of regular boundary points in Markov chains. If P is the transition matrix of a transient Markov chain, then a function (column vector) h is harmonic if it has the mean value property h = Ph, superharmonic if h ≥ Ph. Doob and Hunt have developed a Martin boundary theory for such a chain and they showed that, in terms of the space they construct, there is the usual sort of Poisson-integral representation theorem for the integrable non-negative superharmonic functions. In this framework 2 questions are asked: Is the set of regular points a Borel set, and is the set necessarily nonempty? The answers are yes to the first and no to the second.

1623

Massachusetts Inst. of Tech. [Dept. of Mathematics] Cambridge.

ANTI-LOCALITY OF CERTAIN LORENTZ-INVARIANT OPERATORS, by I. E. Segal and R. W. Goodman. [1965] [10]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-342] and National Research Council) Unclassified

Published in Jour. Math. and Mech., v. 14: 629-638, July 1965.

An operator T on $L_2(E_n)$ is said to be anti-local provided that if f and Tf both vanish in a given region, then f is identically zero. The operators $T = (m^2I - \Delta)^{\lambda}$, where Δ is the self-adjoint formulation of the Laplacian on $L_2(E_n)$, are shown to be anti-local when n is odd and λ is a non-integral real number. The proof utilizes the Laplace transform to compare T with a known anti-local operator (the Hilbert transform) for n = 1, and reduces the problem for arbitrary odd n to the case n = 1. This result is applied to a problem in the quantum theory of fields. Let K_m^+ denote the Hilbert space of positive energy solutions of the Klein-Gordon equation, $(\Box - m^2)\varphi = 0$, m > 0. There exists (within unitar. equivalence) a unique symmetric free quantum field over K_m^+, that is, a quadruple (K, W, ν, Γ), where K is a complex Hilbert space. W is a continuous map from K_m^+ into the unitary operators on K satisfying the Weyl relations $W(\iota)W(\varphi) = \exp[\frac{1}{2}i\,\mathrm{Im}(\iota,\varphi)]$ $W(\iota+\varphi)$ (ι, φ arbitrary in K_m^+), ν is a cyclic vector in K for $W(\varphi)$, $\varphi \in K_m^+$, and Γ is a suitably restricted representation of the unitary group of K_m^+ by unitary operators on K. The following problem arises: How does one utilize the map $\varphi \to W(\varphi)$ to generate a von Neumann algebra of operators on K corresponding to a given space region R at a given time t? The convention in the general theory of quantized fields is discussed. (Math. Rev. abstract, modified)

1624

Massachusetts Inst. of Tech. [Dept. of Mathematics] Cambridge.

ON THE STABILITY OF BAROCLINIC FLOWS AS A FUNCTIONAL OF THE VELOCITY PROFILE, by J. Pedlosky. [1965] [7]p. incl. table. (AFOSR-65-2115) (AF AFOSR-64-492) AD 629031 Unclassified

Also published in Jour. Atmos. Sci., v. 22: 137-145, Mar. 1965.

The stability of all baroclinic flows whose mean state consists of a uniform vertical shear (Eady's problem) plus a small but arbitrary deviation in the zonal velocity is obtained as a functional of the velocity profiles. It is shown that the growth rate of the disturbances is not everywhere an analytic function of the deviation of the profile from uniform shear. The change of stability due to the velocity deviation is obtained by a study of the growth rate at the neutral curve of Eady's problem. Only the vertically antisymmetric and the horizontally symmetric component of the velocity deviation affects the stability of the flow. For large wavelengths it is shown that only the horizontal curvature of the velocity profile alters the stability, and a general condition for a long wave stability cut off is obtained in terms of the curvature. If the curvature is negative the flow is stabilized. The effect of the velocity deviation on the structure of the amplified eigenfunction is displayed. An example, in which the mean flow is horizontally asymmetric about the horizontal mid-point is presented. The Reynolds stress of the amplified baroclinic wave is computed and its vertical structure shown to have a boundary layer character while transporting, horizontally, mean zonal momentum toward the current maximum, increasing the kinetic energy of the mean flow. (Contractor's abstract)

1625

Massachusetts Inst. of Tech. Dept. of Mathematics, Cambridge.

A NECESSARY CONDITION FOR THE EXISTENCE OF AN INERTIAL BOUNDARY LAYER IN A BAROCLINIC OCEAN, by J. Pedlosky. [1965] [4]p. (AFOSR-65-2324) (AF AFOSR-64-492) AD 629802 Unclassified

Also published in Jour. Marine Research, v. 23: 69-72, May 15, 1965.

A criterion for the existence of an inertial boundary current in a baroclinic ocean is derived. It is shown that the effect of topographical variations can play a decisive role in determining whether an inertial boundary current can exist, even if the velocity field is highly baroclinic (Contractor's abstract)

1626

Massachusetts Inst. of Tech. Dept. of Mathematics, Cambridge.

A NOTE ON THE WESTERN INTENSIFICATION OF THE OCEANIC CIRCULATION, by J. Pedlosky. [1965] [3]p. (AFOSR-66-0242) (AF AFOSR-64-492) AD 641732 Unclassified

Also published in Jour. Marine Research, v. 23: 207-209, Sept. 15, 1965.

The purpose of this paper is to provide a simple physical explanation for the westward intensification of the oceanic circulation found in the several dynamically different existing theoretical models of Stommel 1948, and Carrier and Robinson 1962. It has the advantage of showing why the western oceanic boundary is singled out as the boundary-layer region that closes the interior Sverdrup solution. Consider the fundamental characteristics of Rossby waves. Energy at small scales will be transmitted to the east while energy at large scales will move to the west. For slow, large-scale geophysical systems, such as the ocean, the group velocity of Rossby waves is the significant signal velocity. Now, suppose energy of varying scales is put into the ocean, perhaps by the action of a wind stress. The short-scale components will move toward the eastern boundary of the ocean, where they will be reflected as components of a large east-west scale. Meanwhile, the large-scale components will move toward the western boundary, where they will be reflected as small-scale motions. Thus, it is the western boundary that acts as a source of small-scale motions. This is the fundamental reason for the preference for the westward intensification.

1627

Massachusetts Inst. of Tech. [Dept. of Mathematics] Cambridge.

A STUDY OF THE TIME DEPENDENT OCEAN CIRCULATION, by J. Pedlosky. [1965] [6]p. (AFOSR-66-0243) (AF AFOSR-64-492) AD 631155 Unclassified

Also published in Jour. Atmos. Sci., v. 22: 267-272, May 1965.

The response of a simple bounded-ocean model to a fluctuating wind stress is studied. Both the linear response and the resulting steady non-linear circulations are computed. The results of this analysis show that the structures of the steady and fluctuating ocean circulations are strongly dependent on the frequency of the forcing. (Contractor's abstract)

1628

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

EFFECTS OF ROOT RADIUS, STRESS, CRACK GROWTH AND RATE ON FRACTURE INSTABILITY, by F. A. McClintock. [1965] [14]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)457 and National Science Foundation) Unclassified

Published in Proc. Roy. Soc. (London), v. 285A. 58-71, Apr. 6, 1965.

Of various criteria for fracture at the root of a notch, the energy, local stress, and displacement criteria have limited validity. More appropriate is the history of both stress and strain over a small region ahead of the crack, as required for fracture by the coalescence of holes. Expressions are given for crack initiation, growth, and subsequent instability in anti-plane strain of a non-hardening material. Instability is shown to depend primarily on those strain increments arising from crack growth at constant load rather than on those from increasing load at constant crack length. Thus final instability conditions are similar for single and double-ended cracks, round notches, and cracks cut under constant load. Round notches may give instability, restabilization, and final instability. The growth and coalescence of holes in front of a crack in a linearly viscous material is studied for both tensile and anti-plane-strain cracks. The absence of residual strain eliminates instability, but the crack continually accelerates.

1629

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

PLASTIC DEFORMATION IN RANDOM VIBRATION, by D. Karnopp and T. D. Scharton. June 1965 [29]p. incl. diagrs. (AFOSR-65-0987) (AF 49(638)1314) AD 619876 Unclassified

A randomly excited single degree of freedom oscillator is studied in which an idealized form of plastic deformation can take place. Through the use of an artificial process, statistics of this nonlinear, hysteretic system are deduced from linear system response statistics in 2 regimes of operation. The expected accumulated plastic deformation is found as a function of time and some other statistics derivable from the artificial process are indicated. Applications of these methods and results to the prediction of fatigue life under random vibrations are discussed. (Contractor's abstract)

1630

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

INELASTIC EFFECTS IN RANDOM VIBRATION, by D. Karnopp. Oct. 1965, 20p. incl. diagrs. (AFOSR-65-1915) (AF 49(638)1314) AD 626691 Unclassified

A procedure is given by which the vibration of systems containing inelastic elements which exhibit interface slippage or plastic yielding may be visualized. Through this procedure estimates of average amplitudes of vibrations as well as average rates of accumulation of plastic strain may be found. The method involves power balance and is most easily applied in the case of broad band excitation. The type of computations required are

illustrated by means of a single degree of freedom example and two degree of freedom example systems are shown to illustrate the extension of the procedure to multi degree of freedom problems.

1631

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

COUPLED VIBRATORY SYSTEM ANALYSIS USING THE DUAL FORMULATION, by D. Karnopp. Nov. 1965, 15p. incl. diagrs. refs. (AFOSR-65-2675) (AF 49(638)-1314) AD 628216 Unclassified

Principles by means of which an arbitrary vibrational system may be cut into subsystems and described by coupled model equations are exposed and illustrated with an elementary example. The symmetry of the equations attainable when both the usual geometric description and the dual or force space representation are used is shown. The difficulties in use and interpretation of the coupled equations when the coupling is not weak are discussed.

1632

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

RANDOM VIBRATION OF COUPLED OSCILLATORS AND COUPLED STRUCTURES, by T. D. Scharton. Oct. 1965, 134p. incl. illus. diagrs. refs. (AFOSR-66-0156) (AF 49(638)1314) AD 630794 Unclassified

It is proved that the time average power flow between 2 linearly coupled linear oscillators excited by independent white noise sources is proportional to the difference in the time average energies of the oscillators. This proportionality is valid even when the oscillators are strongly coupled if the oscillator energies are defined correctly. The validity of power-flow energy-difference proportionality in systems of more than 2 oscillators is hypothesized. Some conceptual difficulties involved in formulating a coupled mode model of coupled structures are discussed. An experimental investigation of a beam-beam structure demonstrates that the coupled oscillator power flow calculation can be used to predict power flow and energy sharing in coupled continuous structures excited with broadband noise. (Contractor's abstract)

1633

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

HEAT TRANSFER FROM ARGON AND XENON TO THE END WALL OF A SHOCK TUBE, by H. S. Friedman and J. A. Fay. [1965] [8]p. incl. illus diagrs. refs. (AFOSR-66-1089) (AF 49(638)1396) AD 617055 Unclassified

Also published in Phys. Fluids, v. 8. 1968-1975, Nov. 1965.

Heat transfer from argon and xenon to the end wall of a shock tube has been measured by using a thin-film transfer gauge whose temperature rise is monitored by an infrared photocell. Experiments were carried out at initial pressures between 1 and 10 mm Hg in argon and between 0.75 and 2 mm Hg in xenon. For the range of incident shock Mach numbers tested between 9 and 13 in argon and 13 and 18 in xenon, partial ionization would exist behind the reflected shock wave if thermodynamic equilibrium was achieved. By extrapolation of measured ionization rates for these gases, it was concluded that no ionization occurred behind the reflected shock wave in argon but that equilibrium was achieved in xenon, at least for the period during which the heat transfer was measured. Calculations of the heat transfer, made in accordance with existing theories for the corresponding thermodynamic state of the gas, were found to be in good agreement with the experimental measurements.

1634

[Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge]

ON THE METHODS OF GALERKIN, RITZ AND KRYLOV-BOGOLIUBOV IN THE THEORY OF NON-LINEAR VIBRATIONS, by D. E. Newland. [1965] [14]p. incl. diagrs. table, refs. (AFOSR-65-1014) (AF AFOSR-63-154) AD 617855 Unclassified

Also published in Internat'l. Jour. Mech. Sci., v. 7: 159-172, Mar. 1965.

The conditions for equivalence of the Galerkin method and the Ritz minimizing method are reviewed. It is then shown that Galerkin's method may also lead to a result which, for steady state vibrations, is the same as the first approximation of Krylov-Bogoliubov. Both the Ritz method and the first approximation of Krylov-Bogoliubov may therefore be thought of as special cases of the general Galerkin method. The difference between them lies in the different ways in which the describing differential equations are expressed, in the different forms of the approximate solution used, and in the different choice of Galerkin weighting functions. As an example of these differences, the free vibration of a centrifugal pendulum is considered. The exact solution is compared with approximate solutions by the Ritz minimizing method and the method of Krylov-Bogoliubov, and the three results are seen to be in close agreement.

1635

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

MECHANISMS OF COMBUSTION INSTABILITY, by T.-Y. Toong, R. F. Salant and others. [1965] [12]p. incl. illus. diagrs. refs. (AFOSR-65-2206) (AF AFOSR-63-209) AD 624834 Unclassified

Also published in Tenth Symposium (Internat'l.) on Combustion, Cambridge (Gt. Brit.) (Aug. 17-21, 1964), Pittsburgh, Combustion Inst., 1965, p. 1301-1313.

Mechanisms involved in triggering, amplification, and suppression of acoustic waves, due to presence of flames are studied. Experiments performed demonstrate strong interactions between acoustic and flame oscillations can exist through flow oscillations, and that these interactions are due to energy transport between various oscillation modes through both linear and nonlinear couplings. Intensity of interactions can be altered by varying flow velocity through an organ pipe. Under reduced-flow conditions, linear coupling is eliminated and flame exhibits periodic self-sustained oscillations. However, with imposed acoustic excitation of sufficiently large amplitude, interactions again become important, due to nonlinear effects. Nonlinear coupling between longitudinal acoustic oscillations and tangential or radial flow and flame oscillations is also observed. Supporting evidence is presented, which shows that the onset of the above mentioned self-sustained oscillations of diffusion flames is due to instability of travelling Tellmien-Schlichting disturbance waves. (Contractor's abstract, modified)

1636

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

THEORY OF STAGNATION-POINT HEAT TRANSFER IN IONIZED MONATOMIC GASES, by M. L. Finson and N. H. Kemp. [1965] [4]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-353 and Office of Naval Research) AD 617653 Unclassified

Also published in Phys. Fluids, v. 8: 201-204, Jan. 1965.

Calculations were made for the stagnation-point geometry for both the frozen and equilibrium boundary layers in ionized argon and xenon.

1637

Massachusetts Inst. of Tech. Fluid Dynamics Research Lab., Cambridge.

ANALYSIS OF TRANSONIC FLOW BY MEANS OF PARAMETRIC DIFFERENTIATION, by P. E. Rubbert. Nov. 1965, 153p. incl. diagrs. refs. (Fluid Dynamics Research Lab. rept. no. 65-2) (AFOSR-65-1932) (AF AFOSR-65-156) AD 626058 Unclassified

A general method of solving nonlinear partial differential equations was developed and applied to the problem of inviscid transonic flow about airfoils. Solutions are given for nonlifting airfoils at all transonic Mach numbers, including those flows with detached shock waves, and extensions to include lifting and unsteady flows are discussed. Results are given for subsonic and supersonic flow, and for flows at Mach number unity which are in general agreement with other theoretical results and with experiment. Inadequacies in the numerical technique prevented the accurate computation of shock movements, but preliminary results indicate a rearward movement of the shock impinging on the airfoil surface with increasing airfoil thickness, and exhibit the commonly observed rapid accleration behind the shock. The well known local linearization result of Spreiter and Alksne is shown to be an approximation to the present theory for subsonic flow. (Contractor's abstract)

1638

Massachusetts Inst. of Tech. Fluid Dynamics Research Lab., Cambridge.

SUPERSONIC STEADY AND UNSTEADY FLOWS OVER SLENDER AXISYMMETRIC BODIES WITH CONTINUOUS OR DISCONTINUOUS SURFACE SLOPES, PART I, by J. J. Kacprzynski. Dec. 1965, 81p. incl. diagrs. tables, refs. (Fluid Dynamics Research Lab. rept. no. 65-3) (AFOSR-66-0132) (AF AFOSR-65-156) AD 630425 Unclassified

This report contains the first part of an investigation aimed at finding methods for calculating steady and unsteady inviscid flows past slender 3-dimensional bodies of general shape, with continuous or discontinuous slope, but with continuous cross-sectional area. The method is an extension of an approximation proposed by Lighthill (1948) in which the solution is based on the solution of Laplace transformed potential equation and is expressed by Bessel functions. Several characteristic functions, which lead to combinations of Bessel functions, have been introduced and calculated. Considered are cases of axial steady flow and cross-flow past a body with discontinuities in slope, as well as unsteady flows for Mach numbers high enough so that it is possible to assume that $B^2 = (M^2 - 1) \simeq M^2$. The latter investigation induces flows with general unsteady boundary conditions, the body with a harmonically vibrating surface and the gust entry problem. (Contractor's abstract)

1639

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

[ELECTRIC AND MAGNETIC PROPERTIES OF MATTER], by A. von Hippel. Final rept. Nov. 1965, 52p. (Technical rept. no. 204) (AFOSR-65-2210) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-184110) AD 622090 Unclassified

A brief history of the Laboratory for Insulation Research is given, from its inception as part of the Electrical Engineering Dept. 25 years ago up until the present when it ceases to exist as a separate entity due to the creation of the interdepartmental Center of Materials Science and Technology. The scope of the research in modern materials and dielectrics is outlined. Appendices I and II are extensive bibliographies of material research reports from pre-World War II to the present, one a chronological listing and the other, a publication breakdown according to subject field. There are 3 other appendices, including one which lists students awarded degrees and their subjects.

1640

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

CONDITION FOR MAXIMUM RESONANCE ABSORPTION PEAK IN A SINGLE-LINE MOSSBAUER ABSORBER, by U. Shimony. Feb. 1965, 6p. incl. diagrs. table. (Technical rept. no. 197) (Bound with its Technical rept. no. 196) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-184110) AD 613577 Unclassified

For certain scientific and engineering applications of the Mossbauer absorption technique to accurate velocity measurements, measurements should be made in the shortest time possible. For a single-line absorber the thickness that gives the maximum absorption peak is a function of the resonant to nonresonant absorption coefficients and can be found from a table or a curve. This can also serve for absorbers with several peaks of equal intensities.

1641

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

THE CRYSTAL STRUCTURE OF $Bi_2Ti_4O_{11}$, by G. Jensen. Apr. 1965, 22p. incl. diagrs. tables, refs. (Technical rept. no. 198) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-184110) AD 614797 Unclassified

The unit cell of the compound $Bi_2Ti_4O_{11}$ is face-centered monoclinic and contains 4 formula units. Its space group is C 2/c with all atoms in general positions, except for oxygen atoms lying on twofold axes. A phase transition is observed at 250°C, and the structure of the high-temperature modification is discussed. The unit cell of a related structure, probably stabilized by impurities, is also reported. (Contractor's abstract)

1642

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

THE DIELECTRIC SPECTRA OF WATER-ETHANOL MIXTURES IN THE MICROWAVE REGION, by D. E. Buck. June 1965, 17p. incl. diagrs. tables, refs. (Technical rept. no. 200) (Sponsored jointly by Air Force Materials Laboratory; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-184110) AD 618409 Unclassified

The dielectric constant and loss were measured at 8.5, 3.0, 1.0, and 0.3 kMc/sec for solutions of ethanol and water as a function of concentration and temperature. The mixtures exhibit a distribution of relaxation times as opposed to single time constants for the pure components. The distribution of time constants was resolved as the superposition of 2 dispersions, each having a single time constant. The intensity and time constant of the 2 dispersions were found as a function of temperature and concentration and explained in terms of a mechanism in which hydrogen bonds are broken and allowed to reorient. In addition, the dielectric constant and loss were measured for water from 5° to -5°C, and no abnormal behavior was noted at 4°C or in the supercooled state. (Contractor's abstract)

1643

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

MAGNETIC ANNEAL EFFECTS IN SOME GARNETS, by R. P. Hunt. Apr. 1965, 44p. incl. diagrs. refs. (Technical rept. no. 199) (Sponsored jointly by Air Force Cambridge Research Lab.; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-184110) AD 615370 Unclassified

Many properties of polycrystalline and reduced single crystal yttrium iron garnet (YIG) have been attributed to the presence of Fe^{2+} ions which provide mobile electrons that can diffuse locally through the lattice. This electron-diffusion process was studied by means of several low-temperature torque experiments on silicon-doped YIG of the form $Y_3Fe_{5-\delta}Si_\delta$ with $0 < \delta < 0.18$.

Silicon-doped YIG, which contains mobile electrons, shows an induced anisotropy proportional to the doping when magnetically annealed at low temperatures. The kinetics and temperature dependence of this anisotropy were investigated. The garnet also demonstrates a constant high field component of rotational hysteresis which is both temperature and frequency dependent. The intrinsic, unannealed anisotropy behaves in a novel way. At room temperature it coincides with that of normal YIG, but between 150° and 300°K [K_1] increases above that of pure YIG. Below about 150°K, the curves develop asymmetry and are no longer cubic. At 4.2°K, the easy axis has shifted to the [100] direction in the case of 3% doping. (Contractor's abstract)

1644

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

MOSSBAUER STUDIES ON IRON IN THE PEROVSKITES $La_{1-x}Sr_xFeO_3$(0 x 1), by U. Shimony and J. M. Knudsen. Feb. 1965, 39p. incl. illus. diagrs. tables, refs. (Technical rept. no. 196) (Bound with its Technical rept. no. 197) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-184110) AD 613577 Unclassified

Mossbauer spectra of the perovskite series $La_{1-x}Sr_xFeO_y$(0.0 x 1.0, y 3) were obtained with Fe^{57} as the photon-emitting and absorbing nucleus and analyzed in detail. The Neel temperature of anti-

antiferromagnetic $LaFeO_3$ decreases with increasing Sr concentration, in agreement with previous reports. That of antiferromagnetic $SrFeO_{2.5}$ (brownmillerite structure) also decreases as oxygen is introduced to transform it to perovskite $SrFeO_3$. Characteristic Fe^{4+} lines, identified for compounds of high x, have isomer shifts between +0.10 and +0.20 mm/sec relative to a source of Co^{57} in stainless steel Type 310. However, spectra of compounds of intermediate x indicate the existence of an intermediate $Fe^{3+} \rightarrow {}^{4+}$ state, and a correlation between the total isomer shift of a compound and its Fe^{4+} content was attempted. With increasing x a significant discontinuity in the total isomer shift, corresponding to a transition from magnetic order to disorder, was found. Line widths vary around 0.40 mm/sec (compared with 0.26 mm/sec, the narrowest line obtainable in the present setup) and show broadening in a sample fired for a short time. The temperature effect was used to calculate the specific heat.

1645

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

REFRACTIVE INDEX OF $BaTiO_3$ ABOVE THE CURIE POINT, by J. M. Ballantyne. [1965] [2]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-184110) Unclassified

Published in Phys. Rev., v. 138: A646-A647, Apr. 19, 1965.

The temperature dependence of the optical thickness of a pure $BaTiO_3$ crystal is measured interferometrically to an accuracy of 1 part in 10^5, and found to change by 5 parts in 10^4 over the 129-220°C temperature range. The resulting change in refractive index with temperature is calculated by applying a correction for thermal expansion of the crystal.

1646

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

ANGULAR DISTRIBUTIONS FROM SHELL-MODEL FORBIDDEN (d, p) TRANSITIONS TO SPIN 5/2 STATES IN Ca^{43}, Ca^{45} AND Ti^{47}, by T. A. Belote, W. E. Dorenbusch and others. [1965] [7]p. incl. diagrs. tables, refs. (AT(30-1)2098) Unclassified

Published in Nuclear Physics, v. 73: 321-327, Nov. 1965.

The (d, p) transitions to the ground state and first excited states of Ca^{43}, Ca^{45} and Ti^{47} have been measured at deuteron energies near 7 mev. The similarity between the shapes of the angular distributions to the weak 374 kev 5/2 - level in Ca^{43}, the 176 kev level in Ca^{45} and the 5/2 ground state of Ti^{47} suggests that these transitions proceed through a direct-reaction mechanism. (Contractor's abstract)

1647

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

BALLOON OBSERVATION OF THE X-RAY SPECTRUM OF THE CRAB NEBULA ABOVE 15 KEV, by G. W. Clark. [1965] [3]p. incl. tables. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098, and National Aeronautics and Space Administration) Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 91-94, Jan. 25, 1965.

A source of cosmic x-rays with energies above 15-kev was observed in a balloon flight. It was concluded that the x-rays probably came from the Crab nebula. The x-ray spectrum of the Crab nebula was determined approximately in the energy range from 15 to 60 kev. The results provide evidence against the idea that the x-rays from the Crab nebula are the blackbody emission from the surface of a neutron star.

1648

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

CALCULATION OF SOME HOMOLOGY GROUPS RELEVANT TO SIXTH-ORDER FEYNMAN DIAGRAMS, by P. Federbush. [1965] [14]p. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Jour. Math. Phys., v. 6: 941 954, June 1965.

A homology group that determines an upper bound for the number of linearly independent analytic functions connected with the sixth-order ladder diagram is here computed. The formalism is that of Fotiadi, Froissart, Lascoux, and Pham. Calculations use the standard methods of homology theory. It is found that there are at most 127 such functions in general. (Contractor's abstract)

1649

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

ELASTIC SCATTERING OF 160-MEV PROTONS FROM Be^9, Ca^{40}, Ni^{58}, Sn^{120} AND Pb^{208}, by P. G. Roos and N. S. Wall. [1965] [8]p. incl. diagrs. tables, refs. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Phys. Rev., v. 140: B1237-B1244, Dec. 6, 1965.

Using a good-resolution total-energy scintillation spectrometer, the elastic-scattering differential cross sections of 160-mev protons from Be^9, Ca^{40}, Ni^{58}, Sn^{120}, and Pb^{206} have been measured. Optical-model analyses of the data have been made, and the pertinent parameters are given. The most significant result of the analyses is that the extent of the imaginary part of the optical potential has a radius of the order of 10^{-13} cm greater than that of the real part, independent of atomic weight. (Contractor's abstract)

1650

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

EXACT BOOTSTRAP SOLUTIONS IN SOME STATIC MODELS OF MESON-BARYON SCATTERING, by K. Huang and F. E. Low. [1965] [22]p. incl. diagr. tables, refs. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Jour. Math. Phys., v. 6: 795-816, May 1965.

The exact bootstrap solutions to four well-known models of meson-baryon scattering in the nonrecoil, one-meson approximation are studied. The models are the neutral scalar theory, the charged scalar theory, the symmetric scalar theory, and the neutral pseudoscalar theory. A bootstrap solution is defined to be a solution satisfying Levinson's theorem of potential scattering. It is found that the existence of a bootstrap solution depends crucially on the high-energy conditions, which enter the problem through a cutoff function and through subtractions in the dispersion relations. In all the models considered there is no bootstrap solution with no subtraction. With one subtraction there exists more than one bootstrap solution. However, the requirements that (a) the meson-baryon coupling constant should be different from zero, and (b) there should be no inelastic threshold below the elastic threshold, render the bootstrap solution unique. Positions of bound states and their coupling constants depend on 2 arbitrary parameters, which may be taken to be the cutoff momentum and the subtraction constant. (Contractor's abstract)

1651

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

EXACT BOOTSTRAP SOLUTIONS TO THE LOW EQUATION, by K. Huang and A. H. Mueller. [1965] [10]p. incl. diagrs. refs. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)-2098) Unclassified

Published in Phys. Rev., v. 140: B365-B374, Oct. 25, 1965.

Inquiry is made whether the Low equation for meson-baryon scattering in the static one-meson approximation possesses bootstrap solutions, defined to be those solutions satisfying Levinson's theorem of potential scattering. The Low equation is allowed to have arbitrary subtractions and arbitrary bound states, except that the baryon must be the lowest bound state. A 2-parameter family of cutoff functions, including the case of no cutoff, is introduced. Consider 2 x 2 and 4 x 4 crossing matrices of certain general forms, with the Chew-Low theory included as a special case of the latter. To answer the question raised, a simple technique is used based on the crossing relation on the imaginary energy axis. It is shown that for all the crossing matrices considered the unsubtracted Low equation does not possess a bootstrap solution, regardless of the choice of bound states and cutoff function. Further study is made of the case of one subtraction for 2 x 2 crossing matrices to find some necessary bootstrap conditions. These restrict the crossing matrix, determine the form of the cutoff function, and require that in the baryon channel the baryon be the only bound state, while in the other channel there be at most one bound state. These results are generalizations of those obtained earlier by Huang and Low.

1652

Massachusetts Inst. of Tech. [Lab. for Nuclear Science] Cambridge.

INELASTIC DEUTERON SCATTERING AND (d, p) REACTIONS FROM ISOTOPES OF Ti. II. Ti^{47} (d, p)Ti^{48}, by P. D. Barnes, C. K. Bockelman, and O. Hansen. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Phys. Rev., v. 138: B597-B607, May 10, 1965.

The (d, p) reaction from a target of isotopically separated Ti^{47} has been studied at 6-mev bombarding energy. Proton spectra were recorded simultaneously at 24 scattering angles with an over-all energy resolution of 15 kev by means of a broad-range, multiple-gap, heavy-particle spectrograph. Fifty-five proton groups, corresponding to levels in Ti^{48}, were observed. To 40 of these (d, p) groups, transition strengths and values of the orbital angular momenta of the transferred neutrons were assigned by means of a distorted-wave analysis of the differential cross sections. A sum-rule analysis shows that virtually all of the $1f_{7/2}$, $2p_{3/2}$, and $2p_{1/2}$ single-particle strengths and 25% of the $1f_{5/2}$ strength were observed. A level scheme for Ti^{48} is proposed and the available spectroscopic information on the low-lying levels is discussed in terms of current nuclear models. (Contractor's abstract)

1653

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

INELASTIC DEUTERON SCATTERING AND (d, p) REACTIONS FROM ISOTOPES OF TITANIUM. III. Ti^{49}(d, p) Ti^{50}, by P. D. Barnes, C. K. Bockelman and others. [1965] [6]p. incl. diagrs. tables, refs. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research], under AT(30-1)2098) Unclassified

Published in Phys. Rev., v. 140: B42-B47, Oct. 11, 1965.

Fifty-six levels in Ti^{50} have been excited by the (d, p) reaction on Ti^{49} at 6-mev bombarding energy. The differential cross sections for the proton groups were measured at 23 scattering angles. A distorted-wave analysis of the experimental results yielded values of the orbital angular momenta of the transferred neutron and transition strengths for 44 of the observed transitions. A sum-rule analysis indicates that all of the $1f_{7/2}$, $2p_{3/2}$, and $2p_{1/2}$ single-particle strengths and 60% of the $1f_{5/2}$ strength were observed. The present data are compared to other experimental evidence on Ti^{50}, and a level scheme for Ti^{50} is proposed. The spectroscopic data are discussed in terms of the shell model with residual interactions. The results for the transitions to the ground state and 3 lowest excited states of Ti^{50} are shown to be in disagreement with seniority conservation. (Contractor's abstract)

1654

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

JOHNSON-TREIMAN RELATIONS FROM VECTOR-MESON EXCHANGE, by R. F. Sawyer. [1965] [2]p. incl. refs. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Phys. Rev. Ltrs., v. 14 471-472, Mar. 22, 1965.

It is shown that the Johnson-Treiman relations in the SU(6) theory between Kp and πp total cross sections follow also from the octet vector meson exchange model.

1655

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

150 kOe LIQUID NITROGEN COOLED PULSED FLUX-CONCENTRATOR MAGNET, by H. Brechna, D. A. Hill, and B. M. Bailey. [1965] [7]p. incl. illus. diagrs. tables. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098, and Air Force Office of Scientific Research under [AF 49-(638)1468]) Unclassified

Published in Rev. Scient. Instr., v. 36. 1529-1535, Nov. 1965.

A 150 kOe flux-concentrator magnet is described, having a 90 cm^3 conical bore 7 cm long and of 10.4 cm max diam. The field is held at peak value ± 10% for 30-50 msec per pulse. The flux concentrator is energized by a transformer-rectifier set delivering 600 v at 3800A for the duration of the pulse, it is cooled by a closed loop of circulating subcooled liquid nitrogen which in turn is cooled external to the magnet by liquid nitrogen boiling at atmospheric pressure.

1656

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

MEASUREMENT OF TOTAL ATTENUATION CROSS SECTIONS IN ALUMINUM AND GOLD FOR 14.4-KEV GAMMA RAYS, by J. Alonso and L. Grodzins. [1965] [4]p. incl. illus. diagrs. table, refs. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Phys. Rev., v. 17. A975-A978, Feb. 1, 1965.

Total attenuation coefficients of aluminum and gold for 14.4-kev gamma rays have been measured using a resonant (i.e., Mössbauer) detector to reduce forward scattering and background corrections. The results are 390.7 ± 0.7 and 59,290 ± 70 barns per atom for aluminum and gold, respectively. These values imply photoelectric cross sections of 371.0 ± 0.7 and 58,220 ± 70 barns/atom, respectively. The results are in agreement with other, less precise, measurements in this energy region. Present theoretical estimates of these cross sections are high by 5% for aluminum and 35% for gold. (Contractor's abstract)

1657

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge

MÖSSBAUER SCATTERING: THE GYROMAGNETIC MOMENTS OF FIRST 2^+ IN W^{182} AND W^{186} AND Os^{186} AND Os^{188}, by Y. W. Chow, L. Grodzins and others. [1965] [5]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)) Unclassified

Published in Phys Rev. Ltrs., v. 15 369-373, Aug 23, 1965.

A technique for measuring magnetic moments, μ, of excited state by precessing the Mössbauer angular

distribution with an external magnetic field is described. The method is applied to the first 2^+ states in W and OS isotopes and the gyromagnetic ratios, $g_R = \mu/I$ measured are: W^{182}, 0.233 ± 0.027; W^{184}, 0.25 ± 0.03, W^{186}, 0.34 ± 0.03; OS^{186}, 0.32 ± 0.015, and OS^{188}, 0.310 ± 0.027. The agreement with the theoretical predictions of Nilsson and Prior is excellent and indicates both the correctness of the pairing-force model and the absence of net spin polarization effects.

1658

Massachusetts Inst. of Tech. [Lab. for Nuclear Science] Cambridge.

MÖSSBAUER STUDY OF A NEW $LiFeO_2$ POLYMORPH AND $CuFeS_2$ (Abstract), by M. Schieber, N. Blum, and E. R. Bauminger. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, [Atomic Energy Commission], and [Office of Naval Research] under [AT(30-1)2098]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Also published in Bull. Amer. Phys. Soc., Series II, v. 10. 473, Apr. 26, 1965.

A new type of γ-$LiFeO_2$ (γ_s) has been prepared. Mössbauer absorption data are reported for this compound as well as for β-$LiFeO_2$ and for natural $CuFeS_2$ over the temperature range 16 –300 K. γ_s is prepared by a slow heat treatment of the more usual form of γ-$LiFeO_2$(γ_r). γ_s has the smallest unit cell volume of all the known $LiFeO_2$ species, for γ_s, a = 4.0457A and c = 8.6901A, while for γ_r a = 4.0527A and c = 8.7306A. Mössbauer spectra in an external field H_0 = 35.7 kOe and for H_0 = 0 at both 80 and 286 K show nearly identical line-intensity ratios of 3:2:1, which indicates an isotropic distribution of the internal-field directions. This suggests that the measured spontaneous magnetization σ_0 0.5 emu/g is probably due to impurities rather than to any departure from pure antiferromagnetism. β-$LiFeO_2$ has a Mössbauer spectrum similar to that of α-$LiFeO_2$ and shows evidence of long-range order only at liquid-helium temperatures. The saturation value for the internal field at the iron nucleus in $CuFeS_2$ is 345 kOe.

1659

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

NEW MEASUREMENT OF THE A MAGNETIC MOMENT, by D. A. Hill, K. K. Li and others. [1965] [5]p. incl. diagrs., table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)) Unclassified

Published in Phys. Rev. Ltrs., v. 15: 85-89, July 12, 1965.

Polarized Λ's produced in the reaction $\pi^+ N \rightarrow \Lambda + K^+$ pass through a strong longitudinal magnetic field and the angle of precession of the Λ polarization vector is measured. The precession can be observed by virtue of the asymmetry in the decay $\Lambda \rightarrow p + \pi^-$ in which the π meson tends to be emitted opposite to the Λ spin direction. The result obtained for Λ was $-0.77 \pm 0.27\ \mu_N$, which is consistent with other results.

1660

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

NONEXISTENCE OF "PURE BOOTSTRAP" SOLUTIONS TO THE CHEW-LOW THEORY, by K. Huang and A. H. Mueller. [1965] [3]p. incl. diagr. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098)) Unclassified

Published in Phys. Rev. Ltrs., v. 14: 396-398, Mar. 15, 1965

Using an existing definition of a bootstrap solution it was found that there is no bootstrap solution to the Chew-Low theory if the scattering amplitudes satisfy unsubtracted dispersion relations. This result holds for arbitrary pole terms in the Low equation and is shared by any static model in the one-meson approximation with a 2 x 2 real crossing matrix $A_{\alpha\beta}$ having the properties $A^2 = 1$ and $|A_{11}| < 1$. The result also holds when the model is generalized to include inelastic channels.

1661

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

NOTE ON NON-LANDAU SINGULARITIES, by P. Federbush. [1965] [2]p. incl. diagrs. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Jour. Math. Phys., v. 6 825-826, May 1965.

Some non-Landau singularities are discussed using the formalism of Fotiadi, Froissart, Lascoux, and Pham. The simple cases of self-energy and vertex diagrams are treated, as well as the sixth-order scattering ladder diagram.

1662

Massachusetts Inst of Tech. Lab. for Nuclear Science, Cambridge.

PROMPT NEUTRONS FROM THORIUM PHOTOFISSION by C P. Sargent, W. Bertozzi and others

[1965] [13]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Phys. Rev., v. 137: B89-B101, Jan. 11, 1965.

The distribution in angle and velocity of the prompt neutrons from the bremsstrahlung-induced photofission of Th^{232} in the photon energy region near threshold have been measured. Using knowledge of the fission-fragment angular distribution, the data have been interpreted in terms of the neutron distribution relative to the fragment axis. The measurement allows a quantitative estimate of the fraction of neutrons which are not emitted by fully accelerated fragments. The result for this fraction is 0.07 ± 0.09. Assuming isotropic neutron emission in the fragment center-of-mass frame, the analysis also determines some characteristics of the neutron energy spectrum in this frame. The spectrum has an average energy $\bar{\eta} = 1.14 \pm 0.06$ mev and a second central moment $\sigma^2(\eta) = (0.77 \pm 0.06)\bar{\eta}^2$. If it is represented by an evaporation-type spectrum with some distribution of temperatures, there is no significant contribution from temperatures equal to or greater than $\bar{\eta}$. A similar analysis has been made of data on prompt neutrons from the spontaneous fission of Cf^{252} obtained by Bowman, Thompson, Milton, and Swiatecki, and the results compared with those for Th^{232} photofission. (Contractor's abstract)

1663

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

QUANTIZED VORTEX RINGS IN SUPERFLUID HELIUM, A PHENOMENOLOGICAL THEORY, by K. Huang and A. C. Olinto. [1965] [11]p. incl. diagrs. tables, refs. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Phys. Rev., v. 139: A1441-A1451, Aug. 30, 1965.

Rayfield and Reif (RR) and Careri, Cunsolo, and Mazzoldi (CCM) have done some experiments involving ion complexes moving through liquid helium in a constant uniform electric field. The results of RR give direct and compelling evidence that the ion complexes become attached to quantized vortex rings, the existence of which was conjectured by Feynman and Onsager. Their experiments, however, do not yield details concerning the interactions between ion complex and vortex ring. The results of CCM, on the other hand, exhibit a wealth of gross and fine structures, but they do not seem to be immediately understandable in simple terms. This paper attempts to understand all the results of RR and CCM in terms of a phenomenological theory of quantized vortex rings. It is hypothesized that an ion complex can create a vortex ring only if its velocity v and effective radius R satisfy the condition $6\pi vR = nh/m$, $(n = 1, 2, 3, \ldots)$, where h is Planck's constant and m the helium mass. The number 6π is semiempirical. An experiment is suggested to test this hypothesis directly. After creation, the interaction of the vortex ring and the ion complex is described phenomenologically, with all parameters determined directly by experiments. This leads to a definite model that describes in detail the history of an ion complex in liquid helium. The determination of parameters makes extensive use of experimental data, but only one number from CCM. The model then reproduces quantitatively all the data of CCM. (Contractor's abstract)

1664

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

RELATION BETWEEN POLES IN PROPAGATORS AND THE EXISTENCE OF PARTICLES, by R. Perrin. [1965] [2]p. (Sponsored jointly by [Air Force Office of Scientific Research], Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098) Unclassified

Published in Phys. Rev., v. 140: B199-B200, Oct. 11, 1965.

It is shown that in a relativistic field theory the existence of a pole in a propagator at an unphysical value of p^2 does not imply the existence of a discrete state in the theory having this value of p^2 as an eigenvalue. (Contractor's abstract)

1665

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

QUANTUM THEORY OF ELECTRON GAS PLASMA OSCILLATIONS IN A MAGNETIC FIELD, by N. J. Horing. [1965] 63p. incl. refs. (AFOSR-65-0730) [AF 19(604)7344] AD 616042 Unclassified

Also published in Ann. Phys., v. 31: 1-63, Jan. 1965.

The response function for an electron gas in an external magnetic field is investigated by the method of Green's functions using the random phase approximation. The spectrum of plasma oscillations and associated damping are obtained. The dispersion relations for wave vectors both perpendicular and oblique to the magnetic field are studied as power series, and semiclassical models are employed in study of the plasma modes. Detailed formulas for natural damping, which take full account of the influence of the magnetic field, are given for all plasma modes considered.

1666

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

NATIONAL MAGNET LABORATORY, by B. Lax and F. Bitter. Final rept. July 1, 1960-Oct. 31, 1964 Feb. 15, 1965, 43p. incl. tables, refs (AFOSR-65-0733) (AF 19(604)7344) AD 615152 Unclassified

A summary of work done at the National Magnet Laboratory, founded at the Massachusetts Institute of Technology by the Air Force Office of Scientific Research, is presented. The laboratory provides continuous magnetic fields of 255 kgauss, 100 kgauss stronger than available elsewhere. The number and variety of high field magnets and the ease and flexibility of their use are unequalled in the world. The fields of study have included solid state, low temperature and plasma physics. Within these areas such phenomena as superconductivity, magneto-optical effects, cyclotron and magnetic resonance, and transport effects in metals, semimetals and semiconductors were investigated.

1667

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

ANALYSIS OF THE EIGENSTATES OF Pr^{3+} IN $LaCl_3$ USING THE ZEEMAN EFFECT IN HIGH FIELDS, by R. Sarup and M. H. Crozier. [1965] [6]p. incl. tables, refs. (AFOSR-65-0734) [AF 19(604)7344] AD 614852 Unclassified

Also published in Jour. Chem. Phys., v. 42: 371-376, Jan. 1, 1965.

The Zeeman effect of the absorption and fluorescence spectra of Pr^{3+} in $LaCl_3$ was studied at liquid nitrogen and liquid helium temperatures in magnetic fields up to 69 kgauss. Both linear and quadratic effects were observed, and these are used to establish unequivocally the crystal quantum numbers of the observed energy levels. Crystal-field theory is used to calculate the magnetic behavior of the energy levels, and good agreement is found with experiment, but some systematic deviations are also noted. The second-order effect was found useful in understanding the nature of these deviations, and it appears that a crystal-field calculation fitted to the energy levels does not yield the eigenstates giving the best agreement with the observed behavior in high magnetic fields. (Contractor's abstract)

1668

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

PLASMONS IN A MAGNETIC FIELD, by N. J. Horing. [1965] [10]p. (AFOSR-65-1170) [AF 19(604)7344] AD 622641 Unclassified

Also published in Proc. Seventh Internat'l. Conf. on the Physics of Semiconductors, Paris (France) (July 19-24, 1964), Paris, Dunod, 1965, 107-116.

A summary is presented of the results of calculations on plasmons in a magnetic field. The calculations are based on a Green's function formulation of the random phase approximation for the inverse dielectric function of an electron gas in a magnetic field. The Green's function can be obtained in closed form, and the resulting inverse dielectric function has been used to write the plasmon dispersion relation and damping constant in relatively tractable forms which are not encumbered by unwieldy summations over Landau eigenstates.

1669

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

PROGRESS IN MAGNETO-OPTICAL EFFECTS, by B. Lax. [1965] [17]p. incl. diagrs. table, refs. (AFOSR-65-1171) [AF 19(604)7344] AD 622640 Unclassified

Also published in Proc. Seventh Internat'l. Conf. on the Physics of Semiconductors, Paris (France) (July 19-24, 1964), Paris, Dunod, 1965, 253-269.

A review is presented of the recent progress in magneto-optical phenomena in semiconductors and metals. The situation on the Faraday rotation and Voigt effect is improved but not yet complete. The progress in semimetals has shown the promise of the magneto-reflection technique, which should lead to further exploration of new materials at very high fields. The cross-field phenomenon which is suited for semiconductors provides a more sensitive tool for investigating high gap materials. The emphasis in the future of magneto-optical phenomena is most likely to shift from absorption to emission. It is expected that with these new tools and techniques, magnetooptical phenomena will be fruitfully exploited for both basic and applied research from the far infrared to the optical and ultra-violet regions in semiconductors and semimetals

1670

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

ROTATORY DISPERSION OF DIRECT EXCITON IN GERMANIUM, by Y. Nishina, J. Kolodziejczak, and B. Lax. [1965] [5]p. incl. diagrs. (AFOSR-65-1172) [AF 19(604)7344] AD 622757 Unclassified

Also published in Proc. Seventh Internat'l. Conf. on the Physics of Semiconductors, Paris (France) (July 19-24, 1964), Paris, Dunod, 1965, 867-871.

Since the oscillatory behavior of the interband Faraday effect was observed in Ge at room temperature, much interest has been focussed on how the Coulomb interaction between the excited electron and the hole would influence the line shapes of the rotatory dispersion. In order that this problem might be answered quantitatively with some experimental evidence, it was necessary to measure the rotatory dispersion for a single energy state of a direct exciton in a pair of nondegenerate conduction and valence bands This paper presents the experimental results on the Faraday rotation and the Voigt effect of the direct excitons at Γ points in Ge near liquid helium temperature. Good agreement was obtained between the experimental results and those calculated for the Faraday rotation in the photon energy range up to 0 900 ev.

1671

Massachusetts Ins.. of Tech. National Magnet Lab., Cambridge.

MUTUAL INDUCTANCE BRIDGE FOR AC SUSCEPTIBILITY MEASUREMENTS AT LOW FREQUENCIES, by E. Maxwell. [1965] [2]p. incl. diagrs. (AFOSR-65-1379) [AF 19(604)7344] AD 621191 Unclassified

Also published in Rev. Scient. Instr., v. 36 553-554, Apr. 1965.

A mutual inductance bridge for measuring ac magnetic susceptibility at low frequencies, using standard components, is described. The equivalent of a decade mutual indicator is achieved by using a commercial decade autotransformer in combination with a small fixed mutual inductor. The Gertsch RT-61 transformer is used at 30-400 cps and lower, while the RT-60 is used at - 1 kc. Both transformers have a nominal accuracy of 0.001%, which is more than sufficient in this use. A low-noise preamplifier followed by a lock-in amplifier is used for null detection.

1672

Massachusetts Inst. of Tech., National Magnet Lab., Cambridge.

DE HAAS-VAN ALPHEN EFFECT IN PYROLYTIC AND SINGLE-CRYSTAL GRAPHITE, by S. J. Williamson, S. Foner, and M. S. Dresselhaus. [1965] [5]p. incl. diagrs. refs. [AF 19(604)7344] Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. B) 771-775, 1965.

The de Haas-van Alphen oscillations in the magnetic susceptibility of pyrolytic graphite have been observed for the first time and a comparison made with those of single-crystal graphite. These preliminary measurements were performed at temperatures between 1.2° and 4.2° with fields up to 55 kgauss applied along the c-axis. The usual beat pattern attributed to majority electron and hole carriers was found to be identical for both pyrolytic and single-crystal graphite between 1.5 and 20 kgauss. This equality between the pyrolytic and single-crystal graphite frequencies, f_M, and effective masses, m^*, is significant in establishing the graphite band parameters, because the most complete band parameter determination has been made by combining magneto-reflection data in pyrolytic graphite with Shubnikov-de Haas data on single-crystal graphite. Low-temperature de Haas-van Alphen measurements also yield a comparison of the local order in pyrolytic graphite with that in single-crystal graphite. Furthermore, the oscillations of unusually low frequency discovered by Soule (IBM Jour. Res. Develop., v. 8 268, 1964) were confirmed by observation in both graphites. The existence of such low f_M oscillations is shown to be consistent with existing band structure calculations.

1673

Massachusetts Inst of Tech. National Magnet Lab., Cambridge.

HIGH-MAGNETIC-FIELD BUBBLE TRAPPING IN LIQUIDS (Abstract), by M. H Crozier. [1965] [1]p. [AF 19(604)7344] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 305, Mar. 24, 1965.

The author observed the occurrence of a pressure barrier preventing the free movement of bubbles up a column of water in a vertical solenoid magnet operated in the range 165-200kgauss This effect is caused by the body force acting on this diamagnetic liquid due to the field, which results in the occurrence of a local minimum and maximum in the hydrostatic pressure. The corresponding effect can occur in paramagnetic liquids such as liquid air even in a standard 20-kgauss electromagnet, and the "burp" associated with the escape of a large bubble from the trap presents a problem in some experiments. By formulating the theory of the trapping process, one is led to predict that at slightly higher fields our solenoid would also produce a bubble trap in liquid helium, which could give rise to irregularities in the results of low-temperature experiments at very high fields unless bubbles are prevented from forming.

1674

Massachusetts Inst. of Tech. [National Magnet Lab.] Cambridge.

MAGNETIC PROPERTIES OF InAs DIODE ELECTROLUMINESCENCE, by F. L. Galeener, I. Melngailis and others. [1965] [6]p. incl. diagrs. refs. [AF 19-(604)7344] AD 624878 Unclassified

Also published in Jour. Appl. Phys., v. 36 1574-1579, May 1965.

Spontaneous and laser electroluminescence of InAs diodes have been studied in magnetic fields up to 109 kgauss. The peak of the emitted energy shifts linearly with magnetic fields above 20 kgauss at a rate which depends on the carrier concentration of the n-type base material. If the energy shift is described as $\Delta E = \beta heH/m^*c$, the value of m^* is the same as that measured at the Fermi level in bulk n-type material The emission from one laser diode exhibited a splitting which corresponds to a g factor of about 7 for the electron. Evidence was obtained that the laser threshold current is reduced by the component of magnetic field perpendicular to the junction current.

1675

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

OSCILLATORY RF MAGNETORESISTANCE SIZE

EFFECT IN GALLIUM (Abstract), by S. Foner and E. J. McNiff, Jr. [1965] [1]p. [AF 19(604)7344] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 351, Mar. 24, 1965.

Munarin and Marcus observed an oscillatory dc magnetoresistance in gallium at low temperatures with field-modulation techniques. This effect was periodic in H, inversely proportional to thickness, and for certain orientations, increased in amplitude for H as high as 14 kgauss. The authors observed a similar effect in the differential rf absorption of gallium (detected with audio field modulation) from 8 to 30 mcps. The size effect agreed within experimental error with Munarin and Marcus and could be followed to 43 kgauss for H along the a axis. Large superimposed de Haas-Shubnikov oscillations tended to obscure the data above this field. The classical penetration depth was much less than the sample thickness for the frequencies and fields employed. Preliminary transmission studies of rf radiation through gallium crystals have also been made as a function of frequency, field, and orientation. The results of these and related experiments are discussed.

1676

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

FARADAY EFFECT IN SOLIDS, by H. S. Bennett and E. A. Stern. [1965] [14]p. incl. refs. (AFOSR-65-0604) [AF 49(638)1468] AD 614558 Unclassified

Also published in Phys. Rev., v. 137: A448-A461, Jan. 18, 1965.

Expressions for the weak-field Faraday effect in cubic materials are presented for the cases of transmission and reflection. These expressions contain the elements of the complex conductivity tensor. General quantum-mechanical expressions for the diagonal and off-diagonal elements of the frequency-dependent conductivity tensor are computed for arbitrary external magnetic fields and in the zero-wave-vector limit with the aid of dispersion relations. Sum rules for the conductivity tensor elements are also derived. The high-frequency limits of the conductivity elements are shown to reduce to the free-electron-gas results. A simple physical interpretation of the effect of the magnetic field on the conductivity tensor is given, and this shows that 2 effects could contribute to the Faraday effect. These are the Zeeman splittings of the energy levels and the changes of the matrix elements. A calculation of the Faraday effect in the effective-mass approximation is performed. Special attention is given to the contribution of the spin-orbit interaction to 1st order, and it is shown that for practically all nonferromagnetic metals this can be an appreciable effect on the interband part. The spin-orbit effect should be observed as a rapid variation in a comparatively small frequency range. The intraband is not affected by spin-orbit effects to 1st order. (Contractor's abstract)

1677

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

MEASUREMENTS ON NIOBIUM-TIN SAMPLES IN 200-kG CONTINUOUS FIELDS, by D. B. Montgomery and W. Sampson. [1965] [4]p. incl. diagrs. table. (AFOSR-65-1181) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)1468] and Atomic Energy Commission) AD 621303 Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Also published in Appl. Phys. Ltrs., v. 6: 108-111, Mar. 15, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 359, Mar. 24, 1965.

Measurements are made of the critical current as a function of applied magnetic field on several samples of niobium-tin at 4.2 K in dc fields as high as 201 kgauss. The measurements allow a determination of the upper-critical field, even of the best material, to within a few percent. The data also reveal the marked deviation of some materials at high fields from the defect-limited currents of the Lorentz-force model, and indicate a parabolic approach to Hc_2.

1678

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

NONLINEAR SHIELDING IN RARE-EARTH CRYSTAL FIELD INTERACTIONS, by A. J. Freeman and R. E. Watson. [1965] [1]p. (AFOSR-65-1380) (AF 49(638)-1468) AD 622620 Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 16-19, 1964.

Also published in Jour. Appl. Phys., v. 36: 928, Mar. 1965.

Configuration interaction methods were used to estimate the leading nonlinear and linear shielding terms in a number of rare earth ions: Ce^{3+}, Tb^{3+}, Er^{3+}, Tm^{3+}, Ho^{3+}, Dy^{3+}, and Yb^{3+}. Calculations were made as a function of crystalline field strength since the nonlinear shielding is dependent on the strength of the applied external field. Nonlinear shielding of V_2 and V_4 external fields were determined as a function of atomic number as were their effects on apparent V_2, V_4, and V_6 crystal field parameters. It is concluded that antishielding rather than shielding of the V_4 field occurs, but only by a few % at most, the V_2 field is always shielded. For the heavy rare-earth ions, the shielding effects are much smaller than for the lighter ions, with the apparent V_4 and V_6 shielding being very small. The most severe nonlinear effects arise when relatively strong V_2 and V_4 fields contribute to a relatively weak V_6 field

1679

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

GENERATION OF INTENSE MAGNETIC FIELDS, by D. B. Montgomery. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-1980) (AF 49(638)1468) AD 626328 Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 16-19, 1964.

Also published in Jour. Appl. Phys., v. 36: 893-900, Mar. 1965.

The current and future status of high-field superconducting magnets is reviewed. Presently, superconducting magnets to 60 kgauss and a few even to 100 kgauss are within the reach of most research budgets. The potential of niobium-tin materials gives promise of future superconducting fields to 200 kgauss. Other methods of generating fields, such as water-cooled continuous magnets, millisec pulse magnets, and long-pulse cryogenic magnets, will find their principal use in reaching even higher fields, supplementing superconducting magnets, or in circumventing problems which preclude the use of superconductors. Pulse magnets are presently capable of producing millisec fields up to 500 kgauss and long pulses to 250 kgauss. Some design considerations of the magnets discussed are presented. (Contractor's abstract, modified)

1680

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

INTERFEROMETRIC MEASUREMENT OF MICROWAVE HELICON DISPERSION AND THE HOLE DAMPING EFFECT IN INTRINSIC InSb, by J. K. Furdyna. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-1982) [AF 49-(638)1468] AD 627480 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 635-638, Apr. 19, 1965.

Helicon wave propagation is investigated in intrinsic InSb at 35 Gc/sec in the temperature range from 200° to 400°K in magnetic fields up to 100 kgauss. Well-defined Rayleigh-type interference patterns indicate that the hold contribution to the helicon dispersion is negligible in practically the entire available field region, and in this sense the role of the slow carriers is similar to that of the fixed positive ions. However, even at moderate fields, the hold plasma provides the dominant damping mechanism of the helicons. Results, obtained by using the classical helicon model, agree moderately with the known dc mobilities. The inadequacy of the model in the proximity of the quantum regime is a likely cause for the discrepancy. Rayleigh patterns are also obtained by varying the concentration via temperature at fixed field, with more accurate results.

1681

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

LOW-TEMPERATURE ANTIFERROMAGNETIC RESONANCE IN αFe_2O_3, by S. Foner and S. J. Williamson. [1965] [3]p. incl. diagr. refs. (AFOSR-65-1984) (AF 49(638)1468) AD 627197 Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 16-19, 1964.

Also published in Jour. Appl. Phys., v. 36. 1154-1156, Mar. 1965.

Antiferromagnetic resonance (AFMR) at 35, 70, and 121 Gc/sec in single-crystal synthetic and natural α-Fe_2O_3 from 4.2 to 280°K has been observed The usual low-field AFMR as well as the spin-flop resonance mode are observed with pulsed magnetic fields applied parallel to the c axis. The data extend from well below the spin reorientation transition temperature T_M (about -10 C) to well above T_M. The spin-flop mode joins smoothly with the canted high-frequency mode above T_M. The usual AFMR terminates abruptly at T_M. The 3 modes observed here for the first time in α-Fe_2O_3 require either high fields or high frequencies or both for observation. The effects of the Dzyaloshinsky-Moriya field H_{DM} on the spin-flop resonance, the usual AFMR, and possible effects of spontaneous sublattice magnetizations are discussed. (Contractor's abstract)

1682

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

SHIFT OF LANDAU LEVELS IN CROSSED ELECTRIC AND MAGNETIC FIELDS, by Q. H. F. Vrehen. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-1988) [AF 49-(638)1468] AD 626824 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 558-561, Apr. 5, 1965.

In mutually perpendicular strong electric and magnetic fields, a resonance is observed in the optical absorption below the direct-gap band edge in germanium. It is interpreted as the transition between the zeroth Landau levels in the valence and conduction bands. The variation of the position and intensity of this resonance with E/H is in good agreement with a theory of Aronov which treats the optical absorption in crossed fields in the effective-mass approximation. It is shown likely that the whole phenomenon of optical absorption below the gap in crossec fields in germanium can be reasonably described in the effective-mass approximation, up to the highest electric fields attainable.

1683

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

MÖSSBAUER STUDIES OF SPIN FLOP IN ANTIFERROMAGNETIC HEMATITE, by N. Blum, A. J. Freeman and others. [1965] [2]p. incl. diagrs. (AFOSR-65-1990) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1468, [Air Force Office of Scientific Research] Atomic Energy Commission, and [Office of Naval Research] under AT(30-1)2098)
AD 627459 Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 16-19, 1964.

Also published in Jour. Appl. Phys., v. 36 1169-1170, Mar. 1965.

The antiferromagnetic sublattice magnetization below the Morin transition temperature T_M 260 K, are parallel and antiparallel to the trigonal axis of rhombohedral α-Fe_2O_3. Experiments at 80 K, using the Mössbauer technique together with high external magnetic fields on both polycrystalline and single-crystal samples, show that the directions of the sublattice magnetizations flop from along the crystallographic [111] direction into the basal (111) plane. H_c is found to be 67.5 ± 3 kOe. In the polycrystalline sample, this behavior is exhibited through the occurrence of a maximum in the width of the outer lines of the Mössbauer spectrum plotted as a function of H_0. In the single crystal, which is oriented so that the γ rays propagate along the [111] direction, the magnetic transition is clearly observed as a sudden qualitative as well as quantitative change in the appearance of the Mössbauer hyperfine spectrum, below the critical field, the $\Delta m = 0$ lines are the strongest components of the 6-line spectrum. (Contractor's abstract)

1684

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

MAGNETOABSORPTION OF THE INDIRECT TRANSITION IN GERMANIUM, by J. Halpern and B. Lax. [1965] [9]p. incl. diagrs. table. (AFOSR-65-1991) [AF 49(638)1468] AD 626866 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26 911-919, May 1965.

The indirect transition magnetoabsorption in germanium at 1.7 K was studied in the Faraday configuration with the magnetic field perpendicular to the (100), (111) and (110) faces respectively and at fields of up to 74 kilogauss. The main features in the Landau transition spectrum are due to transitions from the states at the top of the valence bands to the electronic ladders in the conduction band. The periodicities obtained in the spectra enabled us to determine the effective masses of the conduction band electrons, the values obtained are in good agreement with those determined from cyclotron resonance. A fine structure corresponding to the spacings of the ladders in the valence bands was observed superposed on the gross structure due to transitions to successive electronic levels. This fine structure was analyzed and a number of valence band levels were identified. Values of the free electron g-factor were deduced and correlated with theory. (Contractor's abstract)

1685

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

NONLINEAR AND LINEAR SHIELDING OF RARE-EARTH CRYSTAL-FIELD INTERACTIONS, by A. J. Freeman and R. E. Watson. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-2000) [AF 49(638)1468]
AD 627775 Unclassified

Also published in Phys. Rev., v. 139: A1606-A1615, Aug. 30, 1965.

Both nonlinear and linear shielding effects are investigated for the rare-earth ions Ce^{3+}, and Tb^{3} through Yb^{3+} inclusive. The method of single substituted configuration is employed and is shown to avoid the difficulties associated with the traditional single-determinant perturbation-theory approach. Results based on both methods are compared; significant differences in linear-shielding predictions are found to be introduced by the inexact traditional approach. Calculations for the nonlinear 5p → 4f effects have been done, and results displayed, as a function of the strength of V_c. The relevance of these effects to experiment is examined qualitatively. (Contractor's abstract)

1686

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

OBSERVATION OF A FAR INFRARED RESONANCE LINE IN ANTIFERROMAGNETIC CoO, by R. C. Milward. [1965] [2]p. incl. diagr. (AFOSR-65-2021) (AF 49(638)1468) AD 627618 Unclassified

Also published in Phys. Ltrs., v. 16: 244-245, June 1, 1965.

Using the technique of Fourier transform interferometry, far IR absorption was studied in single crystal CoO in the antiferromagnetic state. A sharp absorption peak was observed at a frequency of 142.3 ± 0.5 cm^{-1} at liquid helium temperature in 2 independently obtained CoO crystals, which closely corresponds with one of a pair of degenerate modes of antiferromagnetic resonance predicted by Tachiki (Jour. Phys. Soc. Japan, v. 19: 454, 1964). This resonance, however, shows anomalous behavior in the presence of external magnetic fields up to 100 kg and cannot be positively identified as an antiferromagnetic resonance mode. At higher temperatures, absorption measurements show that the resonance line broadens and almost disappears at nitrogen

temperature, being centered at slightly lower frequency and non-observable at room temperature.

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Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

NONLINEAR TWO-FLUID EQUATIONS FOR A SUPERCONDUCTOR, by R. Meservey. [1965] [2]p. (AFOSR-65-2022) [AF 49(638)1468] AD 627617 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 248-249, 1965.

The phenomenological equations of motion obtained from Eckart's variational principle (Phys. Rev., v. 54: 920, 1938 and Phys. Fluids, v. 3: 421, 1961) are given as applied to the 2-fluid model of a superconductor. The resulting equations yield a source term for the normal electrons and the explicit form of the osmotic-pressure term suggested by London (Superfluids, v. 1: 59, 1950).

1688

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

PROGRESS IN SEMICONDUCTOR LASERS, by B. Lax. [1965] [14]p. incl. diagrs. refs. (AFOSR-65-2023) [AF 49(638)1468] AD 627481 Unclassified

Also published in IEEE Spectrum, v. 2: 62-75, July 1965.

The progress in semiconductor lasers is reported in an attempt to bridge the gap between those references concentrating on the injection laser and more recent results on optical photon and electron pumped semiconductor lasers. The history of the semiconductor laser is briefly reviewed from the first speculations of solid state masers in 1954. The basic requirements of any laser are discussed as they apply to semiconductors. Recent developments are considered as well as applications and a variety of magnetic phenomena investigated in connection with semiconductor lasers. It is concluded that rapid progress has been made in semiconductor lasers, a dozen new materials having emerged in 2 1/2 yr as effective media for generating coherent radiation in the infrared from about 0.6 to 8.5 μ. Still the science is just taking its first few steps

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Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

MAGNETIC ANISOTROPY IN ANTIFERROMAGNETIC CORUNDUM-TYPE SESQUIOXIDES, by J. O. Artman, J. C. Murphy, and S. Foner. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-2025) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49-(638)1468], and Office of Naval Research) AD 627620 Unclassified

Also published in Phys. Rev., v. 138 A912-A917, May 3, 1965.

Evaluations of the magnetic dipolar anisotropy K_{MD} are made for the antiferromagnetic Cr, Fe, Ti, and V sesquioxides isomorphous to α-Al_2O_3. In the first 2 systems, the fine structure anisotropy K_{FS} is found by subtracting K_{MD} from the total anisotropy K obtained from antiferromagnetic-resonance (AFMR) data. In Shull magnetic configuration type (c), of which Cr_2O_3 is the prototype, K_{MD} was found to be very sensitive to lattice geometry. An analysis is also made for α-Fe_2O_3. The α-Fe_2O_3 spin flip near 250° K is predictable on a thermodynamic basis. The K_{FS} results in the Cr and Fe cases show little correlation with the corresponding quantities derived from EPR in diluted magnetic systems. The results of variation of lattice parameters are given for possible application to temperature and stress experiments and to diluted crystals. Since the antiferromagnetic properties of the Ti and V oxides currently are not clear, the appropriate K_{MD} calculations are presented for each of the 3 possible spin configurations.

1690

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

ANALYTICAL LINE SHAPES FOR LORENTZIAN SIGNALS BROADENED BY MODULATION, by R. Arndt. [1965] [3]p. incl. refs. (AFOSR-65-2026) [AF 49-(638)1468] AD 627619 Unclassified

Also published in Jour. Appl Phys., v. 36: 2522-2524, Aug. 1965.

General analytical expressions are given for the line shapes of Lorentzian signals broadened by modulation The results are discussed for the cases of the first and second harmonic. The linewidths and the signal intensities have been calculated analytically as a function of the modulation amplitude. (Contractor's abstract)

1691

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

EFFECTIVE CONDUCTION-ELECTRON-LOCAL-MOMENT EXCHANGE INTERACTION IN METALS: RARE-EARTH INTERBAND MIXING, by R. E. Watson, S. Koide and others. [1965] [12]p. incl. diagrs. table, refs. (AFOSR-65-2027) [AF 49(638)1468] AD 628338 Unclassified

Also published in Phys. Rev., v. 139: A167 A178, July 5, 1965.

The effective diagonal-exchange parameter $J_{eff}(0)$ which determines the exchange splitting of a metal's Fermi-surface conduction electrons, has been

investigated with a model involving simple orthogonalized-plane-wave conduction-electron orbitals and rare-earth ion cores. The positive exchange integral and negative interband mixing contributions to $J_{eff}(0)$ have been estimated for the rare earths as a function of nuclear charge Z. The results indicate that interband mixing may dominate, causing a net negative conduction-electron polarization, in agreement with a number of experiments. The interband mixing, and hence the sign of $J_{eff}(0)$, is found to be very sensitive to conduction-electron character. The results also indicate that, for ions other than spherical Gd, the parameter $J_{eff}(0)$ will vary strongly with conduction-electron k direction and may even involve a variation in sign. Such anisotropies in $J_{eff}(0)$ and the nondiagonal $J_{eff}(Q)$ parameters should be a significant source of anisotropies in the Ruderman-Kittel-Yasuya-Yosada conduction-electron spin distribution. (Contractor's abstract)

1692

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

WIEDEMANN-FRANZ LAW IN THE QUANTUM LIMIT FOR ISOTROPIC SCATTERING, by J. Zak. [1965] [7]p. incl. refs. (AFOSR-65-2030) [AF 49(638)1468] AD 628344 Unclassified

Also published in Jour Phys. and Chem. Solids, v. 26: 1021-1027, June 1965.

A temperature gradient is introduced into the density matrix equation by analogy with the Boltzmann transport equation. The electric and heat currents are defined in the case of isotropic scattering, in which particular case, it is shown that the Wiedemann-Franz law holds even in the details of the oscillations of both the electric and thermal conductivities. (Contractor's abstract)

1693

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge

LINE SHAPE AND AMPLITUDE OF GIANT QUANTUM OSCILLATIONS IN ULTRASONIC ABSORPTION, by Y. Shapira and B. Lax. [1965] [9]p. incl. diagrs. refs. (AFOSR-65-2031) [AF 49(638)1468] AD 627482 Unclassified

Also published in Phys Rev., v. 138. A1191-A1199, May 17, 1965.

The line shape of the giant quantum oscillations and the dependence of the amplitude of these oscillations on ultrasonic frequency, magnetic field, and temperature are calculated on the basis of the theory of Gurevich et al (Soviet Phys.-JETP, v. 18: 403, 1964). Expressions for determining cross sections of the Fermi surface, effective masses, g factors, matrix elements of the electron-phonon interaction, and electron relaxation times, by the use of giant quantum oscillations, are given. Measurements of the line shape and amplitude of the giant quantum oscillations in gallium are presented and compared with theory.

1694

Massachusetts Inst. of Tech., National Magnet Lab., Cambridge.

OPTICAL ZEEMAN EFFECT IN THE R_1 AND R_2 LINES OF Mn^{4+} IN Al_2O_3, by M. H. Crozier. [1965] [2]p. incl. table. (AFOSR-65-2555) [AF 49(638)1468] AD 628346 Unclassified

Also published in Phys. Ltrs., v. 18: 219-220, Sept. 1, 1965.

The Zeeman effect of the $^2E(\bar{E}) \rightarrow {}^4A_2$ and $^2E(2\bar{A}) \rightarrow {}^4A_2$ lines (R_1 and R_2 respectively) of Mn^{4+} in Al_2O_3 at high magnetic fields is observed, in conjunction with paramagnetic resonance studies of the $^2E(\bar{E})$ state carried out at Bell Telephone Laboratories (G. F. Imbusch and S. Geschwind, Phys. Ltrs., v. 18: 109, 1965). The value $g = (-)3.08$ deduced for the $2E(\bar{E})$ state agrees well with the e.p.r. value, while for the $^2E(2\bar{A})$ state, $g = 1.12$ is obtained.

1695

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

LOW FREQUENCY FIELD MODULATION DIFFERENTIAL MAGNETOMETER; APPLICATIONS TO THE DE HAAS-VAN ALPHEN EFFECT, by A. Goldstein, S. J. Williamson, and S. Foner. [1965] [10]p. incl. diagrs. table, refs. (AFOSR-65-2559) [AF 49(638)-1468] AD 627777 Unclassified

Also published in Rev. Scient. Instr., v. 36: 1356-1365, Sept. 1965.

Low frequency field modulation techniques (FMT) for measurements of differential magnetic susceptibility are discussed and specific applications to the de Haas-van Alphen effect are analyzed. The method utilizes a small ac modulating field which is superimposed on a large applied dc magnetic field. Differential changes in magnetization of the sample are synchronously detected with the aid of a suitable arrangement of pickup coils. The FMT is applicable to a wide variety of magnetic measurements and is particularly valuable for de Haas-van Alphen or magnetic transition studies at high magnetic fields. Advantages of this technique include: simplicity, versatility, direct applicability to axial high field water-cooled and superconducting solenoids or transverse magnets, high differential sensitivity ($d\sigma/dB = 3 \times 10^{-6}$ emu/gG), convenient access to the sample environment, and use of standard commercially available electronic components. Details of the detection coil assembly, sample rotation devices, and low temperature accessories are presented along with a general discussion of the

data processing techniques. Modifications for transverse field modulation and accurate orientation of the dc or modulation field with respect to the sample are also discussed. (Contractor's abstract)

1696

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

DIELECTRIC CONSTANT OF ^{3}He IN THE CRITICAL REGION, by C. E. Chase and G. O. Zimmerman. [1965] [3]p. incl. diagr. refs. (AFOSR-65-2566) [AF 49(638)1468] AD 628345 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 483-485, Sept. 13, 1965.

A systematic study was undertaken of the equation of state of ^{3}He, for the purpose of investigating certain quantum corrections in detail. A dielectric-constant technique was employed in which the density of a very thin layer of fluid (about 2×10^{-2} cm thick), contained between the plates of a condenser, is derived from the measured change in capacitance as the condenser is filled. Measurements are reported of the density along the critical isotherm, which we believe to be substantially free from the objections of previous methods. The measurements show that $\delta = 3.49 \pm 0.1$ over a very wide range of pressure, confirming the existence of substantial deviations from the law of corresponding states. Considerable asymmetry was also found between the high-density and low-density sides of the critical isotherm.

1697

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

CONDUCTION-ELECTRON POLARIZATION IN METALS, by R. E. Watson and A. J. Freeman. [1965] [4]p. incl. diagrs. (AFOSR-65-2567) [AF 49(638)1468] AD 628189 Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 339, Mar. 24, 1965.

Also published in Phys. Rev. Ltrs., v. 14: 695-698, Apr. 26, 1965.

The conventional free-electron Ruderman-Kittle-Kasuya-Yosida (RKKY)-theory of conduction-electron polarization yields a spin density $\rho(r)$ given by $\int \chi(Q) J(Q) [e^{iQ \cdot r} + e^{-iQ \cdot r}] dQ$, where $Q = k - k'$ is the vector difference of k vectors. The conduction-electron local-moment exchange integral $J(Q)$ is commonly treated as being constant or as a local-moment form factor and any difference between theory and experiment is often ascribed to the susceptibility function $\chi(Q)$. The authors determined the Q dependence of $J(Q)$ and find strong differences from either the constant or form-factor assumptions. Repercussions on the spin density are found to be severe. The spin density of the origin with respect to that at a typical near-neighbor or next-nearest-neighbor position in a metal may differ markedly from the traditional RKKY result. Numerical results are reported for exchange integrals determined using the $Gd^{3+}4f^7$ wavefunction to represent a local spin distribution and conduction electrons represented by plane waves orthogonalized to the entire Gd^{3+} core.

1698

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

SUPERFLUID FLOW IN A VENTURI TUBE, by R. Meservey. [1965] [4]p. incl. diagrs. [AF 49(638)-1468] AD 629192 Unclassified

Also published in Phys. Fluids, v. 8: 1209-1212, July 1965.

It is shown from Bernouilli's equation that a Venturi tube or Pitot tube as ordinarily used will have practically no level difference with irrotational fluids. A quantitative solution is given in the case of a Venturi tube of various dimensions. The observed level difference with water follows simply from the rotational acceleration term of the Navier-Stokes equation. This result for irrotational fluids is discussed with respect to experiments using liquid helium and superconductors. (Contractor's abstract)

1699

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

BORN RECIPROCITY PRINCIPLE AND UNITARY SYMMETRY, by E. E. H. Shin. [1965] [3]p. incl. refs. (AFOSR-65-2570) (AF 49(638)1468) AD 629183 Unclassified

Also published in Jour. Math. Phys., v. 6: 1307-1309, Aug. 1965.

In view of the past attempts by Born et al to explain elementary particles using the Born reciprocity principle as a postulate and of the recent success of unitary symmetry schemes, it is sought to establish a contact between the reciprocity principle and unitary symmetry in connection with the problem of elementary particles. (Contractor's abstract)

1700

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

ZEEMAN EFFECT IN THE 4f - 5d SPECTRUM OF Ce^{3+} IN CaF_2, by M. H. Crozier. [1965] [3]p. incl. diagrs table. (AFOSR-65-2584) (AF 49(638)1468) AD 627954 Unclassified

Also published in Phys. Rev., v. 137: A1781-A1733, Mar. 15, 1965.

The Zeeman effect of the Ce^{3+} ion with tetragonal charge compensation in CaF_2 has been studied at 4.2°K. An absorption line at 3131.6A has been split with fields of 60 kG, and although all the components cannot be resolved, there is good agreement with electron paramagnetic resonance results for the ground state. Axial stress results identify the upper state as having crystal quantum number $\mu = \pm 1\ 2$. The occurrence of $4f^n - 4f^{n-1}5d$ spectra in the trivalent rare earths is discussed. In an appendix, a result is established concerning the use of the Zeeman effect to identify the $\mu = \pm 1/2$ and $\mu = \pm 3\ 2$ components of a cubic Γ_8 level split by a tetragonal distortion. (Contractor's abstract)

1701

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

EQUATION OF STATE ON ^{4}He IN THE CRITICAL REGION, by L. Tisza and C. E. Chase. [1965] [3]p. incl. diagrs. refs. (AFOSR-65-2585) [AF 49(638)1468] AD 629186 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965

Abstract published in Bull. Amer Phys. Soc., Series II, v. 10: 532, Apr. 26, 1965.

Also published in Phys. Rev. Ltrs., v. 15: 4-6, July 5, 1965.

Tisza pointed out several years ago that the thermodynamic functions are nonanalytic at the critical point and presumably exhibit branch-point singularities. Recently a great deal of progress has been achieved in providing mathematical description of such singularities. In order to integrate these results with the formalism of thermodynamics, it is necessary to choose a set of natural variables, that are within the scheme of a single fundamental equation and are adapted to the intrinsic symmetry of the system. There is evidence of a near symmetry in the critical region of fluids, the thermodynamic role of which has not been sufficiently appreciated. This asymmetry is masked if the traditionally favored independent variables are used. To demonstrate this thesis, the authors analyzed the measurement of Edwards and Woodbury who determined the orthobaric densities of ^{4}He to within 36 mdeg of T_c for the liquid and 50 mdeg for the vapor.

1702

[Massachusetts Inst. of Tech., National Magnet Lab., Cambridge]

ULTRASTRONG MAGNETIC FIELDS, by F. Bitter. [1965] [10]p. incl. illus. diagrs. (AFOSR-65-2587) [AF 49(638)1468] AD 628259 Unclassified

Also published in Scient. Amer., v. 213: 64-73, July 1965.

Methods that produce, for brief periods, magnetic fields with strengths in the neighborhood of 10 million gauss and that appear capable of achieving fields exceeding 100 million gauss are described. In creating these ultrastrong magnetic fields (fields > 10 million gauss), an implosion technique is employed which depends on the principle of flux compression. A magnetic field of a certain flux density is produced inside a metal cylinder which is surrounded by a ring of high explosive timed to go off when the pulsed field reaches its peak. The subsequent implosion of the cylinder compresses the magnetic flux, thereby raising the field to several million gauss. The direct magnetic effects of ultrastrong fields and how they might be used to create extremely high pressures is discussed.

1703

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

FAR-INFRARED ABSORPTION IN N-TYPE SILICON DUE TO PHOTON-INDUCED HOPPING, by R. C. Milward and L. J. Neuringer. [1935] [4]p. incl. diagrs. refs. (AFOSR-65-2932) [AF 49(638)1468] AD 629187 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 664-667, Oct. 18, 1965.

The first experimental observations of far-infrared photon-induced hopping of a charge carrier between impurity centers in a compensated semiconductor are reported. The absorption coefficient of compensated n-type silicon at 2.5°K shows resonance peaks between 10 and 100 cm^{-1} which agree with the calculations of Blinowski and Mycielski (Phys. Rev., v. 136: A266, 1964) for such a process. In addition, it is shown that uncompensated material will act as a far-infrared transmission filter under these conditions with a threshold adjustable by variation of the doping level.

1704

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

BLOCH ELECTRONS IN EXTERNAL ELECTRIC AND MAGNETIC FIELDS, by H. C. Praddaude. [1965] [5]p. (AFOSR-66-0083) [AF 49(638)1468] AD 629182 Unclassified

Also published in Phys. Rev., v. 140: A1292-A1296, Nov. 15, 1965.

The Schrödinger equation for a Bloch electron in external electric and magnetic fields is rewritten with the help of redundant variables, the wave function being obtained when a limiting process is carried out. The connection with the standard effective-mass approximation is discussed, and an application to the case of crossed electric and magnetic fields is carried out for the simple case of 2 parabolic bands in order to examine the

singularity $\frac{1}{2}m^*(E/B)^2$ that appears in the energy in the effective-mass approximation when $B \to 0+$. It is concluded that below a certain value of E/B the character of the solution changes and the effective-mass formula is then not applicable. (Contractor's abstract)

1705

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

UPPER CRITICAL FIELDS OF Nb-Ti ALLOYS: EVIDENCE FOR THE INFLUENCE OF PAULI PARAMAGNETISM, by Y. Shapira and L. J. Neuringer. [1965] [7]p. incl. diagrs. refs. (AFOSR-66-0223) [AF 49(638)-1466] AD 629195 Unclassified

Also published in Phys. Rev., v. 140: A1638-A1644, Nov. 29, 1965.

Resistivity, flow-resistance, and ultrasonic-attenuation measurements were carried out on Nb-37 at.% Ti and Nb-56 at.% Ti in dc magnetic fields up to 150 kG. The transition temperatures and the dependence of the upper critical field on temperature were measured by the resistive method. The transition temperatures are: T_c = 9.2 ± 0.2°K for Nb-37 at.% Ti and T_c = 9.0 ± 0.2°K for Nb-56 at.% Ti. Flow-resistance measurements gave the following values for the Ginzburg-Landau-Abrikosov-Gor'kov upper critical field at T = 0: 112 ± 7 kG for Nb-37 at.% Ti and 188 ± 9 kG for Nb-56 at.% Ti. Changes in the ultrasonic attenuation were observed near the upper critical field. The data support the view that the Pauli paramagnetism plays a role in determining the upper critical field. However, the effect of the Pauli paramagnetism is found to be smaller than predicted by Maki. (Contractor's abstract)

1706

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

FLUX CREEP AS A DOMINANT SOURCE OF DEGRADATION IN SUPERCONDUCTING SOLENOIDS, by Y. Iwasa and D. B. Montgomery. [1965] [3]p. incl. diagrs. (AFOSR-66-0224) [AF 49(638)1468] AD 629189 Unclassified

Also published in Appl. Phys. Ltrs., v. 7: 231-233, Nov. 1, 1965.

This report gives experimental evidence that the mechanism of unstable flux creep arising from thermal instabilities is responsible for the current degradation commonly observed in superconducting solenoids. Transient flux creep was induced in a sample by means of suitable magnetic field pulses. With the sample carrying a transport current, the resistivity arising during flux creep produced transient joule heating, and when the current was large enough, the heating was sufficient to exceed the local critical temperature, thereby resulting in a quench. The experiments point up the critical role played by flux creep and confirm the extreme sensitivity of flux creep to thermal perturbations. However, it remains unanswered as to why coils do not always quench in the sensitive zone (near 15 kilogauss), why currents are often less than 23 A, especially in large coils, and why coils in general, are more subject to instabilities.

1707

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

THE MINIMUM PROPAGATING CURRENT OF A COMPOSITE SUPERCONDUCTOR, by J. E. C. Williams. [1965] [2]p. incl. diagr. (AFOSR-66-0227) [AF 49(638)-1458] AD 629190 Unclassified

Also published in Phys. Ltrs., v. 19: 96-97, Oct. 1, 1965.

Stekly (Avco-Everett Report 210, March 1965) has shown that it is possible to stabilize an inherently unstable superconductor at its short sample current by shunting it with sufficient normal material. Stable operations can also be achieved, however, at currents below the short sample value with less normal material. It is the purpose of this letter to show that this leads to an increased overall current density in some instances which should be considered in coil design. Superconductors of high pinning strength, like NbZr, if operated at a minimum propagating current, will give lower overall current density at full stabilization than at low values of the loading parameter. Where coils of minimum weight or minimum volume are needed, this is an important consideration.

1708

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

EFFECTS OF HIGH MAGNETIC FIELDS ON THE ULTRASONIC VELOCITY AND ATTENUATION IN Nb-25% Zr, by Y. Shapira and L. J. Neuringer. [1965] [4]p. incl. diagrs. refs. (AFOSR-66-0228) [AF 49(638)1468] AD 629185 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 724-727, Nov. 1, 1965.

The report contains the observation of changes in the velocity and attenuation of ultrasonic waves propagating in the superconducting and normal states of Nb-25% Zr, caused by the presence of a high dc magnetic field. These changes are abrupt near the upper critical field H_{c2}, determined by magnetization measurements. The conventional interpretations of the changes in the ultrasonic attentuation and the velocity near H_{c2} do not apply to this high-field super-conductor because the effects of the magnetic field necessary to destroy superconductivity are large. On the other hand, the velocity and attenuation changes observed in the superconducting state agree with the predictions of the Alpher-Rubin theory (Jour. Acoust. Soc. Amer., v. 26: 452, 1954) which was originally derived for impure metals in the normal state. As expected, the theory also accounts for the results in the normal state. The results for changes in

shear wave velocity and absorption and changes in longitudinal wave attenuation near the upper critical field are reported. It is noted that there are some deviations from theory.

1709

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

SWEEP OF LOW IMPEDANCE IRON CORE MAGNETS DOWN TO ZERO FIELD, by H. C. Praddaude. [1965] [1]p. incl. diagr. (AFOSR-66-0231) [AF 49(638)1468] AD 629193 Unclassified

Also published in Rev. Scient. Instr., v. 36 1644, Nov. 1965.

Because a residual field remains when a magnet current is reduced to zero, a reverse current is required in order to reduce the field to zero. Since in most magnet power supplies there is no provision built in that allows the magnet current to be reversed, a simple device was built which when properly connected to the magnet, produces a reverse current of up to 1A.

1710

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

TEMPERATURE-OSCILLATION METHOD FOR OBSERVING DE HAAS-VAN ALPHEN OSCILLATIONS AND OTHER MAGNETIC PHENOMENA, by R. R. Oder and E. Maxwell. [1965] [2]p. incl. diagr (AFOSR-66-0236) (Sponsored jointly by Advanced Research Projects Agency, and Air Force Office of Scientific Research under [AF 49(638)1468]) AD 629194 Unclassified

Also published in Phys. Ltrs., v. 19. 108-109, Oct. 1, 1965.

The development of a technique for the direct measurement of $(\partial M/\partial T)_H$ and its application to the observation of De Haas-Van Alphen effects and other magnetic phenomena are reported. The technique consists of oscillating the temperature and measuring the resultant magnetic moment oscillations. A typical measurement on a sample of zinc 1 mm thick, and using a modulation frequency of 100 cps, is given. The system is able to detect $\partial M/\partial T = 10^{-5}$ gauss K with a sample volume of 2×10^{-2} cm^3 using a temperature oscillation amplitude of 10m K at 100 cps.

1711

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

MOSSBAUER TECHNIQUES USING HIGH-FIELD WATER-COOLED SOLENOIDS, by N. A. Blum. [1965] [16]p. incl. diagrs (AFOSR-66-0268) [AF 49(638)1468] AD 629151 Unclassified

Also published in Mossbauer Effect Methodology; Proc. of the First Symposium, New York (Jan. 26, 1965), ed. by I. J. Gruverman. New York, Plenum Press, v. 1: 147-162, 1965.

A description is given of the Mossbauer apparatus used in conjunction with the high-field water-cooled solenoids. In the course of designing and constructing a velocity spectrometer capable of performing with reasonably high resolution (0.1 mm/sec or better) at sample temperatures down to about 1°K using the high-field solenoids with fields up to 150 kOe, several problems were encountered and these are discussed. As a very simple example of a spectrum obtained with the apparatus, the result of an absorption experiment is shown which illustrates the general applicability of the method in simplifying complex spectra.

1712

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

DE HAAS-VAN ALPHEN EFFECT IN PYROLYTIC AND SINGLE-CRYSTAL GRAPHITE, by S. J. Williamson, S. Foner, and M. S. Dresselhaus. [1965] [19]p. incl. illus. diagrs. tables, refs. (AFOSR-66-0270) [AF 49-(638)1468] AD 629184 Unclassified

Also published in Phys. Rev., v. 140: A1429-A1447, Nov. 15, 1965.

The de Haas-van Alphen (DHVA) oscillations were observed in the differential susceptibility of well annealed pyrolygic graphite (PG) with the low-frequency field-modulation technique. Observation of a long period, minority-carrier DHVA oscillation in PG and SCG confirms Soule's discovery of such an oscillation in SCG and provides a sensitive test for the Slonczewski Weiss band model. The minority-carrier oscillation in PG is qualitatively but not quantitatively similar to the one in SCG. This oscillation is attributed to magnetic energy levels passing through the Fermi level near the Brillouin-zone corner at $k_z = \pi/c$, where $\theta = 0°$ there is no extremal area of the Fermi surface at zero field, when spin-orbit interactions are neglected. This interpretation is supported by the calculation of an oscillatory free energy and by the excellent agreement for PG between the predicted values and experimental results for the period, effective mass, period anisotropy, and phase. The phase is not the value which would be predicted from a free-electron model for either a maximal or a minimal cross-sectional area. (Contractor's abstract)

1713

Massachusetts Inst of Tech National Magnet Lab., Cambridge.

[MAGNET RESEARCH AND DEVELOPMENT, AND SOLID STATE RESEARCH PROGRAMS, by B. Lax] Quarterly technical status rept. no 22, Oct 1-Dec 31, 1965 [34]p incl illus. (AFOSR-66-0273) (AF 49-(638)1468) AD 638343 Unclassified

The Laboratory's work for the quarter on magnet research and development and solid state research is presented. A record field of 226 kG in a new 1¼" bore magnet was achieved. The current density and heat flux at the center are the largest ever sustained in a water-cooled magnet. The upper critical field of several samples of V_3Ga was in the range of 180-195 kG far lower than previously estimated. A new theory of crossed field magnetoabsorption for degenerate bands and large electric fields has been developed. A combined experimental and theoretical treatment of magnetoabsorption and Faraday rotation in Insb has provided very accurate values for the band parameters. The high field magnetic susceptibility of iron and nickel was measured up to 148 kG. The RF periodic size effect in single crystal gallium has been found to be the basis of an accurate and convenient technique for measuring high magnetic fields. New results on internal fields and magnetic properties of solids were obtained using the Mossbauer effect in high fields. Temperatures down to about 25 millidegrees were reached using the adiabatic demagnetization apparatus. The complete Fermi surface of thulium metal was determined using augmented plane wave calculation of the energy bands. The computed bands have an s-d character resembling those of the transition metals. A calculation of the contribution of core polarization to the hyperfine fields of 4d ions of transition metals has been made by the spin-polarized Hartree-Fock method.

1714

Massachusetts Inst. of Tech., National Magnet Lab., Cambridge.

FERRIMAGNETIC STRUCTURE OF MAGNETOELECTRIC $Ga_{2-x}Fe_xO_3$, by R. B. Frankel, N. A. Blum and others. [1965] [3]p. incl. diagr. (AFOSR-66-0277) [AF 49(638)1468] AD 629188 Unclassified

Also published in Phys. Rev. Ltrs., v. 15, 958-960, Dec. 20, 1965.

High-magnetic field Mössbauer and magnetic-moment experiments have been performed with $Ga_{2-x}Fe_xO_3$.

This magnetic system is of considerable interest because it is piezoelectric, weakly magnetic, and magnetoelectric. The crystal structure has been determined and a magnetic ordering inferred. The magnetic-moment measurements were made using a vibrating sample magnetometer in fields up to 75 kOe. The samples used for the Mössbauer absorption experiments consisted of ^{57}Fe enriched powders, grown from a flux, embedded in lucite, and having x = 0.8 and 1.2. A mosaic absorber made of small x-ray oriented single crystals was also studied. Measurements were made over the temperature range 4.2° to 320 K and in external magnetic fields up to 130 kOe. At low temperatures the zero-external field-absorption spectra indicate that there are at least 2 magnetically nonequivalent sites. In a large external field, the hyperfine spectrum lines corresponding to $\Delta m = 0$ vanish, while each of the outer lines (corresponding to $\Delta m = \pm 1$) splits into 2 well-resolved components of unequal intensity. Detailed analysis of the experimental results for both the single crystal and polycrystalline absorbers indicates that at zero external field all spins lie in the a-c plane (c < a < b), that the observed moment is due to ferrimagnetic rather than to a canted spin structure, and that the spins are unequally divided between the 2 sublattices.

1715

Massachusetts Inst. of Tech., National Magnet Lab., Cambridge.

QUANTUM OSCILLATIONS IN THE ULTRASONIC ATTENUATION IN CHROMIUM, by Y. Shapira, W. D Wallace and others. [1965] [2]p. incl. diagr. (AFOSR-66-1318) (In cooperation with Wayne State U., Detroit, Mich. AF AFOSR-64-695) (AF 49(638)1468) AD 639007 Unclassified

Also published in Phys. Ltrs., v. 17, 184-185, July 15, 1965.

For abstract see item no. 3101.

1716

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

MAGNETIC BUBBLE TRAPPING IN LIQUIDS, by M. H. Crozier. [1965] [3]p. incl. diagrs. table. (AFOSR-66-1322) [AF 49(638)1468] AD 639888 Unclassified

Also published in Jour. Appl. Phys., v. 36, 3802-3904, Dec. 1965.

In a high magnetic field, a liquid is subject to forces due to its para- or diamagnetism which contribute to the hydrostatic pressure at each point. It is shown that this contribution may give rise to a local pressure minimum at which bubbles in the liquid will accumulate. This effect is often produced in commercial liquid nitrogen with a standard laboratory electromagnet, because of the paramagnetism caused by a small oxygen content, and can cause experimental problems. The corresponding effect caused by diamagnetism has now been observed in water with a high-field solenoid operated in the range 165-205 kG, and it is predicted that a bubble trap will likewise occur in liquid helium when a magnet of this design is operated at slightly higher fields. Such an effect can produce irregularities in the results of low-temperature experiments in high magnetic fields unless bubbles are prevented from forming.

1717

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

XII. HIGH FIELD MAGNETS AND MAGNETOSPECTROSCOPY, by B. Lax. [1965] [24]p. incl diagrs refs. (AFOSR-66-1646) [AF 49(638)1468] AD 639002 Unclassified

Also published in Science in the Sixties, Tenth

Anniversary AFOSR Scientific Seminar, Cloudcroft, N. M., (June 1965), ed. by D. L. Arm. Albuquerque, Mexico U. Office of Publications, 1965, 138-161.

This discourse reviews the extent and scope of high magnetic-field research and magnetospectroscopy that has evolved during the last decade. The activity and productivity has far exceeded the expectations of even its most ardent participants. Only a few years ago such phenomena as the Mössbauer effect, coherent radiation with lasers, and high field superconductivity did not exist. But each of these now has become a prominent area of research which will play an important future role under the heading of high magnetic fields. However, there are many which have not been mentioned which promise to enrich this field of science even further.

1718

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

CALCULATION OF THE MAGNETIC SUSCEPTIBILITY IN GRAPHITE (Abstract), by M. S. Dresselhaus, S. J. Williamson, and G. F. Dresselhaus [1965] [1]p [AF 49(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 110, Jan. 27, 1965.

Recent measurements by Williamson et al of the magnetic susceptibility in single-crystal and pyrolytic graphite have confirmed the long-period oscillations first reported by Soule. Using the band parameters obtained from the magnetoreflection experiment, the circular cross-sectional area of the Fermi surface $k_z = \pi c_0$ has been computed, and the result is within 15% of the observed long-period oscillation in pyrolytic graphite. At this point in the zone, there is neither an extremum in the cross-sectional area of the Fermi surface nor a stationary value of the cyclotron effective mass, but there is a 2-fold degeneracy of the energy levels. A calculation of the temperature dependence of the magnetic susceptibility in the low-field limit is discussed in connection with this long-period oscillation.

1719

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

A CLOSED-LOOP COOLING SYSTEM FOR SUPERCONDUCTING BUBBLE CHAMBER MAGNETS, by H. H. Kolm. [1965] [4]p. incl. diagrs. [AF 49(638)1468] Unclassified

Published in Proc. Internat'l. Symposium on Magnet Technology, Stanford U., Calif., (Sept. 8-10, 1965), ed. by H. Brechna and H. S. Gordon. Springfield, Clearinghouse for Federal Scientific and Technical Information, Dept. of Commerce, 1965, 611-614.

Widespread effort is being devoted to the cryogenic problems associated with the design of large superconducting magnets to be used with bubble chambers, MHD generators, fusion experiments, energy storage inductors, and as external booster coils to surround high-filed copper and aluminum magnets. A new method of maintaining a structure at liquid helium temperature is described, and its advantages over the bath immersion technique is pointed out. The new method relies on the reluctance of liquid helium to solidify at pressures substantially above its critical point (2.3 atm). At 4.2°K and about 100 atm, helium has a very low viscosity and is incapable of undergoing phase change, therefore representing an ideal heat transfer medium which can be circulated through a system of small diameter tubing permeating the superconducting structure. The high-pressure helium is cooled by a heat exchanger immersed into a remotely located storage dewar containing boiling helium at atmospheric pressure: the helium loop also contains a circulating pump. The superconducting magnet is surrounded only by a single-wall vacuum jacket containing a radiation shield cooled by circulation of liquid nitrogen, this vacuum jacket is connected to the remote storage dewar. The system permits effective use of the total enthalpy during cool-down, and it achieves heat transfer which is stable with respect to local thermal perturbations; these 2 fundamental advantages are discussed. Two prototype systems are described and their schematic illustrations are given.

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Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

COVALENCY IN IRON-SERIES FLUORIDES (Abstract), by D. E. Ellis, A. J. Freeman, and R. E. Watson. [1965] [1]p. [AF 49(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 33, Jan. 27, 1965.

Investigations of the role of covalency in iron-series fluorides have been continued, using the cluster model as applied to $KNiF_3$. Previous work suggested 3 factors that needed to be understood: (1) the nature of the orbitals that yield an accurate cluster description, (2) the accuracy of evaluating matrix elements for a given 1-electron Hamiltonian, and (3) the definition and use of a rigorous 1-electron Hamiltonian. Although factor (1) is the most interesting physically and includes, for example, s-p hybridization, the role of the other 2 factors must be understood more completely first. It has been found that estimates of covalency are very sensitive to (2), particularly as regards the inclusion of multicenter integrals involving overlap densities. The present paper reports results of further investigations into factors (2) and (3). Particular emphasis in (3) is placed on including effects of the proper renormalization of the molecular orbitals, inclusion of metal-ligand overlap terms in the Hamiltonian and the role of self-consistency in the Hamiltonian. These are found to significantly affect the theoretical predictions of experimental quantities.

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Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

CROSSFIELD MAGNETOABSORPTION IN GALLIUM ARSENIDE (Abstract), by Q. H. F. Vrehen. [1965] [1]p. [AF 49(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10. 534, Apr. 26, 1965.

The oscillatory behavior of the interband optical absorption in a semiconductor in a magnetic field is changed in 2 respects by a transverse electric field. First, the photon energies at which transition occur shift to lower values and, secondly, the intensity of normally allowed transitions is reduced, whereas normally forbidden transitions now get a finite-transition probability. Experimentally, these effects were first studied in germanium with a modulation technique. Both allowed and forbidden transitions show up in the differential spectrum. Using this same technique, which is more sensitive for the detection of oscillations than a standard absorption measurement, the authors found magnetooscillations interband absorption in gallium arsenide at room temperature and in magnetic fields from 40 to 64 kOe. A preliminary analysis of the data yields for the reduced mass of the electron and hole involved in the transition a value of (0.04 ± 0.005) times the electron mass.

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Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

DISSIPATION IN TYPE II SUPERCONDUCTORS IN THE MIXED STATE IN ALTERNATING MAGNETIC FIELDS (Abstract), by E. Maxwell and W. P. Robbins. [1965] [1]p. [AF 49(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10. 359, Mar. 24, 1965.

The authors investigated the dissipative effects in some indium-bismuth alloys in the mixed state by observing the out-of-phase component χ'' of the ac magnetic susceptibility while the specimen was subjected to a continuously swept superimposed dc field. Observations were made at different sweep rates for a number of field amplitudes and frequencies. $\chi'' \cong 0$ below H_{c1}. At H_{c1} there is a local maximum in χ'' associated with the initial field penetration. Between H_{c1} and H_{c2}, there is a plateaulike region in which the dominant dissipative mechanism appears to be flux. At H_{c2}, there is a maximum in χ'' probably associated with hysteresis effects. Above H_{c2}, are some minor features that could be due to surface superconductivity. In the plateaulike region, χ'' is a function of $(dH\ dt)_{dc}$ which is consistent with a simple viscous-flow model in which the viscous resistance is large determined by the steady-flow velocity imposed by the swept dc field.

1723

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

FAR-INFRARED ANTIFERROMAGNETIC RESONANCE IN SINGLE-CRYSTAL COBALTOUS OXIDE (Abstract), by R. C. Milward. [1965] [1]p. [AF 49(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Nov. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 315, Mar. 24, 1965.

Using the technique of Fourier transform interferometry, one of a pair of degenerate modes of antiferromagnetic resonance, recently predicted by Tachiki to occur at frequencies of 192 and 554 cm^{-1} at 0 K, has been observed at 142.3—0.5 cm^{-1} near liquid-helium temperature, in 2 independently obtained CoO crystals. The true linewidth at half-absorption is estimated to be 3.5 cm^{-1}. At higher temperatures, the line broadens, being centered at 141—1 cm^{-1} at 80 K, with a half-width ~ 10 cm^{-1}, and is nonexistent at 295 K ($\sim T_N$). An external magnetic field of 42 kG applied parallel to a [100] axis and the direction of light propagation produces no observable shift in position of the resonance line at the lowest temperature, but causes the appearance of a satellite absorption peak at ~ 146.5 cm^{-1}. No explicit theory for the magnitude and magnetic-field dependence of such an effect has yet been formulated with which to compare the experimental findings. The far-infrared absorption spectrum of CoO shows 2 other broad absorption lines centered at about 167 and 188 cm^{-1}, which are existent both above and well below the Néel temperature.

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Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

FLUORINE-FREE-FLUX FOR GROWTH OF RARE EARTH GARNETS, by M. Schieber. [1965] 9p incl. illus. diagrs. table, refs. (Bound with its AFOSR-65-1917; AD 627224) [AF 49(638)1468] Unclassified

Published in Fifth Rare Earth Research Conf., Iowa State U., Ames, Aug. 30-Sept. 1, 1965, Book 4, p. 79-88.

A composition diagram which compares various mixtures used for growing rare earth garnets is described. The flux components of PbO-B_2O_3 or PbO-PbF_2 recommended for growth of either rare earth iron, gallium or aluminum garnets are expressed in terms of a pseudoternary diagram. The crystals discussed in this paper are $Eu_3Fe_5O_{12}$, $Eu_3Ga_5O_{12}$, $Tm_3Al_5O_{12}$.

$Tm_3Ga_5O_{12}$, $Yb_3Ga_5O_{12}$, and $Yb_3Fe_2Ga_3O_{12}$. The crystals are characterized by lattice constant, morphology, and in some cases, by magnetic susceptibility data. (Contractor's abstract)

1725

Massachusetts Inst. of Tech. [National Magnet Lab.] Cambridge.

HELICON-WAVE PROPAGATION IN n-TYPE InAs AT MICROWAVE FREQUENCIES (Abstract), by J. K. Furdyna. [1965] [1]p. [AF 49(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 545, Apr. 26, 1965.

Helicon-wave propagation was investigated in n-type InAs at 35 Gc/sec, in the temperature range from 78 to 300 K in magnetic fields up to 100 kG. A microwave analog of the Rayleigh refractometer was used in the measurements. This arrangement is in many ways superior to the Fabry-Perot dimensional resonance technique used in previous helicon experiments in this frequency range, particularly in the presence of considerable losses. Moreover, this approach permits a quantitative study of the helicon-damping processes. Interference patterns consisting of as many as 10 full oscillations between 40 and 100 kG were observed at temperatures as high as 300 K, allowing a precise determination of the electron concentration. In addition, the quantity $e/(m^* \langle \tau^{-1} \rangle)$ was obtained from the envelope of the interference pattern. The latter quantity is close to the known electron mobility, but shows a slight dependence on the magnetic field. This variation arises possibly due to the proximity of the quantum limit, which may render the semiclassical model used in the present analysis not fully satisfactory at the highest fields.

1726

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

INTERBAND TRANSITIONS IN PYROLYTIC GRAPHITE AT THE ZONE CORNER (Abstract), by J. G. Mavroides and M. S. Dresselhaus [1965] [1]p. [AF 49(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10. 109, Jan. 27, 1965

Using the magnetoreflection technique, interband transitions associated with the Brillouin-zone corner (point H) have been studied in pyrolytic graphite in the photon-energy range $0.06 < \hbar\omega < 0.50$ ev, using magnetic fields up to 110 kG. Oscillations of relatively strong intensity in the magnetoreflection are identified with allowed transitions between the lowest 6 magnetic-energy levels for each of the doubly degenerate energy bands at point H. An analysis of these transitions on the basis of the Slonczewski-Weiss band model gives accurate values for 2 band parameters, $\gamma_0 = 3.18 \pm 0.02$ and $|\Delta| = 0.009 \pm 0.003$ ev. With these band parameters and $E_F = 0.019$ ev, a value of $(3.7 \pm 0.6)\ 10^{11}$ cm^{-2} is obtained for the cross-sectional area of the Fermi surface at the plane $k_z = \pi/c_0$. In addition to these relatively strong oscillations, 4 weaker forbidden interband transitions are observed and correspond to the selection rule $\Delta_n = 0$.

1727

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

MAGNETIC ANISOTROPY IN ANTIFERROMAGNETIC α-$(Cr_{1-f}Al_f)_2O_3$, by J. O. Artman, J. C. Murphy, and S. Foner. [1965] [2]p. incl. diagrs. refs. [AF 49(638)-1468] Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 16-19, 1964.

Published in Jour. Appl. Phys., v 36: 986-987, Mar. 1965.

In antiferromagnetic crystals the results of AFMR when combined with other data, yield the anisotropy K. By subtracting the magnetic dipolar anisotropy (K_{MD}) from K, the fine structure anisotropy K_{FS} is found. For Cr_2O_3, the K_{MD} computation of Tachiki and Nagamiya, 0.059 cm^{-1}/ion, had been accepted as a basis for further analyses. However, in the course of computing K_{MD} by modern machine methods for various sesquioxide antiferromagnets, this value has been found to be inappropriate. The Shull magnetic structure (c) to which Cr_2O_3 belongs is one in which the magnetic geometry effectively is almost cubic. The computed K_{MD} value thus is sensitive to small changes in lattice geometry. Presently accepted room-temperature crystal parameters yield $K_{MD} = 0.0088$ cm^{-1}/ion, 1/6 the former result; consequently Cr_2O_3 AFMR data have been reanalyzed. The temperature behavior of K_{FS} and K_{MD} in pure Cr_2O_3 and in $(Cr_{1-f}Al_f)_2O_3$ crystals is discussed. Similar K_{MD} calculations have been made for the Ti, V, and Fe sesquioxides. In the case of α-Fe_2O_3 a prediction has been made, with the use of AFMR data, the spin-flip near 263 K. The experimentally found decrease of this spin-flip temperature with increasing f in the $\alpha(Fe_{1-f}Al_f)_2O_3$ system is discussed in the light of existing information. (Contractor's abstract)

1728

Massachusetts Inst. of Tech. National Magnet Lab , Cambridge.

MEASUREMENT OF THE ABSOLUTE VALUE OF THE PENETRATION DEPTH USING FLUX QUANTIZATION, by R Moservey. [1965] [4]p. incl. diagrs. [AF 49-(638)-1468] Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v LT9 (Pt. A)· 455-458, 1965.

The aim of the study is to develop a precise and absolute measurement of the penetration depth λ and the flux quantum in superconductors A rectangular loop consisting of 2 superconducting plates is separated by an insulating layer of thickness δ and shorted at the edges by 2 thin superconducting links. The loop is part of an external circuit fed from a current source. If 1 flux quantum Φ_0 is added to the flux inside this rectangular loop, the relation $\Phi_0 = \mu \cdot \Delta H \cdot W[\delta + 2\lambda]$ is attained where μ is the permeability, ΔH is the change in the field inside the insulator between successive units of flux, δ is the insulator thickness, and W is the width of the loop. Assuming that μ 1 and $\Phi_0 = hc/2e$, one can obtain λ from a measurement of ΔH, δ, and W. For Al_2O_3 insulating layers about 50A thick, $d = \lambda/10$, so that a relatively inaccurate value of $\delta(\pm 20\%)$ leads to an error in λ of only 1%. In the present measurements it was found that, at a current slightly above where resistance first appeared, the voltage across the shorting links was periodic with magnetic field, it was this effect which was measured and not the periodicity in the critical current. The method appears to give good results for the penetration depth, but leads to an apparent temperature dependence of the flux quantum.

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Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

OPTICAL ABSORPTION IN GERMANIUM IN HIGH ELECTRIC AND MAGNETIC FIELDS (Abstract), by Q. H. F. Vrehen and A. Frova. [1965] [1]p. [AF 49-(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 343, Mar. 24, 1965.

A sensitive method for measuring the change in the optical absorption in a semiconductor, due to the presence of a high electric field, was developed by Frova and Handler. This technique was used to measure the electric-field-induced absorption in germanium in the presence of a high magnetic field for photon energies just below the direct gap-band edge. Electric fields up to 7×10^4 v/cm and magnetic fields up to 62 kG in the longitudinal configuration and up to 95 kG in the transverse configuration were used. In what follows, absorption stands for the difference in absorption coefficient with and without the electric field. In the longitudinal configuration, then, the main effect of the magnetic field is to shift the absorption curve to slightly higher photon energies. In the crossed-field configuration, the shape of the absorption curve changes markedly. For photon energies near the gap, the absorption increases over that in the case without a magnetic field; for lower energies, there is a strong decrease in the absorption as compared to the zero magnetic-field case

1730

[Massachusetts Inst. of Tech. National Magnet Lab., Cambridge]

OSCILLATORY FARADAY ROTATION OF THE INDIRECT TRANSITION IN GERMANIUM (Abstract), by J. Halpern. [1965] [1]p. [AF 49(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 545, Apr. 26, 1965.

The oscillatory Faraday rotation of the indirect transition in germanium has been observed on transmission. The experiments were carried out at magnetic fields of up to 103 kG and at helium temperatures on a heat-sunk sample. From the position of the indirect energy gap, the temperature was determined as 8 K. The sample was intrinsic, with a carrier concentration $n < 10^{13}/cm^3$. The data were taken with the direction of propagation (and the magnetic field) perpendicular to a (110) face. Comparison of the Faraday rotation with the corresponding transmission as a function of wavelength shows that there are oscillatory curves corresponding to both the exciton absorption and to the Landau steps. The entire indirect transition rotation is superposed on a very large dispersive tail that probably arises from the $\Gamma_{25'} \rightarrow \Gamma_{2'}$ direct-energy-gap transition. At the temperatures and magnetic fields in question, the oscillatory effects are of the order of 2% of the total rotation.

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Massachusetts Inst. of Tech. [National Magnet Lab.] Cambridge.

SOUND PROPAGATION IN ^{4}He NEAR THE CRITICAL POINT (Abstract), by R. C. Williamson and C. E. Chase. [1965] [1]p. (Sponsored jointly by Advanced Research Projects Agency, and Air Force Office of Scientific Research under [AF 49(638)1468])

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 532, Apr. 26, 1965.

Recent measurements of the velocity of 1-mc/sec sound in ^{4}He close to the critical point have been extended to include several isotherms both above and below T_c. Measurements at 4.5° and 5°K can be combined with direct measurements of density and isothermal compressibility to yield the specific-heat ratio γ. The authors have also recalcalculated the adiabatic compressibility along the critical isobar and isotherm using an improved empirical equation of state, previously reported results in the liquidlike phase ($P > P_c$ or $T < T_c$) are only slightly affected, but the compressibility in the gaslike phase is appreciably changed.

1732

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

SUPERFLUID BEHAVIOR IN A VENTURI TUBE (Abstract), by R. Meservey. [1965] [1]p. [AF 49(638)-1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 532-533, Apr. 26, 1965.

In a venturi tube, the level difference in the standpipes is commonly used to measure the velocity of water flowing in a pipe. It has been suggested that the venturi tube would be useful in measuring the flow velocity of a persistent current of superfluid helium. However, for irrotational flow it is easily shown that there is almost no level difference for reasonably long standpipes. A quantitative solution of the problem is given and its application to superfluid helium and superconductors is discussed.

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Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

ULTRASONIC ATTENUATION IN Nb-20% Ti AND Nb-40% Ti ALLOYS TO 150 kG (Abstract), by Y. Shapira and L. J. Neuringer. [1965] [1]p. [AF 49(638)1468] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 359, Mar. 24, 1965.

The attenuation of 10-mc/sec ultrasonic shear waves propagated in Nb-20% Ti and Nb-40% Ti alloys (nominal composition, weight percent) was measured in a parallel dc magnetic field up to 150 kG. The measurements were performed between 1.4 and 8 K. A dip in the attenuation was observed at high magnetic fields. The field at which this dip occurs was determined as a function of the temperature. At 1.5°K, this dip appears at 90 kG for Nb-20% Ti, and at 132 kG for Nb-40% Ti. These fields are close to those at which the onset of resistivity occurs in alloys of similar composition. The magnitude of the dip at 4.2°K is ~ 0.15 db/cm for Nb-20% Ti and ~ 0.25 db/cm for Nb-40% Ti. The dip in the absorption coefficient in shape from the absorption edge that was found at the upper critical field of Nb-25% Zr.

1734

Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

ULTRASONIC PROPAGATION NEAR THE CRITICAL POINT IN HELIUM, by C. E. Chase and R. C. Williamson. [1965] [4]p. incl. diagrs. refs. (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under [AF 49(638)1468] Unclassified

Published in Proc. Ninth Internat'l Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. A): 657-660, 1965.

A logarithmic singularity in the specific heat at constant volume at the critical point has been reported to occur in argon (Bagatskii, M. I., Voronel, A. V., and Gusak, V. G., Soviet Phys., v. 16: 517, 1963) and oxygen (Voronel, A. V., Chaskin, Y. R. and others, Soviet Phys., v. 18: 598, 1964). Such a result is in direct contradiction to standard theory, according to which constant volume must remain finite at the critical point. It can readily be shown that these results imply the existence of a corresponding singularity in the adiabatic compressibility, accompanied by a zero in the sound velocity and large absorption. Accordingly, a study was undertaken of the sound velocity at 1 mcps in the critical region of helium. Results on the ultrasonic velocity and absorption and on the adiabatic compressibility are consistent with the presence of a logarithmic singularity in the specific heat at constant volume.

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Massachusetts Inst. of Tech. National Magnet Lab., Cambridge.

ANISOTROPY OF THE DE HAAS-VAN ALPHEN EFFECT IN PYROLYTIC GRAPHITE (Abstract), by S. J. Williamson, S. Foner, and M. S. Dresselhaus. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [AF 49(638)1468], Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 109-110, Jan. 27, 1965.

Measurements of de Haas-van Alphen frequencies have been made as a function of the angle θ between the

applied field B_0 and the c axis in pyrolytic graphite. The audiofrequency field-modulation technique with synchronous detection at the fundamental and higher harmonics was used to monitor the differential susceptibility at temperatures between 4.2° and 1.2°K. Majority-carrier oscillations were observed for θ as large as 80°, and the results are qualitatively the same as obtained by Shubnikov-de Haas measurements on natural single-crystal graphite by Soule, McClure, and Smith. However, despite close agreement for $\theta = 0$, quantitative differences are evident for larger values of θ. The anisotropy also yields information about interlayer order.

1736

Massachusetts Inst. of Tech. Research Lab. of Elec Electronics, Cambridge.

THE REAL-TIME SORTING OF NEURO-ELECTRIC ACTION POTENTIALS IN MULTIPLE UNIT STUDIES, by W. Simon. [1965] [4]p. incl. illus. (AFOSR-65-0904) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 613088 Unclassified

Also published in Electroencephalog. and Clin. Neurophysiol. Jour., v. 18: 192-195, Feb. 1965.

Measurements from clusters of nerve cells provide clues to the functional relationships of cells in the central nervous system. Action potentials from individual cells are distinguished from each other by waveform, of which there are several clearly defined groups. A description is given for a method by which action potentials recorded simultaneously can be sorted in a moderate-size computer in real-time and on-line.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PENETRATION OF AN ION THROUGH A MONOLAYER OF SIMILAR IONS ADSORBED ON A METAL, by J. W. Gadzuk and E. N. Carabateas. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-0905) (Sponsored jointly by Air Force Aeronautical Systems Division, Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 613113 Unclassified

Also published in Jour. Appl. Phys., v. 36 357-360, Feb. 1965.

A fractional monolayer film of ions is formed by the adsorption of a gas onto a metal substrate. These ions form a discrete dipole layer, the potential across it being the change in electron work function of the surface. As additional ions are brought to the surface, they penetrate only a fraction f of the potential across the dipole layer. In this work the penetration coefficient f valid for the entire range of coverages is derived for 2 limiting types of films, immobile and mobile. By considering thermal effects, a penetration coefficient for partially mobile films is also derived. The values obtained for the penetration coefficient are applicable to any substrate-adsorbate system The theoretical expressions for the penetration coefficient are evaluated for cesium on tungsten and compared with the data of Taylor and Langmuir. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

INTERPRETATION OF THE ANOMALOUS SURFACE REFLECTION OF X-RAYS, by B. E. Warren and J. S. Clarke. [1965] [2]p. incl. diagrs. (AFOSR-65-0906) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 613112 Unclassified

Also published in Jour. Appl. Phys., v. 36: 324-325, Jan. 1965.

When an x-ray beam falls upon a polished surface at an angle greater than the critical angle θ_c, there is besides the normal reflected beam an abnormal beam at a smaller angle with the surface. The abnormal beam makes an angle with the surface which is close to the critical angle θ_c. It is proposed that this abnormal beam is caused by scattering of the primary beam at close distances to the surface. The scattered radiation will be strongly reflected if its angle of incidence is slightly less than θ_c. This proposal is analyzed, and the identification of the scatterer is partially discussed

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Massachusetts Inst. of Tech Research Lab. of Electronics, Cambridge.

NEGATIVE-ENERGY PLASMA WAVES AND INSTABILITIES AT CYCLOTRON HARMONICS, by A. Bers and S. Gruber. [1965] [2]p. incl diagrs. refs. (AFOSR-65-1144) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) Unclassified

Also published in Appl. Phys. Ltrs., v. 6: 27-28, Jan. 15, 1965.

Electrostatic plasma waves are studied which are associated with an unperturbed particle distribution function of the form, $f_0(v) = \delta(v_\perp - v_{0\perp})\delta(v_\parallel - v_{0\parallel})/2\pi v_{0\perp}$. An important characteristic of these negative waves is that they exist for small densities ($\omega_p \ll \omega_c$). Hence a plasma which contains even a small fraction of its particles in the form above may exhibit instabilities at cyclotron harmonics. The dispersion plots for stable waves with the above form are given. It is determined

which of these are negative energy waves and then shown that these lead to instabilities in the presence of a dispersive medium.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OPTIMUM QUANTIZATION, by J. D. Bruce. Mar. 1, 1965, 65p. incl. diagrs. table, refs. (Technical rept. no. 429) (AFOSR-65-1145) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 461646
Unclassified

The exact expression for the quantization error as a function of the parameters defining the quantizer, the error-weighting function, and the amplitude probability density of the quantizer-input signal is presented. An algorithm is developed that permits the determination of the specific values of the quantizer parameters that define the optimum quantizer. This algorithm is then extended so that optimum quantizers can be determined for the case in which the quantizer-input signal is a message signal contaminated by noise. In each of these cases the algorithm is based on a modified form of dynamic programming and is valid for both convex and nonconvex error-weighting functions. Examples of optimum quantizers designed with the first of these 2 algorithms for a representative speech sample are presented. The performance of these optimum quantizers is compared with that of the uniform quantizers.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HYPERFINE STRUCTURE OF Hg^{193*}, Hg^{195}, AND Hg^{195*} BY ZEEMAN-LEVEL CROSSINGS, by W. W. Smith. [1965] [10]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1146) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E)) AD 612529
Unclassified

Also published in Phys. Rev., v. 137: A330-A339, Jan. 18, 1965.

Hyperfine-structure measurements by optical detection of Zeeman-level crossings in the $6s6p\,^3P_1$ state were made with natural-linewidth precision in 3 radioactive isotopes of mercury. The magnetic dipole (A) and electric quadrupole (B) interaction constants in mc/sec implied by these measurements are: Hg^{195} (9.5-h half-life) $A(^3P_1) = 15813.46 \pm 0.23$, Hg^{195*} (isomer, 40 h) $A(^3P_1)$ -2368.04 ± 0.08, $B(^3P_1)$ -782.45 ± 0.86, Hg^{193*} (isomer, 11 h) $A(^3P_1) = -2399.69 \pm 0.06$, $B(^3P_1)$ 724.8 ± 90.0. The g_J factor for the $^3P_1$ state of Hg^{199} is obtained from a new level-crossing measurement. The value, including second-order Zeeman and Zeeman-hyperfine corrections, is $g_J' = 1.486118 \pm 0.000016$. The Bohr-Weisskopf hfs anomaly is also found and calculated to be $^{195}\Delta^{199}(^3P_1) = 0.1476$ (76%). The contribution to the anomaly from the $S_{1/2}$ electron is extracted and used to estimate admixture coefficients in the single-particle model of the nucleus with configuration mixing.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SUPERPOSITION IN A CLASS OF NONLINEAR SYSTEMS, by A. V. Oppenheim. Mar. 31, 1965, 62p. incl. diagrs. refs. (Technical rept. no. 432) (AFOSR-65-1147) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 614483
Unclassified

Many nonlinear systems can be interpreted as linear transformations between vector spaces under appropriate definitions for the vector operations on the inputs and outputs. The class of systems which can be represented in this way, is discussed here. This class, referred to as the class of homomorphic systems, is shown to include all invertible systems. Necessary and sufficient conditions on a noninvertible system such that it is a homomorphic system, are derived. A canonic representation of homomorphic systems is presented. This representation consists of a cascade of 3 systems, the first and last of which are determined only by the vector space of inputs and the vector space of outputs, respectively. The second system in the canonic representation is a linear system. Necessary and sufficient conditions are presented under which all of the memory in the system can be concentrated in the linear portion of the canonic representation. A means for classifying homomorphic systems, suggested by the canonic representation, is discussed. This means of classification offers the advantage that systems within a class differ only in the linear portion of the canonic representation. Applications of the theory are considered for a class of nonlinear feedback systems. (Contractor's abstract)

1743

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NONEQUILIBRIUM ELECTRIC CONDUCTIVITY OF TWO-PHASE METAL VAPORS, by A. W. Rowe and J. L. Kerrebrock. 1965 [2]p. incl. diagrs. (AFOSR-65-1220) (Sponsored jointly by Aeronautical Systems Division, and Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 616162
Unclassified

Also published in AIAA Jour., v. 3: 361-362, 1965.

Rankine cycle nuclear-electric power systems, using alkali metal working fluids and MHD generators in place of turbines, show promise of producing considerably high power per unit of system mass. Attainment of adequate electric conductivity in the alkali metals at temperatures accessible to reactors is a major problem. An approximate theory of wet nonequilibrium gas has been developed: This theory was tested by comparison with experiments conducted in a high-temperature potassium loop. It is concluded that: (1) nonequilibrium ionization is difficult to attain in alkali metal MHD generators with wet vapor unless droplet growth is stimulated; (2) electrical techniques may be useful for study of droplet nucleation and growth, and (3) the successful operation of the high-temperature loop is an indication that alkali-metal systems might be operable at higher temperatures than are now proposed.

1744

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ADJUSTABLE RUBY INTENSITY STANDARD FOR ESR SPECTRA, by D. S. Thompson and J. S. Waugh. [1965] [1]p. incl. diagr. (AFOSR-65-1221) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Institutes of Health) AD 615847 Unclassified

Also published in Rev. Scient. Instr., v. 36: 552, Apr. 1965.

A description is presented on an adjustable ruby standard against which intensity comparisons can be made in electron spin resonance spectra. Its adjustability consists in (1) rotation of the ruby trigonal axis with respect to the magnetic field, by means of which a ruby resonance can be placed near, but not overlapping, any resonance of interest in the range of 1000-7000 G at X band; and (2) translation through the cavity wall, by means of which the effective number of spins experiencing the microwave field can be varied from 0 to about 10^{17} spins with a 0.05% Cr^{+++} ruby.

1745

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MAGNETIC FIELD OF NON-CYLINDRICAL COILS, by W. J. C. Grant and M. W. P. Strandberg. [1965] [4]p. incl. diagrs. table. (AFOSR-65-1222) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 616831 Unclassified

Also published in Rev. Scient. Instr., v. 36: 343-346, Mar. 1965.

An exact calculation is presented for the magnetic field produced by a pair of rectangular coils. The calculation is not based on approximation tailored for the central region of the configuration. For current sheets of rectangular cross section, a closed analytical expression for the fields is obtained which is exactly valid for all points on the principal coordinate planes and for all possible combinations of coil parameters. The calculation is extended to sources of arbitrary thickness by numerical integration. Detailed numerical application is made to the calculation of field homogeneity in the central region of the configuration.

1746

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ANTIFERROMAGNETIC RESONANCE LINEWIDTH IN MnF_2 NEAR THE TRANSITION TEMPERATURE, by J. C. Burgiel and M. W. P. Strandberg. [1965] [11]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 616092 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 865-875, 1965.

The antiferromagnetic resonance (AFMR) linewidth of MnF_2 is studied near the Néel temperature. In the presence of an applied magnetic field, the linewidth diverges approximately as $|T - T_N|^{-5/6}$. In the absence of an applied field, the line-width is larger and diverges approximately $|T - T_N|^{-4/3}$. The linewidth is independent of the direction of the magnetic field and is the same for both branches of the AFMR spectrum. Though qualitative attempts to explain the temperature dependence both in the presence and absence of an applied magnetic field are made, a detailed theoretical explanation is still lacking. Above T_N, the electron paramagnetic resonance (EPR) in MnF_2 is observed. For H parallel to c at temperatures near T_N, the linewidth increases approximately as $|T - T_N|^{-3/8}$. A smaller increase occurs for H perpendicular to c.

1747

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE POWER DENSITY SPECTRUM OF TELEVISION RANDOM NOISE, by T. S. Huang. 1965 [5]p. incl. diagrs. (AFOSR-65-1462) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 617650 Unclassified

Also published in Appl. Opt., v. 4: 597-601, May 1965.

The 2-dimensional power density spectrum of television random noise is derived in terms of the

1-dimensional spectrum of the noise considered as a time function. Assuming the scanning lines to be infinitely thin, the 2-dimensional power density spectrum $S^*(u, v)$ is found to consist of an infinite number of identical parallel impulse sheets which are translations of each other along the vertical direction. The shape of each impulse sheet is identical to that of the 1-dimensional power density spectrum of the noise considered as a time function. A comparison is made of the subjective effect of noise from the 1-dimensional and 2-dimensional points of view

1748

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PLASMA ROTATION IN A HOLLOW CATHODE DISCHARGE, by D. L. Morse. [1965] [6]p. incl. illus. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) Unclassified

Also published in Phys. Fluids, v. 8: 516-521, Mar. 1965.

Langmuir probe measurements of the external plasma generated by a hollow-catnode discharge, operated in argon, indicate the presence of a flutelike density perturbation, or wave of plasma, rotating with a left-handed sense about the magnetic field. The velocity of rotation is found to be closely related to the Hall drift speed of particles in the measured outward radial electric and axial magnetic fields. Azimuthal electric fields are found whose net effect is to increase the outward radial transport of plasma across the magnetic field. A discussion of this phenomenon in terms of a previously described theory is given.

1749

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MEASUREMENT OF THE KERNELS OF A NON-LINEAR SYSTEM OF FINITE ORDER, by M. Schetzen. [1965] [13]p. incl. diagrs. (AFOSR-65-1464) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), Office of Naval Research under DA 36 039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) Unclassified

Also published in Internat'l. Jour. Control, v. 1: 251-263 Mar. 1965.

A method of measuring the Volterra kernels of a finite-order nonlinear system is presented. The kernels are obtained individually as a multidimensional impulse response. The multidimensional kernel transforms also can be obtained by the method described. As an extension a technique of obtaining the Volterra kernels from a multidimensional step response is presented. This technique is useful for nonlinear systems which can be considered to be of given finite order for only a limited range of input amplitudes. (Contractor's abstract)

1750

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MAXIMUM CUTOFF FREQUENCY OF VARACTOR DIODES, by P. Penfield, Jr. [1965] [2]p. incl. diagr. (AFOSR-65-1465) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) Unclassified

Also published in Proc. IEEE, v. 53: 422-423, Apr. 1965.

The maximum cutoff frequency of varying-resistance varactors is calculated by applying the formulas for constant resistance, using the average series resistance $R_{max}/2$. The derived cutoff frequency is $1/\pi \epsilon \rho$, and it is found to be independent of the dimensional geometry of the varactor.

1751

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THOMSON SCATTERING COMPUTATIONS FOR LABORATORY PLASMAS, by E. T. Gerry and R. M. Patrick. [1965] [3]p. incl. diagrs. (AFOSR-65-1466) (In cooperation with Avco Corp., Everett, Mass., under AF 49(638)1129) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under DA 36-039-AMC-03200(E), Atomic Energy Commission and National Science Foundation) Unclassified

The Salpeter theory is applied to calculation of the Thomson scattering of a laser beam from typical laboratory plasmas. It is proposed to use this scattering as as means of determining the properties of plasma. The character of the scattered spectrum depends upon the ratio of the Debye length to the length in the plasma over which the scattered radiation adds coherently. The inverse of this ratio, α, depends only on the plasma temperature and the electron density.

1752

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELECTRODYNAMICS OF MOVING MEDIA by P. Penfield, Jr. and H. A. Haus 1965 [1]p. (AFOSR-65-1467) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 617649 Unclassified

Also published in proc. IEEE, v. 53 422, Ap. 1965

A critical analysis is presented of P. M. Brown's comments (Proc. IEEE, v. 52: 1362-1363, Nov. 1964) on a study of electrodynamics of moving medi. by Tai (Proc. IEEE, v. 52: 685-689, June 1964). The present note supports the view that all formulations of electromagnetism of moving media lead to the same predictions of mechanical, as well as electromagnetic measurements; the choice is purely aesthetic.

1753

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CAUSATIVE FORMS IN JAPANESE, by S.-Y. Kuroda. [1965] [21]p. (AFOSR-65-1468) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E), National Institutes of Health, and National Science Foundation) Unclassified

Also published in Foundation of Language, Dordrecht (Netherlands), D. Reidel, v. 1: 30-50, 1965.

Clarification is made of some of the syntactic formalisms involved in causative formation by means of the morpheme sase, a causative auxiliary, which serves to derive causative sentences from simple ones. Six transformations are introduced and clarified in the grammar: intransitivization; ni- and o-causitivizations; recurring-object deletion; o-adjustment; and implicit understanding. A conspicuous result of this study is that what is revealed in English as a generative-grammatical feature, namely the category of pseudo-intransitive verbs, in a sense, also reflects itself as a generative-grammatical feature in Japanese, although on the whole it seems of a very different structure. This supports the view that generative-grammatical features might also be, not arbitrary features possessed by particular languages by chance, but well-rooted in the essential structure of human behavior.

1754

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ASPECTS OF THE THEORY OF SYNTAX, by N. Chomsky. Cambridge, Massachusetts Inst. of Tech. Press, 1965, 251p. incl. diagrs. refs. (Special technical rept. no. 11) (AFOSR-65-1570) (Sponsored jointly by Air Force Electronic Systems Division; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 616323 Unclassified

Generative grammar is a finite set of rules which enumerate an infinitely large number of grammatical sentences in a language. It is an approach to linguistic theory and to the structure of particular languages. The development of generative grammar is reviewed and a reformulation of its theory is proposed. Emphasis is placed on syntax. Semantic and phonological aspects are considered only when they apply to syntax. Background of the theory is discussed, essential points are summarized and clarified, defects in earlier versions of the theory are considered, and residual problems are raised and discussed briefly.

1755

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE EVOKED VOCAL RESPONSE OF THE BULLFROG: A STUDY OF COMMUNICATION BY SOUND, by R. R. Capranica. Cambridge, Massachusetts Inst. of Tech. Press. [1965] [110]p. incl. illus. diagrs. tables, refs. (Special technical rept. no. 12; Research monograph no. 33) (AFOSR-65-2224) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 623315 Unclassified

The research attempts to bridge the existing gap between the naturalistic observations of sound communication in anurans and the anatomical and physiological findings in their auditory nervous system. The motivation for this research concerns the author's interest in the neural representation of complex meaningful sounds - stimuli for which the nervous system is presumably designed to process. Such a representation, although suggested by electrophysiological recordings of patterns of activity in various neural centers, requires a behavioral confirmation that these, in fact, are the principles by which information is processed within the intact animal. To this end, vocal behavior has been evoked from the males of laboratory colonies of bullfrogs (Rana catabeiana) in response to a restricted class of natural and synthetic sounds. The evoked vocal responses, having the signal characteristics of the bullfrog's mating call, were highly selective. To playbacks of the mating calls of 34 different species of frogs and toads, only the mating calls of certain male bullfrogs would evoke calling from the laboratory animals. By employing a standardized experimental technique, quantitative measures of evoked calling have been obtained for a large number of synthesized bullfrog mating calls.

1756

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

RESPONSES OF SINGLE DORSAL CORD CELLS TO PERIPHERAL CUTANEOUS UNMYELINATED FIBRES, by L. M. Mendell and P. D. Wall. [1965] [3]p. incl. diagrs. (AFOSR-65-2417) (Sponsored jointly by Air Force Aeronautical Systems Division; Air Force Office of Scientific Research under AF AFOSR-64-591, [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), Bell Telephone Laboratories,

Inc., National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, and Teagle Foundation, Inc.) AD 618000
Unclassified

Also published in Nature, v. 206: 97-99, Apr. 3, 1965.

An investigation of the response of cells in the dorsolateral tract of the cat to C fibers was carried out. The fundamentally different effects of A and C stimulation on the dorsolateral column (DLC) cells are emphasized. The A fibers, after a short intense burst, turn the cell off, which is probably the result of the negative feedback exerted by the A's on themselves as seen by the negative dorsal root potential. The C fibers, on the other hand, turn the postsynaptic cell on after the repetitive discharge, which may be the effect of the positive feedback of the C's on the A's as seen by the positive dorsal root potential. It is evident from these results that both A and C fibers converge on many of the dorsal horn cutaneous cells. Furthermore, the C fibers produce a disproportionately large delayed discharge. There are prolonged inhibitory and excitatory effects after the arrival of mixed volleys. Therefore, the overall pattern will depend on the balance between the numbers of myelinated and unmyelinated fibers carrying the afferent volley.

1757

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE FORCE DENSITY IN POLARIZABLE AND MAGNETIZABLE FLUIDS, by L. J. Chu, H. A. Haus, and P. Penfield, Jr. June 1, 1965, 39p. incl. diagrs. refs. (Technical rept. no. 433) (AFOSR-65-2275) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 617109
Unclassified

The force density in polarizable and magnetizable fluids in nonuniform motion is evaluated in a way that is consistent with the special theory of relativity. The derivation is based on a generalization of the principle of virtual work. For application of the principle, it is necessary to know the energy density and power-flow density in a local rest frame of the fluid element under consideration. These are obtained from thermodynamic information and an extrapolation of the Poynting theorem applied to a rigid, nondeforming medium. Two different formulations of electrodynamics of moving and deforming media are compared. It is shown that they lead to the same force density if the same thermodynamic information is used in each of them. A simple model for the force density is obtained, starting from the E-H formulation.

1758

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE LOGICAL STRUCTURE OF MIND. AN INQUIRY INTO THE PHILOSOPHICAL FOUNDATION OF PSYCHOLOGY AND PSYCHIATRY, by E. von Domarus and W. S. McCulloch. [1965] 62p. (AFOSR-65-2277) (Sponsored jointly by Air Force Aeronautical Systems Division; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 616334
Unclassified

The history of both physics and mathematics shows that the only escape from an antiquated metaphysic is into the metaphysic subsumed by the systematic context of the symbols requisite to convey experience in its achieved distinction. In the so-called mental sciences, the necessity of this process becomes obtrusive. Chapter one of this paper is the description of it as obvious in psychology; chapter two, of its subtle appearance culminating in explicit formulation in physics. These chapters are intended to provide the systematic context for the symbols Mind and Matter. The notions intended are conjugate abstrate analyzing all entities concrete in experience. They are such that, on account of the giveness of fact, neither can be supposed without the other. Chapter three relates these notions so as to formulate, symbolically, 'Minding' and 'Mattering' as exhibited in the development of propositionalizing issuing in the logical structure of mind. This thesis of von Domarus which sets forth the notions needed for an understanding of psychology, psychiatry, and finite automata has been translated into English by McCulloch, who has added a 3 page introduction to it entitled AEKTON.

1759

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THERMAL AND CHEMICAL ASPECTS OF THE THERMONUCLEAR BLANKET PROBLEM, by W. G. Homeyer. July 29, 1965, 114p. incl. diagrs. tables, refs. (Technical rept. no. 435) (AFOSR-65-2278) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) AD 619669 Unclassified

A theoretical study was made of the blanket that must surround a thermonuclear plasma to provide energy conversion and removal, neutron and γ-ray shielding, and regeneration of the tritium burned in the D-T reaction. Power distributions and heat transfer were calculated and materials problems analyzed for blanket assemblies that A. J. Impink, Jr. has shown are capable of tritium regeneration. The blanket arrangement chosen as a model consisted of a molybdenum vacuum wall in the form of a long cylindrical shell, cooled by fused Li_2BeF_4 and surrounded by an annulus, 55 cm thick, consisting of fused Li_2BeF_4 and graphite to channel the flow of coolant. Nuclear heating was calculated on a digital computer for neutron flux distributions calculated by Impink. In vacuum walls of 1, 2, and 3 cm of molybdenum, 16, 25, and 31%, respectively, of the D-T neutron energy are absorbed. The total heat liberated in the inner blanket is 17.5 mev per fusion. The absorption of secondary γ rays accounts for half of the total heating and almost all of the heating of the vacuum

wall. Heat transfer and thermal stress limit the thermonuclear power to 400-500 w/sq cm of neutron energy incident on the molybdenum first wall, which is 2 cm thick. A total blanket thickness of approximately 120 cm will reduce the power loss caused by nuclear heating in the magnet of 2% of the total power. (Contractor's abstract, modified)

1760

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FUSION REACTOR BLANKET EXPERIMENT, by P. S. Spangler. July 13, 1965, 173p. incl. illus. diagrs. tables, refs. (Technical rept. no. 437) (AFOSR-65-2279) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E 03200(E), and National Science Foundation) AD 619671 Unclassified

The behavior of 1-14 mev neutrons was measured in cylinders, 46 cm in diameter and 38 cm thick, to evaluate previous theoretical calculations on neutron economy and tritium production in proposed fusion reactor blankets. The cylinders were constructed from 0.5-in. graphite slabs and 1-in. layers of solid lithium-beryllium fluoride salt encased in aluminum pans. The neutron spectrum was measured with a series of threshold detectors: U-238 (n,f), P-31 (n,p), Fe-56 (n,p), I-127 (n,2n), and F-19 (n, 2n). The spectra in the graphite assemblies are characterized by a sharp peak near 14 mev, with a smaller, broader peak at 3 mev. Farther from the source, the 14-mev peak is attenuated more than the 3-mev peak. Adding 3-cm Mo to the base of the assembly shifts the 3-mev peak to lower energies and increases its size at the expense of the 14 mev peak, because of the Mo-92 (n, 2n) reaction. Addition of the lithium-beryllium fluoride has no effect, because of the similarity in the scattering properties of the salt and the graphite. The removal of neutrons through the Li-6 (n,t) reaction was not observed, because of the small size of the assembly and the low (1-3% isotopic content of Li-6 in the salt. Preliminary measurements indicate the feasibility of directly measuring the tritium produced in the assemblies by the Li-6 (n,t) and Li-7 (n,tn) reactions. (Contractor's abstract)

1761

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STUDY OF A THERMONUCLEAR REACTOR BLANKET WITH FISSILE NUCLIDES, by L. N. Lontai. July 6, 1965, 101p. incl. diagrs. tables, refs. (Technical rept. no. 436) (AFOSR-65-2280) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) AD 619670 Unclassified

The use of fissile nuclides in a fusion power reactor heat-extraction blanket is investigated from the point of view of tritium regeneration and power production. The existence of a stable, steady-state D-T plasma in a cylindrical configuration is postulated. Nuclear reaction rates are analyzed with the aid of theoretical methods and multigroup, multiregion computer codes developed by A. J. Impink, Jr. Codes developed by W. G. Homeyer have been used to calculate nuclear heating rates. Optimization studies of several blanket configurations show that a blanket with a thin Mo first wall, a narrow, fused $(LiF)_2BeF_2$ first-wall coolant region, and ~50 cm 21%C and 79% fused (LiF-BeF_2-UF_4) primary attenuator region with 17 to 27 mole per cent $(U^{238})F_4$ and ~50% Li^6 enrichment is feasible and practical. The calculated tritium regeneration is adequate. The total heat recovery is approximately twice that in a nonfissile blanket; approximately 90% of the heat is liberated in the primary attenuator region. The heating rate in the first wall and in the coolant region is independent of the UF_4 salt composition. The thermonuclear power limit is ~5 mw/m^2 of neutron energy incident on the first wall. The performance of blankets with a UF_4 fused-salt coolant region has been found to be marginal; fissioning metallic first-wall configurations are not feasible. (Contractor's abstract)

1762

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

GAMMA-RAY SPECTRA IN FUSION BLANKET MOCK-UPS, by L. M. Petrie Jr. July 20, 1965, 106p. incl. illus. diagrs. tables, refs. (Technical rept. no. 438) (AFOSR-65-2281) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) AD 619672 Unclassified

Gamma-ray spectra have been measured in cylinders, 18 in. in diameter and 15-16 in. thick, to evaluate previous theoretical calculations of gamma-ray spectra in proposed fusion reactor blankets. The cylinders were constructed of 0.5 in. graphite slabs and 1-in. thick layers of lithium-beryllium fluoride salt mixture contained in aluminum pans. Molybdenum plates were used to approximate first walls, 0-1.25 in. thick. The cylinders were irradiated by 14-mev neutrons produced by bombarding a tritium target with a beam of deuterons from a 150-kv Cockroft-Walton accelrator. The target was positioned on the center line of the cylinder, 5.25 in. from its base. The γ-ray spectra were measured by collimating a beam of γ rays leaking out of the side of the blanket mock-up and by using a sodium iodide scintillation crystal as a detector. The γ-ray spectra from the graphite assemblies are characterized by a large peak at 4.43, a smaller peak at 6.87, and a still smaller peak at 4.95 mev. The spectra in the salt assemblies are characterized by large peaks at 6.63 and 5.13 mev, and several smaller peaks. The relative magnitude of these peaks at different depths in the assemblies are in agreement with previous theoretical calculations. Varying the thickness of the first wall had no observable effect on the spectrum. The absolute

magnitude of the measured spectrum differs from previous theoretical calculations by a factor of approximately 4. (Contractor's abstract)

1763

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NEUTRON ECONOMY IN FUSION REACTOR BLANKET ASSEMBLIES, by A. J. Impink, Jr. June 22, 1965, 257p. incl. diagrs. tables, refs. (Technical rept. no. 434) (AFOSR-65-2282) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) AD 619668 Unclassified

The conceptual design of a blanket assembly for a hypothesized fusion power reactor is considered from the point of view of neutron economy. Requirements and limitations imposed on the blanket by the plasma and by other components of the reactor system are analyzed, and the conceptual arrangement of a suitable blanket utilizing a refractory metal first wall and fused-salt cooling is presented. Neutron transport and scattering models are compared in terms of applicability to the present problem. Multigroup, multiregion formulations for neutron transport and scattering in various energy regimes are developed; solutions are obtained by a combination of analytical and numerical methods. A multigroup treatment of resonance absorption and scattering is outlined, and a method of calculating approximate absorption cross sections in the resonance energy region is derived. Comparison of theoretical predictions with published experimental measurements in several test cases has been made to determine the adequacy of the models and computational procedures. Calculated tritium breeding ratios and neutron-induced reaction rates in a variety of permutations on the basic blanket configuration are summarized and compared. It is shown that the proposed blanket design is adequate from the point of view of neutron economy.

1764

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE COMPUTATION PROBLEM WITH SEQUENTIAL DECODING, by J. E. Savage. Feb. 16, 1965, 77p. incl. diagrs. refs. (Technical rept. no. 439; Lincoln Lab. technical rept. no. 371) (AFOSR-65-2296) (In cooperation with Massachusetts Inst. of Tech., Lincoln Lab., Cambridge) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 621713 Unclassified

Fano Sequential Decoding is a technique for communicating at a high information rate and with a high reliability over a large class of channels. However, equipment cost and variation in the time required to decode successive transmitted digits limit its use. The work is concerned with the latter limitation. Others have shown that the average processing time per decoded digit is small if the information rate of the source is less than a rate R_{comp}. This report studies the probability distribution of the processing time random variable and applies the results to the buffer overflow probability, i. e., the probability that the decoding delay forces incoming data to fill and overflow a finite buffer. It is shown that the overflow probability is relatively insensitive to the buffer storage capacity and to the computational speed of the decoder, but quite sensitive to information rate. In particular, halving the source rate more than squares the overflow probability. These sensitivities are found to be basic Sequential Decoding and arise because the computation per decoded digit is large during an interval of high channel noise and grows exponentially with the length of such an interval. A conjecture is presented concerning the exact behavior of the overflow probability with information rate. This conjecture agrees well with the (limited) experimental evidence available. (Contractor's abstract)

1765

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A SIMPLE DERIVATION OF THE CODING THEOREM AND SOME APPLICATIONS, by R. G. Gallager. 1965 [16]p. incl. refs. (AFOSR-65-2401) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 621832 Unclassified

Also published in IEEE Trans. Inform. Theory, v. IT-11: 3-18, Jan. 1965.

Upper bounds are derived on the probability of error that can be achieved by using block codes on general time-discrete memoryless channels. Both amplitude-discrete and amplitude-continuous channels are treated, both with and without input constraints. The major advantages of the present approach are the simplicity of the derivations and the relative simplicity of the results, on the other hand, the exponential behavior of the bounds with block length is the best known for all transmission rates between zero and capacity. The results are applied to a number of special channels, including the binary symmetric channel and the additive Gaussian noise channel.

1766

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SYNTHESIS OF A CLASS OF NON-LINEAR SYSTEMS, by M. Schetzen. [1965] [14]p. incl. diagrs. (AFOSR-65-2402) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space

Administration, National Institutes of Health, National Science Foundation) AD 623067 Unclassified

Also published in Internat'l. Jour. Control, v. 1: 401-414, May 1965.

A problem in the practical application of the Volterra series to non-linear theory is the synthesis of systems with a given set of Volterra kernels. A method is described for determining whether a given Volterra kernel can be synthesized exactly by using only a finite number of multipliers. A method for the synthesis of such kernels is also presented. The use of the techniques discussed here is illustrated by examples. (Contractor's abstract)

1767

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

GENERALIZED SNR AND PERFORMANCE INDEX OF FILTERS FOR WAVEFORM ESTIMATION, by V. R. Algazi. 1965, 1p. incl. diagr. (AFOSR-65-2403) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 621835 Unclassified

Also published in Proc. IEEE, v. 53: 725-726, July 1965.

For a random signal corrupted by additive statistically independent noise, it is common practice to use the SNR as a gain-invariant measure of the disturbance caused by noise. After filtering, however, the signal will be distorted and noisy; hence, the common definition of SNR is not directly applicable. An adequate definition is presented for a generalized SNR for noisy signals and the SNR of optimum mean-square filters is discussed. The SNR performance of filters may be a misleading measure of their merit.

1768

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

TEMPERATURE AND FREQUENCY DEPENDENCE OF ULTRASONIC ABSORPTION IN LIQUID HELIUM BELOW 1°K, by W. A. Jeffers, Jr. and W. M. Whitney. [1965] [15]p. incl. diagrs. refs. (AFOSR-65-2404) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, and National Science Foundation) AD 621831 Unclassified

Also published in Phys. Rev., v. 139: A1082-A1096, Aug. 16, 1965.

From measurements of the temperature dependence of the amplitude of ultrasonic pulses propagated over a fixed path in liquid helium, the attenuation coefficient has been determined at the 6 frequencies 1.00, 2.02, 3.91, 6.08, 10.2, and 17.7 mc/sec, at temperatures extending down to 0.2°K. Below 0.6°K, the observed variation of the absorption coefficient α (cm^{-1}) with frequency f (mc/sec) and temperature T (°K) can be represented by the empirical equation $\alpha = 0.11\, f^{3/2}T^3$. This behavior differs from that predicted by several existing theories that are based upon the 3-phonon or 4-phonon interaction between longitudinal acoustic quanta and thermal phonons. Over the temperature interval 0.6-0.8°K, the measured attenuation is somewhat greater than would be expected from an extrapolation of the results below 0.6°K into this temperature region. A comparison of the data with some calculations by Khalatnikov suggests that the additional absorption arises from thermal conduction in the normal fluid. An equation that is analogous to the classical Kirchhoff expression adequately accounts for this contribution to the total absorption, even at temperatures for which the lifetime of the thermal phonons exceeds the period of the sound wave. (Contractor's abstract)

1769

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ORTHOGONAL DETECTION TO REDUCE COMMON CHANNEL INTERFERENCE, by T. H. Crystal. 1965 [2]p. incl. diagr. (AFOSR-65-2405) (Sponsored jointly by Air Force Electronic Systems Division; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 621901 Unclassified

Also published in Proc. IEEE, v. 53: 742-743, July 1965.

It is shown that, since DSB is a linear modulation procedure which creates 2 shifted versions of the modulating signal spectrum, 2 DSB signals with overlapping spectra may be separated perfectly, rather than approximately, by a finite linear demodulation procedure. Because of the linearity of the modulation and demodulation process, there is no justification for comparison with nonlinear schemes nor for extending this procedure for more signals.

1770

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AN IONIZATION PROCESS IN A LOW-ENERGY CESIUM PLASMA, by H. L. Witting and E. P. Gyftopoulos. [1965] [10]p. incl. diagrs. table, refs. (AFOSR-65-2406) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) AD 619854 Unclassified

Also published in Jour. Appl. Phys., v. 36: 1328-1337, Apr. 1965.

The mechanism of ion formation in cesium plasmas at relatively low electron temperatures (3500°K) and pressures of a few Torr are investigated. It is concluded that most of the ions are molecular and that they are formed by collisions between cesium atoms in the first excited state. The excited atoms are predominantly produced by inelastic electron collisions. The excitation cross section is computed by means of the impact parameter method. It has a maximum value of 100×10^{-16} cm^2 at 7 ev. The de-excitation cross section is computed and found to be approx. constant at $50 \times 10^{-16} cm^2$. Radiation trapping and diffusion of excited atoms are also studied. The ionization cross section is calculated by means of statistical thermodynamics from the measured recombination coefficient for the inverse of the ionizing process. It is found to be $1450 \times 10^{-16} cm^2$. The plasma is uniform throughout its volume except in the immediate vicinity of the bounding electrodes. The proposed mechanism results in performance characteristics for cesium thermionic converters, operating in the "ignited mode", which are in qualitative and quantitative agreement with experimental data.

1771

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ULTRASONIC ATTENUATION IN AMMONIUM CHLORIDE, by C. W. Garland and J. S. Jones. [1965] [6]p. incl. diagrs. table, refs. (AFOSR-65-2407) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)] and National Science Foundation) AD 619851 Unclassified

Also published in Jour. Chem. Phys., v. 42: 4194-4199, June 15, 1965.

The attenuation coefficient α of longitudinal ultrasonic waves propagating along the [100] direction in single-crystal ammonium chloride has been measured as a function of frequency from 5 to 55 mc/sec and as a function of temperature from 200° to 270°K. A sharp maximum is observed in α at the order-disorder critical temperature. The results are analyzed in terms of a relaxation model with a highly temperature-dependent relaxation time. (Contractor's abstract)

1772

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME USEFUL EXPRESSIONS FOR OPTIMUM LINEAR FILTERING IN WHITE NOISE, by D. Snyder. [1965] [2]p. (AFOSR-65-2408) (Sponsored jointly by Air Force Office Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 620006 Unclassified

Also published in Proc. IEEE, v. 53: 629-630, June 1965.

Optimum linear filters for extracting a message from an additive noise are considered. The expression for minimum phase $H_{opt}(s)$ is derived.

$$H_{opt}(s) = 1 - \frac{N_0^2}{[S_a(-s^2) + N_0]^+} .$$

1773

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

GENERAL CRITERION FOR MIRROR INSTABILITY OF A PLASMA, by D. J. Rose. [1965] [5]p incl. diagrs. (AFOSR-65-2409) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) AD 619942 Unclassified

Also published in Phys. Fluids, v. 8: 951-955, May 1965.

A plasma column in an axial magnetic induction B exhibits the well-recognized "mirror" instability if the pressure $p_\perp$ perpendicular to B becomes too high, as follows. A small azimuthally symmetric bulge in the field may trap additional plasma via the usual mirror effect. The increased diamagnetism further weakens the field in the bulge, thus trapping more plasma, and so forth. The criterion for stability against this mode for an azimuthally symmetric velocity distribution function $f(v, \theta)$ is given. The integral is a measure of changing $p_\perp$ if an incipient bulge forms in the plasma column; the K_0 term represents stabilizing effect of a finite wavelength perturbation. This criterion is more general than the two-temperature criteria obtained hitherto. (Contractor's abstract, modified)

1774

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME IMPLICATIONS OF THE STOCHASTIC BHEAVIOR OF PRIMARY AUDITORY NEURONS, by W. M. Siebert. [1965] [10]p. incl. illus. diagrs. refs. (AFOSR-65-2410) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 619855 Unclassified

Presented at meeting of Internat'l. Organization of Pure and Applied Biophysics, Paris (France), June 22-27, 1964.

Also published in Kybernetik, v. 2: 206-215, June 1965.

Since the only way in which auditory information can

reach the more central parts of the nervous system is via the VIIIth nerve, the effective 'neural noise' implied by stochastic 'coding' of auditory information must set some sort of limits on auditory discriminations. This paper shows that these limits can be calculated if an appropriate statistical model of the neural activity is accepted. Of course, no more than a bound on discrimination performance can be determined in this way, since there is no reason to suppose that the central processing in the nervous system is effectively ideal-- particularly in the artificial situations of auditory psychophysics. But if these bounds closely approximate performance (and there is some reason to believe they may, at least for the very simple auditory discriminations treated in this paper) then it seems reasonable to maintain that the observed stochastic 'coding' in a sense accounts for or explains these behavioral limits.

1775

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CESIUM ION-BEAM NEUTRALIZATION WITH ENERGETIC ELECTRONS, by G. C. Theodoridis and E. P. Gyftopoulos. [1965] [4]p. incl. diagrs. table, refs. (AFOSR-65-2411) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) AD 621833 Unclassified

Also published in AIAA Jour., v. 3: 1414-1417, Aug. 1965.

The neutralization of the positive space charge of cesium ion beams of energies up to 2500 ev by means of energetic electrons (of the order of 100 ev) is investigated experimentally. It is found that neutralization occurs provided that electrons are supplied at the same rate as the ions. The results are independent of any other parameter of the electron beam. An attempt is made to justify the observed experimental results by means of a two-stream collective scattering interaction between the energetic electrons and the ion-beam plasma. The one-dimensional dispersion relation for this interaction indicates the existence of growing longitudinal oscillations under the conditions prevailing in the experiments. These oscillations may be the mechanism by which the electron drift energy is thermalized, thus leading to the observed neutralization. The results of this work suggest that neutralizing electrons can be introduced into the ion beam of an ion-propelled spaceship by means of an electron gun instead of being made available by placing a hot electron source in the vicinity of the ion beam. Through use of an electron gun, the electron current can be controlled continuously, and the electron emitter can be well protected.

1776

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EFFECTS OF ACOUSTIC STIMULI ON SPONTANEOUS SPIKE DISCHARGES IN AUDITORY NERVE FIBERS (Abstract), by N. Y.-S. Kiang and M. B. Sachs. [1965] [1]p. (AFOSR-65-2412) (In cooperation with Massachusetts Eye and Ear Infirmary, Boston) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, and Public Health Service) Unclassified

Presented at Fall Meeting of the Amer. Physiol. Soc., California U., Los Angeles, Aug. 23-27, 1965.

Also published in Physiologist, v. 8: 208, Aug. 1965.

Single auditory nerve fibers in anesthetized cats exhibit spike discharges even in the absence of controlled acoustic stimuli. These fibers respond to appropriate tonal stimuli by showing an increase in the rate of discharge. When spike discharges are driven by either tonal or noise stimuli, the addition of certain other tones results in a reduction in the rate of driven activity. These last tones, when presented alone, do not reduce the discharge rate to a level below that of spontaneous activity. Under certain conditions, a temporary reduction of discharge rate below spontaneous level can be demonstrated but these reductions cannot be maintained. It is suggested that the generation of evoked discharges may involve mechanisms that differ from those that generate spontaneous discharges.

1777

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EFFECTS OF EARLY EXPERIENCE ON BEHAVIOR: EXPERIMENTAL AND CONCEPTUAL CONSIDERATIONS, by R. Melzack. [1965] [29]p. incl. illus. diagrs. refs. (AFOSR-65-2413) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Institutes of Health) AD 621081 Unclassified

Also published in Psychopathology of Perception; Proc. Fifty-third Annual Meeting of the Amer. Psychopathological Assoc., New York (Feb. 1963), ed. by P. H. Hoch and J. Zubin. New York, Grune and Stratton, Inc., 1965, 271-299.

Experiments on restriction of sensory experience in Scottish terrier and Beagles indicate that selection of particular neural patterns and information filter under the control of central nervous system process that correspond to prior experience at the early stages of synaptic transmission must be with the environment. Severe restriction of the early sensory experience of dogs produces striking abnormalities in their behavior at maturity such as extremely high level of behavioral arousal, failure to attend selectively to environmental stimuli, abnormal response to noxious stimulation, social submissiveness, and excessive licking behavior. One of the mechanisms proposed to account for these effects of restrictions describes a circle in which failure to filter out irrelevant information (on the basis of prior experience) leads to excessive arousal which, in turn,

interferes with mechanisms (perhaps innately determined) that would normally act in the selection of cues for adaptive response. The behavioral and physiological data obtained with the restricted beagles lend support to the conceptual approach based on current knowledge of information selection in the central nervous system. This conceptual approach has no difficulty in dealing with the obvious genetic contribution to behavior, and it is further substantiated by a comparison of the effects of restriction and brain lesions.

1778

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ROTATIONAL-BEAM POWER THEOREMS, by P. Penfield, Jr. 1965 [6]p. incl. refs. (AFOSR-65-2414) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 620714 Unclassified

Also published in IEEE Trans. Electron. Devices, v. ED-12: 258-263, May 1965.

General power theorems for rotational electron beams and some moving plasmas are derived by using 3 sets of variables: Clebsch variables, Lin's variables, and polarization variables. In each case, the most general power theorem, with unspecified linear operators, is given and for the polarization-variable case this is specialized to some cases of interest. Unfortunately, the physical interpretation of the variables used is not always clear, and the physically unmeasurable variables may not always behave as measurable ones would, so that the theorems are of limited usefulness. (Contractor's abstract)

1779

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE SPINOCERVICAL TRACT: DORSAL COLUMN LINKAGE, CONDUCTION VELOCITY, PRIMARY AFFERENT SPECTRUM, by A. Taub and P. O. Bishop. 1965 [21]p. incl. diagrs. refs. (AFOSR-65-2415) (Sponsored jointly by Air Force Aeronautical Systems Division; Air Force Office of Scientific Research under AF AFOSR-64-591; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, and Teagle Foundation, Inc.) AD 621834 Unclassified

Also published in Exper. Neurol., v. 13: 1-21, Sept. 1965.

Microelectrode studies of single units in the spinocervical tract of the cat under barbiturate anesthesia demonstrate a monosynaptic linkage between the spinocervical tract and dorsal column cutaneous afferents at the segmental level of dorsal root entry. The spinocervical tract is substantially independent of the dorsal spinocerebellar tract, at least 75% of units studied terminating in the region of the ipsilateral lateral cervical nucleus. Mean over-all conduction velocity of units in the spinocervical tract is 58.0 m/sec, compared with mean over-all conduction velocity of cutaneous afferents in the dorsal columns providing input to these spinocervical tract units of 38.6 m/sec. The dorsal column input contains the $A\alpha$ cutaneous component, of which the small-fibered half is most effective in exciting spinocervical tract units. The $A\delta$ component is lacking. The spinocervical tract primary afferent input contains at least all of the A group to the $A\delta$ component. Thus slow-conducting cutaneous primary afferent fibers may project to fast-conducting long pathways. Some functional and clinical aspects of the spinocervical tract and its homologue are discussed. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STIMULUS CODING IN THE AUDITORY NERVE AND COCHLEAR NUCLEUS, by N. Y.-S. Kiang. [1965] [16]p. incl. illus. diagrs. refs. (AFOSR-65-2416) (In cooperation with Massachusetts Eye and Ear Infirmary, Boston) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 617591 Unclassified

Also published in Acta Oto-Laryngol., v. 59: 186-200, [1965].

The average time pattern of response of any auditory nerve fiber to simple acoustic stimuli is predictable from its 'tuning curve' and rate of spontaneous discharge. In contrast, units in the cochlear nucleus may exhibit radically different response patterns to the same stimulus though their tuning curves and rates of spontaneous discharge are virtually identical. Messages carried by the auditory nerve are apparently recoded in the cochlear nucleus in a number of different ways. Consequently the nucleus should not be considered merely as a relay station.

1781

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MEASUREMENT OF HYPERFINE STRUCTURE OF THE J = 3, K = 2 INVERSION LINE OF $N^{14}H_3$, by S. G. Kukolich. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-2418) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E)) Unclassified

Also published in Phys. Rev., v. 138: A1322-A1325, May 31, 1965.

The magnetic hyperfine structure of the J = 3, K = 2

inversion line of $N^{14}H_3$ has been measured in a maser spectrometer employing the method of separated oscillating fields. The molecular-resonance line-width of this system is 350 cps at 23 kmc/sec. The measured frequencies of the 3-2 inversion-line components are (in cycles/sec): 22834 247 980 ± 50, 22 834 209 990 ± 50, 22,834,207,230 ± 50, 22 834 185 130 ± 20, 22 834 163 020 ± 50, 22 834 160 270 ± 50, 22 834 122 270 ± 50. The pairs of lines adjacent to the main line were unresolved previously. (Contractor's abstract)

1782

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EVIDENCE FOR A CONSIDERABLE NONLINEAR DIPOLE ABSORPTION IN GALLIUM ARSENIDE, by R. Geick. [1965] [5]p. incl. diagrs. refs. (AFOSR-65-2419) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E)) AD 617998 Unclassified

Also published in Phys. Rev., v. 135: A1495-A1499, May 31, 1965.

A comparison is made of the infrared lattice absorption spectra of Ge and GaAs. For this purpose an approximate damping function is derived for GaAs. The comparison of the damping functions shows that both the nonlinear dipole moment and the anharmonicity should be important for the absorption of GaAs in the 2-phonon and 3-phonon summation bands. The matrix elements for these 2 mechanisms are found to have nearly the same order of magnitude. In the absorption coefficient and in the imaginary part of the dielectric constant, the anharmonicity in connection with the infrared-active lattice mode dominates at frequencies near the resonance frequency ω_o, while the nonlinear dipole moment dominates in the 3-phonon summation-band region where $(\omega^2/\omega_o^2 - 1) \gg 1$. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ULTRASONIC ATTENUATION MEASUREMENTS IN POLY-L-GLUTAMIC ACID SOLUTIONS, by J. J. Burke, G. G. Hammes, and T. B. Lewis. [1965] [6]p. incl. diagrs. tables, refs. (AF AFOSR-65-2420) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Institutes of Health) Unclassified

Also published in Jour. Chem. Phys., v. 42: 3520-3525, May 15, 1965.

Ultrasonic attenuation measurements of poly-L-glutamic acid in 0.2M NaCl(aqueous)-dioxane (2:1) have been carried out over a frequency range from 6 to 175 mc/sec using a pulse-echo method. Attenuation in excess of the pure solvent was found over the entire pH range investigated (5.4-9.0). A distribution of relaxation times is observed at all pH values. This distribution approaches a single relaxation time as the pH is raised. The amplitude parameter characterizing the attenuation and the average relaxation time does not vary markedly with pH. The amplitude parameter is approximately proportional to the polymer concentration in contrast to the average relaxation time which is not strongly dependent on the polymer concentration. The process primarily responsible for the observed chemical relaxation is probably the interaction between solvent and polymer. The minimal volume change associated with the observed process has been calculated and is approximated ± 3 cc/mol of monomer. Although the ultrasonic attenuation clearly depends on whether the polymer molecule is in the form of a helix or random coil, the transition from helix to coil is not primarily responsible for the observed excess absorption. By combining these results with other data, bounds for the average relaxation time characteristic of the helix-coil transition can be estimated as $5 \times 10^{-8} < \tau < 10^{-5}$ sec.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HELIUM AFTERGLOW AND THE DECAY OF THE ELECTRON ENERGY, by J. C. Ingraham and S. C. Brown. [1965] [8]p. incl. diagrs. table, refs. (AFOSR-65-2441) (Sponsored jointly by Air Force Electronic Systems Division; [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and Atomic Energy Commission) AD 617999 Unclassified

Also published in Phys. Rev., v. 138: A1015-A1022, May 17, 1965.

The electron energy decay in the afterglow of a pulsed dc discharge in helium has been studied over a pressure range from 0.03 mm to 5 mm Hg. The energy decay is found to be influenced by cooling due to electron-atom elastic recoil and heating due either to electron-metastable superlastic collisions at low pressures or to the ionizing collision between 2 metastable atoms at high pressures. The analysis allows for the deviation of the electron velocity distribution from Maxwellian resulting from these heating effects. (Contractor's abstract)

1785

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NOTE ON FOURIER COEFFICIENTS OF POWER-LAW DEVICES, by P. Penfield, Jr. 1965 [1]p. (AFOSR-65-2442) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 618237 Unclassified

Also published in Proc. IEEE, v. 53: 503, May 1965.

The author previously discussed the integral $I(\alpha, n; \beta)$

and presented a form which is useful in evaluating Fourier coefficients of power-law devices. This note makes 5 further comments on the integral. There have been additional formulas found, the integral is a special case of integrals of a type that have come to be known as "Bennett functions", and a set of tables of the function $I(\alpha, n; \beta)$ has been calculated.

1786

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AMPLITUDE NOISE IN LASER OSCILLATORS, by H. A. Haus. 1965 [2]p. incl. diagrs. refs. (AFOSR-65-2452) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Reserch under DA 36-039-AMC-03200(E)) AD 623055 Unclassified

Also published in IEEE Jour. Quant. Electron., v. QE-1: 179-180, July 1965.

An analysis is presented of the amplitude noise in a maser oscillator represented by the van der Pol equivalent circuit, based on a corrected version of the method of Mullen (Proc. IRE, v. 48: 1467, 1960). The spectral density and power spectra, both above and below threshold, are evaluated.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME MAPPING PROPERTIES OF RC AND RL DRIVING-POINT IMPEDANCE FUNCTIONS, by T. S. Huang. 1965 [3]p. incl. diagrs. (AFOSR-65-2453) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 623053 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 257-259, June 1965.

It is shown that RC or RL driving-point impedance function Z(s) maps the closed right-half s plane onto a region in the Z plane which is covered by the closed circular disk with the straight line segment joining Z(O) and $Z(\infty)$ as a diameter; and which covers the open circular disk with center at Z(u) and radius = $1/1\frac{1}{2}uZ'(u)|$, and the straight line segment $Z = Z(u) + jtu\,Z'(u)$, $-1 < t < 1$, for any real positive number u. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AN MHD CHANNEL FLOW WITH TEMPERATURE DEPENDENT ELECTRICAL CONDUCTIVITY, by J. B. Heywood. [1965] [3]p. incl. diagrs. refs. (AFOSR-65-2454) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Science Foundation) AD 623054 Unclassified

Also published in AIAA Jour., v. 3: 1752-1754, Sept. 1965.

It is the purpose of this work to demonstrate by analyzing a particularly simple model how these peculiar velocity distributions can occur even when the temperature distribution is approximately parabolic, and the effect of the MHD terms in the energy equation is small. A channel flow is chosen as the model since at high Hartmann numbers this illustrates several features of a boundary layer in that viscous forces are only important close to the channel walls.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STIMULUS CODING IN THE COCHLEAR NUCLEUS, by N. Y.-S. Kiang, R. R. Pfeiffer and others. 1965 [23]p. incl. illus. diagrs. table, refs. (AFOSR-65-2455) (In cooperation with Massachusetts Eye and Ear Infirmary, Boston) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 623066 Unclassified

Presented at Ninety-eighth Annual Meeting of the Amer. Otological Soc., Colorado Springs, Colo., May 25-26, 1965.

Also published in Ann. Otol., Rhinol., Laryngol., v. 74: 463-485, June 1965.

The purpose of this study is to examine evidence for the proposition that units in different subdivisions of the cochlear nucleus have characteristically different discharge patterns. The cat was chosen as the appropriate animal for study primarily because its cochlear nucleus has been studied in detail by anatomists. A secondary advantage is that some of the discharge characteristics of units in the cat's cochlear nucleus have already been described. The present report may be regarded as one of a continuing series of studies on the cochlear nucleus.

1790

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OPTICAL RADAR RESULTS AND IONOSPHERIC SPORADIC E, by G. Fiocco. [1965] [3]p. incl. diagrs. table, refs. (AFOSR-65-2456) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham, and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 617049 Unclassified

Also published in Jour. of Geophys. Research, v. 70: 2213-2215, May 1, 1965.

Correlations between optical radar echoes at heights between 110 and 140 km and ionospheric sporadic E are reported and interpreted as further evidence that the optical echoes were caused by extraterrestrial incoming particles and that E may at times be related to the same cause. (Contractor's abstract)

1791

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

TEMPERATURE DEPENDENCE OF THE ANTIFERROMAGNETIC ANISOTROPY IN MnF_2, by J. C. Burgiel and M. W. P. Strandberg. [1965] [5]p. incl. diagrs. refs. (AFOSR-65-2458) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 617997 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 877-881, 1965.

Existing data on the temperature dependence of the sublattice magnetization and of the antiferromagnetic resonance frequency of MnF_2, together with new antiferromagnetic resonance data, are used to determine the temperature dependence of the antiferromagnetic anisotropy energy E_A. For most temperatures from 0°K to the Néel temperature $E_A \propto M^{2.88 \pm 0.16}$, where M represents the sublattice magnetization. The experimental results are discussed in terms of the existing theoretical treatments of this problem, particularly the classical theory of Zener, and the spin-wave theory of Oguchi. Considerations indicate the existence of nearly complete correlation between neighboring spins at all temperatures right up to the Néel temperature. (Contractor's abstract)

1792

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DETERMINATION OF OPTIMUM NONLINEAR SYSTEMS FOR GENERALIZED ERROR CRITERIA BASED ON THE USE OF GATE FUNCTIONS, by M. Schetzen. 1965 [9]p. incl. diagrs. (AFOSR-65-2459) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 618340 Unclassified

Also published in IEEE Trans. Inform. Theory, v. IT-11: 117-125, Jan. 1965.

A generalization of the error criteria in the analysis of optimum nonlinear systems is presented. The experimental and analytical techniques presented are based upon the expansion of the nonlinear system in the orthogonal set of gate functions that were introduced into the study of nonlinear systems by Bose in 1956. It is shown that, for various error criteria, the coefficients in the expansion can be determined independently of each other. By making use of this result, methods are developed for the determination of nonlinear systems with and without memory, for which an arbitrary weighted function of the error or the probability of an arbitrary function of the error is a minimum. (Contractor's abstract)

1793

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE SUBJECTIVE EFFECTS OF TWO-DIMENSIONAL PICTORIAL NOISE, by T. S. Huang. 1965 [11]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2461) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 618341 Unclassified

Also published in IEEE Trans. Inform. Theory, v. IT-11: 43-53, Jan. 1965.

A study has been made of the subjective effects of the class of independent additive rectangular low-pass Gaussian noises. Three original pictures, varying in the amount of detail, were used. The general shapes of the isopreference surfaces σ- k_1 - k_2 space where σ is the rms value, and k_1 and k_2 are the bandwidths of the noise in the horizontal and vertical directions, respectively, were found. If the objectionability of noise is a linear functional of the noise spectrum, then one may deduce that for the class of noises whose spectra are symmetrical with respect to both horizontal and vertical frequencies, the weighting function in the integral representing noise objectionability is similar in shape to these isopreference surfaces. (Contractor's abstract)

1794

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

RADIO MEASUREMENTS OF VENUS NEAR 1-CM WAVELENGTH (Abstract), by D. H. Staelin and A. H. Barrett. [1965] [2]p. (AFOSR-65-2463) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Aeronautics and Space Administration) Unclassified

Presented at 118th meeting of Amer. Astronom. Soc., Kentucky U., Lexington, Mar. 14-17, 1965

Also published in Astronom. Jour., v. 70: 330-331, June 1965.

During June and July, measurements of Venus were made with a five-channel microwave radiometer operating at 21.9, 23.5, 25.5, 29.5, and 32.4 Gc/sec. A single-channel radiometer at 21.1 Gc/sec was used separately. The five-channel radiometer was composed of separate Dicke-type radiometers which were connected simultaneously to the antenna feed by means of frequency-selecting filters. The antenna was a 28-ft paraboloid. The spectrum of Venus was determined by comparison with the moon. The antenna patterns measured at each frequency were used to relate the observations of the moon and Venus. The absorption in the terrestrial atmosphere was determined by solar extinction measurements and by measurements of ground-level humidity. The average observed brightness temperatures and relative rms uncertainties for 13 separate experiments were: 502 ± 82°K, 404 ± 28°K, 450 ± 23°K, 428 ± 20°K, 463 ± 32°K, and +30 ± 24°K, in order of increasing frequency. If data at each frequency are considered separately, the uncertainties are: ± 20%, ± 10%, ± 10%, ± 10%, ± 15%, and ± 10%, respectively. There is some evidence for fluctuations in the shape of the spectrum. The observations seem to be inconsistent with atmospheric models incorporating only nonresonant absorption mechanisms.

1795

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DYNAMICALLY INDEPENDENT EQUILIBRIUM EQUATIONS FOR RLC NETWORKS, by C. F. Price and A. Bers. 1965 [4]p. incl. diagrs. (AFOSR-65-2464) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 617994 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 82-85, Mar. 1965.

This paper presents a systematic derivation of a system of first-order dynamically independent equilibrium equations for an RLC network. The dynamically independent equations are obtained from a set of topologically independent equilibrium equations which are written in terms of a judiciously chosen set of independent, current and voltage, network variables. It is thus shown that superfluous variables, which are the result of dynamic constraints on the network, can be eliminated by inspection. Finally a method for writing the dynamically independent equilibrium equations by inspection of the network is presented. Therefore, it is shown that by the above techniques the set of dynamically independent equations can be obtained with little more labor than the more conventional equilibrium equations whose variables are only topologically independent. (Contractor's abstract)

1796

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

BOUNDS ON THE NATURAL FREQUENCIES OF LC STRUCTURES, by H. B. Lee. 1965 [2]p. (AFOSR-65-2465) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 617992 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 127-128, Mar. 1965.

The purpose of this communication is to prove the following theorem: The smallest (nonzero) natural frequency which one can realize from a set of positive capacitors $C_1, \cdots C_m$ and a set of positive inductors $L_1, \cdots L_n$, results when one does the following: (1) connects the capacitors in parallel to produce a capacitance $C_p = C_1 \cdots + C_m$; (2) connects the inductors in a series to produce an inductance $L_s = L_1 \cdots + L_n$; (3) connects C_p and L_s in parallel. Similarly, the largest (finite) natural frequency which one can realize results when one performs as follows: (1) connects the capacitors in a series to produce a capacitance $C_s = (C_1^{-1} \cdots + C_m^{-1})^{-1}$; (2) connects the inductors in parallel to produce an inductance $L_p = (L_1^{-1} \cdots + L_n^{-1})^{-1}$; (3) connects C_s and L_p in parallel. The theorem is useful, as it provides the following bounds on the natural frequencies of any transformerless LC structure: $1/\sqrt{L_p^0 C_s} \geq \omega_\nu \geq 1/\sqrt{L_s C_p^\infty}$. The proof rests upon the fact that every natural oscillation is self-exciting.

1797

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PROCESSING AND TRANSMITTING INFORMATION THROUGH THE CENTRAL NERVOUS SYSTEM, by J. L. Hall. [1965] [6]p. incl. diagrs. (AFOSR-65-2466) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 618993 Unclassified

Also published in IEEE Student Jour., v. 3: 29-34, May 1965.

Experiments were performed to explore the relationship between patterns of neural activity in the central nervous system and the binaural localization of sounds. Acoustic clicks were presented to the 2 ears of anesthetized cats that had been operated upon so as to expose the brain. A neural model was attained identifying the relative amounts of cell activity in the left and right accessory nuclei of the brain's superior olive with position of the virtual image, with the result that the image was perceived on the side where fewer cells respond. On comparison between predictions of the model with results from human psychophysics, the cells fired more when the stimulus to the contralateral ear (on the opposite side) comes first and when the clicks

are made more intense. There was good agreement between these results and those of psychophysical experiments on humans.

1798

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CONVECTION AND THE DIFFERENTIAL ROTATION OF THE SUN, by N. O. Weiss. [1965] [3]p. (AFOSR-65-2467) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 618261 Unclassified

Also published in The Observatory, v. 85: 37-39, Feb. 1965.

Criteria for estimating the superadiabatic temperature gradient required to produce a given convective energy flux in a rotating solar convective zone are discussed. It appears that, although the effect of rotation is negligible in the photosphere, it may double the superadiabatic gradient in the deep convective zone. Consequently, if convective heat transport is the same at the poles as at the equator of the Sun, the polar regions should be cooler by an amount of order 20°K.

1799

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SPIKE DISCHARGE PATTERNS OF SPONTANEOUS AND CONTINUOUSLY STIMULATED ACTIVITY IN THE COCHLEAR NUCLEUS OF ANESTHETIZED CATS, by R. R. Pfeiffer and N. Y.-S. Kiang. [1965] [16]p. incl. diagrs. tables, refs. (AFOSR-65-2468) (In cooperation with Massachusetts Eye and Ear Infirmary, Boston) (Sponsored jointly by Air Force Office of Scientific Research, Army Research (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, and Public Health Service) AD 618345 Unclassified

Also published in Biophys. Jour., v. 5: 301-316, May 1965.

Interspike interval histograms of spontaneous and stimulated activity were computed from spike discharges of single units in the cochlear nucleus. These histograms indicate that a number of different types of spontaneous discharge patterns exist in the nucleus. The type of spontaneous activity of a given unit is related to its activity in response to continuous tones. Correlations were found between the discharge patterns of units and their anatomical locations within the nucleus. (Contractor's abstract)

1800

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DIELECTRIC DISPERSION OF SOME PEROVSKITE ZIRCONATES, by C. H. Perry, D. J. McCarthy, and G. Rupprecht. [1965] [2]p. incl. diagr. table, refs. (AFOSR-65-2469) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and National Science Foundation) Unclassified

Also published in Phys. Rev., v. 138: A1537-A1538, May 31, 1965.

The assignment of the normal-mode spectrum in perovskites has been achieved by a comparison of the vibrations of calcium, strontium, barium, and lead titanates and zirconates. In addition, for the antiferroelectric material lead zirconate, about 90% of the value of the low-frequency dielectric constant is the result of a low-frequency optically active mode. (Contractor's abstract)

1801

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

QUARTERLY PROGRESS REPORT NO. 79, by H. J. Zimmermann and G. G. Harvey. Oct. 15, 1965, 267p. incl. illus. diagrs. tables, refs. (AFOSR-65-2729) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), Air Force Research and Technology Division, National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 624220 Unclassified

This report, the seventy-ninth in a series of quarterly progress reports issued by the Research Lab of Electronics, contains a review of the research activities of the Laboratory for the 3-month period ending Aug 31, 1965. Various subjects in the broader topics of general physics, plasma dynamics, and communication sciences and engineering are reviewed.

1802

Massachusetts Inst. of Tech. Research Lab of Electronics, Cambridge

PROBABILITIES ASSOCIATED WITH SPIKE DISCHARGES IN AUDITORY NERVE FIBERS (Abstract), by P. R. Gray, N. Y.-S. Kiang, and J. W. Shipley [1965] [1]p. (AFOSR-65-2756) (In cooperation with Massachusetts Eye and Ear Infirmary, Boston) (Sponsored jointly by Air Force Office of Scientific Research Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, and Public Health Service) AD 622537 Unclassified

Presented at Fall Meeting of the Amer. Physiol. Soc., California U., Los Angeles, Aug. 23-27, 1965.

Also published in Physiologist, v. 8: 179, Aug. 1965.

The time patterns of spike discharges in auditory nerve fibers are influenced by both stimulus characteristics and refractory properties of the neurons. Conventional post stimulus-time (PST) histograms reflect the combined influence of these 2 factors, but these factors can be studied separately by appropriate processing of the data. Statistical analyses of spontaneous activity suggest that one may consider a neuron to be "recovered" when it has not discharged during the previous 20 msec. The effect of the stimulus on a fiber that has apparently recovered can be studied by estimating the conditional probability of a spike in a particular interval of time, given some minimum time since the last firing. Analysis of these "recovered probabilities" helps to explain certain otherwise puzzling features of the conventional PST histograms and leads to a more complete understanding of the relation between discharge probabilities of these fibers and the mechanical motion of cochlear structures.

1803

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

BOUNDS ON IMPEDANCE FUNCTIONS OF R, ± L, ± C, T NETWORKS, by T. S. Huang and H. B. Lee. [1965] [12]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 616091 Unclassified

Also published in Jour. Franklin Inst., v. 279: 83-94, Feb. 1965.

It is shown that if $Z_{ij}(s)$ is an open circuit impedance of a 2-part network N containing positive resistances, positive and negative inductances, positive and negative capacitances, and ideal transformers, then $Z_{ij}(j\omega)$ satisfies the inequality for all real ω, where the impedance Z_{ij} of N for all reactive elements are either open or short-circuited. The inequality is useful for finding bounds on the magnitude, phase angle, and the real and imaginary parts of the $Z_{ij}(j\omega)$. (Contractor's abstract)

1804

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CORRELATION FUNCTIONS IN NUCLEAR RELAXATION. I. ANALYSIS OF RANDOM MOTIONS FROM FIELD DEPENDENCE OF RELAXATION TIMES, by J. M. Deutch and J. S. Waugh. [1965] [5]p. incl. refs. (AFOSR-66-0089) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 624352 Unclassified

Also published in Jour. Chem. Phys., v. 43: 1914-1918, Sept. 15, 1965.

The contributions to T_1 in a fluid arising from spin-rotational interaction and chemical-shielding anisotropy are discussed in terms of their simultaneous use to analyze the detailed nature of random rotations without the need of a microscopic theory. This possibility often exists because of the involvement of different correlation functions of the lattice variables and the experimental distinguishability of the latter mechanism through its magnetic-field dependence. The method is illustrated by comparing the results to be expected for 3 different random processes: (1) rotational diffusion, (2) random walk among the m_j states of a rotational manifold of fixed J with no selection rules, and (3) the same with a rigorous $\Delta m_j = \pm 1$ selection rule. Possible favorable experimental cases are discussed. (Contractor's abstract)

1805

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

LOW-FREQUENCY INSTABILITY OF PARTIALLY IONIZED PLASMA, by D. L. Morse. [1965] [8]p. incl. diagrs. table. (AFOSR-66-0090) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E) and National Science Foundation) AD 624357 Unclassified

Also published in Phys. Fluids, v. 8: 1339-1346, July 1965.

The stability of a partially ionized plasma in a magnetic field is investigated. The electron and ion flow equations and continuity equations are used to describe low-frequency, macroscopic variations of plasma density and space potential. The solutions to the linearized forms of these equations consist of a set of eigenfunctions of perturbed density, and a complex frequency eigenvalue corresponding to each perturbed density eigenfunction. It is found that rotating "flutelike" density perturbations may grow when a steady radial electric field is present, either parallel or antiparallel to the unperturbed density gradient. The growth rate is proportional to a "corrected" electric field, which includes the time-invariant gradients of both density and space potential. The stabilizing effects of diffusion, parallel and perpendicular to the magnetic field, are considered. (Contractor's abstract)

1806

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OPTIMUM PREFILTERING IN SAMPLED DATA SYSTEMS WITH READ-IN JITTER, by B. Liu and R. E. Kahn. [1965] [7]p. incl. diagrs. (AFOSR-66-0091) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office

of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 625673 Unclassified

Presented at IEEE Internat'l. Convention, New York, Mar. 22-26, 1965.

Also published in IEEE Internat'l. Conv. Rec., pt. 7: 127-133, 1965.

This paper treats the problem of the simultaneous optimization of the presampling filter and the post-sampling filter in a sampling and reconstruction scheme where jitter is present at the sampler. The cases of both high frequency and extremely low frequency jitter are considered. The optimum filters with read-in jitter are determined and the minimum mean-squared errors are calculated. It is shown that in both cases the optimum prefilter limits the input spectrum to an angular frequency band of total width $2\pi\rho$ where ρ is the sampling rate.

1807

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

IMPULSES ORIGINATING IN THE REGION OF DENDRITES, by P. D. Wall. [1965] [18]p. incl. illus. diagrs. refs. (AFOSR-66-0092) (Sponsored jointly by Air Force Aeronautical Systems Division; Air Force Office of Scientific Research under AF AFOSR-64-591, [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), Bell Telephone Laboratories, Inc., National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, and Teagle Foundation, Inc.) AD 624355 Unclassified

Also published in Jour. Physiol. (London), v. 180: 116-133, Sept. 1965.

The nature of impulses recorded in the region of dendrites in the most dorsal part of the dorsal horn is examined. Small extracellular action potentials can be recorded in the substantia gelatinosa. They are not produced by either terminals of afferent fibers or by the small cells of substantia gelatinosa. It is shown that there spikes have exactly the same qualitative properties as those evoked in the cell bodies of deeper cells. Continuous recordings can be made from the dendritic region to the cell body region of these cells. Spontaneous activity is only present in the cell body region but, when the receptive field of the cell is stimulated, impulses are initiated in the dendrites and are not conducted back into the dendrites from the cell body. It is tentatively concluded that the region from which impulses can be initiated extends up into the dendrites as the intensity of bombardment and firing of the cell increases. The presence of multiple trigger zones and travelling impulses in dendrites would mean that the cell has far greater potentialities for the analysis and abstraction of patterns in its afferents than in the case for a cell with a single trigger zone in the region of its axon hillock.

1808

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MICROWAVE SCATTERING DUE TO ACOUSTIC-ION-PLASMA-WAVE INSTABILITY, by V. Arunasalam and S. C. Brown. [1965] [9]p. incl. diagrs. table, refs. (AFOSR-66-0093) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and Atomic Energy Commission) AD 624356 Unclassified

Also published in Phys. Rev., v. 140: A471-A479, Oct. 18, 1965.

An analysis is presented of an experimental study of microwave scattering from nonequilibrium plasmas in which the electrons had a large steady drift velocity with respect to the ions. According to theory, such plasmas must support "relatively undamped" acoustic-ion-plasma waves due to a 2-stream instability type of mechanism. Measurements of the frequency-power spectrum of the scattered signal show agreement with theory. In particular, as predicted, the measured scattering cross sections were large in comparison with the Thomson cross section. The effects of collisions predicted by theory did not show up in the experimental results. As expected from theoretical considerations of nonlinear effects (such as the nonlinear coupling between the plasma modes of different wave numbers), the relative drift velocity and the electron-ion temperature ratio tend toward a saturation value as the plasma current is increased. The experiment results indicate that the nonlinear effects are relatively weak.

1809

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

GLASS-COATED TUNGSTEN MICROELECTRODES, by H. A. Baldwin, S. Frenk, and J. Y. Lettvin. [1965] [3]p. incl. diagr. (AFOSR 66-0094) (Sponsored jointly by Aeronautical Systems Division; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), Bell Telephone Labs., Inc., National Aeronautics and Space Administration, National Institutes of Health, and Office of Naval Research) AD 624353 Unclassified

Also published in Science, v. 148: 1462-1464, June 11, 1965.

Unusually rugged microelectrodes for recording the activity of single nerve cells of fibers can be constructed from tapered tungsten wire on which a glass capillary is collapsed and surface bonded. Tip diameter in the range between 1 and 5 u provides relatively low impedance detection of extracellular potentials.

1810

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE LORENTZ FORCE, by P. Penfield, Jr. 1965 [1]p. incl. refs. (AFOSR-66-0095) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E)) AD 625671 Unclassified

Also published in Proc. IEEE, v. 53: 1144, Aug. 1965.

The author disagrees with Szablya (Proc. IEEE, v. 53: 418, Apr. 1965) who claims that the Minkowski form of the Lorentz force density on a swarm of electrons in electric and magnetic fields is the correct form. Szablya's proof is discussed in relation to the Chu and Minkowski forms. The author concludes that neither form is complete, or can be measured, except in free space where they agree anyway, and that the total force, including electromagnetic and mechanical contributions, is numerically the same whether evaluated according to the Minkowski or the Chu formulation.

1811

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

LONGITUDINAL WAVES IN A WEAKLY IONIZED GAS, by U. Ingard and K. W. Gentle. [1965] [2]p. (AFOSR-65-0096) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and Office of Naval Research) Unclassified

Also published in Phys. Fluids, v. 8: 1396-1397, July 1965.

An analysis is made of the speed of sound in a weakly ionized gas. It is concluded that the speed is unchanged within the experimental accuracy, but that the sound wave is slightly amplified by the ionized medium. The effect is damped by viscous and conduction losses.

1812

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STRONG COUPLING IN NUCLEAR RESONANCE SPECTRA. V. PERTURBATION THEORY FOR THE EXTREME COUPLING CASE, by J. S. Waugh and E. L. Wei. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-0097) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and National Institutes of Health) AD 624354 Unclassified

Also published in Jour. Chem. Phys., v 43, 2308-2311, Oct. 1, 1965.

The perturbation theory of NMR spectra is given for the case in which the relative chemical shift $\nu_0\delta$ between two groups much smaller than the coupling constant J. Results are given for the systems AB, AB_2, AB_3, A_2B_2, and A_2B_3 from which it is possible to obtain the parameters from the appropriate spectra without detailed analysis. The proton spectra of methylacetylene is discussed as an example. (Contractor's abstract)

1813

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

RESISTANCE OF AN N-DIMENSIONAL CUBE, by O. J. Tretiak and T. S. Huang. [1965] [2]p. incl. diagr. (AFOSR-66-0098) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 625674 Unclassified

Also published in Proc. IEEE, v. 53: 1271-1272, Sept. 1965.

An expression is derived for the resistance across the two opposite vertices of an n-dimensional cube each edge of which is a one-ohm resistance.

1814

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STAINING PROPERTIES OF LANTHANUM ON CELL MEMBRANES, by C. F. Doggenweiler and S. Frenk. [1965] [6]p. incl. illus. refs. (AFOSR-66-0099) (Sponsored jointly by Aeronautical Systems Division; Air Force [Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), Bell Telephone Labs., National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 624620 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 53: 425-430, Feb. 1965.

The introduction of L_a^{3+} either prior to fixation (incubation in $L_a(NO_3)_3$ or during fixation by using a $L_a(M_nO_4)_3$) results in unusual tagging of several structures, both intra- and extracellular. In particular, a surprising degree of density is produced in the intercellular substance in the nervous systems of vertebrates and invertebrates. The method used is described.

1815

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ON THE DETECTABILITY OF THE QUADRATIC NMR ELECTRIC-FIELD EFFECT IN LIQUIDS, by J. M. Deutch and J. S. Waugh. [1965] [2]p. incl. refs. (AFOSR-66-0100) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E)) AD 625672 Unclassified

Also published in Jour. Chem. Phys., v. 43: 2568-2569, Oct. 1, 1965.

The failure to observe shifts and splittings of NMR spectra of CHF_3 and CH_3NO_2 in a strong macroscopic electric field is reported, even though the Lorentz cavity model predicts success.

1816

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

BINAURAL INTERACTION IN THE ACCESSORY SUPERIOR-OLIVARY NUCLEUS OF THE CAT, by J. L. Hall. [1965] [10]p. incl. illus. diagrs. (AFOSR-66-0521) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)], National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 37: 814-823, May 1965.

Acoustic clicks were presented through earphones to the 2 ears of anesthetized cats, and the electrical response activity of single nerve cells in the accessory nucleus of the superior olive was studied. Stimulus parameters investigated included interaural time difference, interaural intensity difference, and average intensity. Attention was concentrated on cells that were excited by stimulation of the contralateral ear and inhibited by stimulation of the ispilateral ear. The experimental results are incorporated into van Bergeijs's model for binaural interaction, for which it is postulated that localization judgements are obtained on the basis of a comparison of the amounts of response activity in the two accessory nuclei. The model yields predictions that are in agreement with results from human psychophysics. The model predicts that the virtual image should be lateralized toward the side receiving prior or more intense stimulation. A time-intensity trading relationship that is in agreement with results from "centering" experiments is derived. The model predicts minimum detectable changes in interaural time difference of 5-10 usec and minimum detectable changes in interaural intensity difference of 0.1-0.5 db. (Contractor's abstract)

1817

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

BOUNDS ON TWO-ELEMENT-KIND IMPEDANCE FUNCTIONS, by T. S. Huang. [1965] [1]p. incl. diagr. (AFOSR-66-0522) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 620641 Unclassified

Also published in Electron. Ltrs., v. 1: 29, Apr. 1965.

Four types of two-element-kind networks are considered: R, ± C; R, ± L; ± R, C; and ± R, L networks. Regions in the Zplane are found within which the impedance function Z ($j\omega$) must lie. (Contractor's abstract)

1818

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

TEMPERATURE DEPENDENCE OF THE RAMAN SPECTRUM OF $BaTiO_3$, by C. H. Perry and D. B. Hall. [1965] [3]p. incl. diagrs. table, refs. (AFOSR-66-0523) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and National Science Foundation) AD 626365 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 700-702, Oct. 25, 1965.

The Raman spectrum of single-crystal $BaTiO_3$ has been observed in the Stokes region over the temperature 4°-475°K and becomes more complex as the temperature is lowered from the paraelectric state to the ferroelectric state. A strongly temperature-dependent vibration (varying between 230/cm and 270/cm^{-1}) has been observed and interpreted as the longitudinal mode associated with the low-frequency transverse ferroelectric 'soft' mode. This transverse mode could not be observed, and it was presumably hidden under the relatively broad Rayleigh line. The results imply that the model which attributes the ferroelectric transition to an instability against an optical vibration may still be applicable, except that the variation of dielectric constant with temperature is not just associated with the low-frequency transverse mode but with the temperature-dependent longitudinal mode.

1819

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

NONLINEAR NETWORK FOR THE MEASUREMENT OF THE RELATIVE ELECTRICAL CONDUCTIVITY BETWEEN HIGHLY CONDUCTING MATERIALS, by

B. T. Lubin, T. L. Földvári, and W. D. Jackson. [1965] [2]p. incl. diagrs. (Sponsored jointly by Aeronautical Systems Division; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 626358 Unclassified

Also published in Rev. Scient. Instr., v. 36: 1663-1664, Nov. 1965.

This report describes a technique for determining the relative electrical conductivity between highly conductive substances also using an inductive coil method, but in conjunction with a nonlinear network that was previously used for inductive transducers. The method presented indicates a possibility to measure the electrical conductivity in situations where direct contact measurements are difficult or impossible to make, such as in the case of a 2-phase liquid metal flow.

1820

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FACILITATION AND INHIBITION IN THE VISUAL SYSTEM AFTER PHOTIC STIMULATION, by A. Cavaggioni and M. H. Goldstein, Jr. [1965] [24]p. incl. diagrs. refs. (AFOSR-66-0525) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 626366 Unclassified

Also published in Arch. Ital. Biol., v. 103: 397-420, Sept. 10, 1965.

A large enhancement of the characteristic waveform recorded from visual cortex in response to electric stimulation of the optic radiation is observed after photic stimulation. Only points 3, 4, and 5 of the shock-evoked response are enhanced. These results are in agreement with those reported by Schoolman and Evarts (Jour. Neurophysiol., v. 22: 112-119, 1959). A similar enhancement is demonstrated after the termination of a prolonged photic stimulation. The enhancement is greatly reduced by deep barbiturate anesthetization. On presentation of the shock stimuli to the optic chiasm, an inhibitory effect is shown at the lateral geniculate body which is coincident with the facilitation of the cortex. The experiments indicate that it is not likely that the enhancement following transients in photic stimulation is mediated by reticular pathways.

1821

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME DIELECTRIC AND ELECTRO-OPTIC PROPERTIES OF $BaTiO_3$ SINGLE CRYSTALS, by C. J. Johnson. [1965] [3]p. incl. diagrs. table. (AFOSR-66-0526) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, and National Science Foundation) AD 626361 Unclassified

Also published in Appl. Phys. Ltrs., v. 7: 221-223, Oct. 15, 1965.

A study was made of the Curie temperature, static dielectric constant, and electro-optic coefficient of barium titanate single crystals. The results indicate that the Curie temperature is not a fixed material property, but shows some dependence on the sample history and environment. The static dielectric values show that Curie-Weiss behavior does exist, and the constants C and T_0 were found to be $C = 1.5 \times 10^5 C°(\pm 0.1 \times 10^5 C°)$ and $T_0 = 115°C$ ($\pm 1°C$). The value obtained for the electro-optic coefficient was $g_{11} - g_{12} = 0.10$ (meters)^4/(coulombs)^2. (± 0.02).

1822

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OPTIMUM ANGLE MODULATION, by C. J. Boardman and H. L. Van Trees. 1965 [18]p. incl. diagrs. table, refs. (AFOSR-66-0529) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) Unclassified

Also published in IEEE Trans. Commun. Theory, v. COM-13: 452-469, Dec. 1965.

The problem of transmitting an analog message over a channel corrupted by additive Gaussian noise using angle modulation of a sinusoidal carrier is considered. The problem is formulated as a continuous estimation problem, where the desired output is a waveform that is the maximum a posteriori estimate of the transmitted message. The resulting structure is a nonrealizable, nonlinear system. Next, a demodulator structure that is realizable with delay is found, whose performance approximates the optimum system. Keeping the demodulator structure optimum, the transmitted signal is now optimized to obtain the best overall system. Two types of system constraints are considered. The demodulator is constrained to be above threshold, and the rms transmitted bandwidth is constrained. The modulator consists of a linear preemphasis network which causes the overall system to be optimum. Finally, the optimum system is compared to a phase modulation system using an optimum demodulator and properly chosen modulation index. For the class of message spectra, the difference is small. (Contractor's abstract)

1823

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MEASUREMENT OF THE WIENER KERNELS OF A NON-LINEAR SYSTEM BY CROSS-CORRELATION, by Y. W. Lee and M. Schetzen. [1965] [18]p. incl. illus., diagrs. (AFOSR-66-0530) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) Unclassified

Also published in Internat'l. Jour. Control, v. 2: 237-254, Sept. 1965.

A practical and relatively simple method of measuring the Wiener kernels of a nonlinear system is presented. The method is based upon cross-correlation techniques and avoids orthogonal expansions such as those of the Wiener method of measurement. The application of this method to the experimental characterization of a nonlinear system is discussed. (Contractor's abstract)

1824

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME USEFUL EXPRESSIONS FOR OPTIMUM LINEAR FILTERING IN WHITE NOISE: II, by D. L. Snyder. [1965] [2]p. (AFOSR-66-0547) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, and National Science Foundation) AD 626362 Unclassified

Also published in Proc. IEEE, v. 53: 1254-1255, Sept. 1965.

The realization of minimum phase $H_{opt}(s)$ as a unity feedback system is considered, and the properties of the forward-loop filter, denoted by $G_{opt}(s)$, are examined. The poles of the loop filter always coincide with those of the filter generating the message. An easy method is provided for obtaining the minimum mean-square error when the optimum loop filter is known.

1825

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

INFRARED MATERIALS: FAR INFRARED REFLECTANCE SPECTRA AND DIELECTRIC DISPERSION OF A VARIETY OF MATERIALS HAVING THE PEROVSKITE AND RELATED STRUCTURES, by C. H. Perry. [1965] [11]p. incl. refs. (AFOSR-66-0548) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and National Science Foundation) AD 626357 Unclassified

Many compounds possessing the perovskite and related structures exhibit unusual properties, such as ferroelectricity and antiferromagnetism. Knowledge of the nature of the interatomic forces in the crystals prove extremely useful in explaining these phenomena. Of particular interest is the temperature-dependent low frequency mode which recent theories show is responsible for the ferroelectric and antiferroelectric behavior in certain perovskite titanates, zirconates and hafnates. The transmittance of a number of these materials were observed from 800-50/cm^{-1}. Reflectance measurements at room temperature were made of a wider range in the far infrared. Two cubic perovskite fluorides are included. The data were analyzed using the Kramers-Kronig relationship to obtain the dielectric dispersion of these materials. The resonances observed are related to presumed normal modes of vibration of the crystals and comparison is made between the various materials.

1826

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ABSOLUTE INSTABILITIES WITH DRIFTED HELICONS, by A Bers and A. L. McWhorter. [1965] [4]p. incl. diagrs. refs. (AFOSR-66-0549) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and National Science Foundation) AD 626912 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 755-758, Nov. 8, 1965.

Analytic results are reported for an exact computer analysis of helicon-wave instabilities in a drifted electronhole plasma. The results, which are based on a recently developed technique for determining the nature of instabilities, show, for example, that in InSb with equal electron and hole concentration, an absolute instability should appear above a threshold magnetic field, at an arbitrarily small electric field. Furthermore, a physical picture of the instabilities is developed which shows that the electron negative-energy wave with both positive and negative group velocities becomes unstable in the presence of the resistive medium background provided by the holes.

1827

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HITTING AND MARTINGALE CHARACTERIZATIONS OF ONE-DIMENSIONAL DIFFUSIONS, by M. A. Arbib. [1965] [16]p. (AFOSR-66-0550) (Sponsored jointly by Aeronautical Systems Division; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Institutes of Health) AD 626260 Unclassified

Also published in Zeitschr. Wahrscheinlichkeitstheorie, v. 4: 232-247, Nov. 1965.

The main theorem of the paper is that, for a large class of one-dimensional diffusions (i. e. strong Markov processes with continuous sample paths): if x(t) is a continuous stochastic process possessing the hitting probabilities and mean exit times of the given diffusion, then x(t) is Markovian with the transition probabilities of the diffusion. For a diffusion x(t) with natural boundaries at $\pm \infty$, there is constructed a sequence $\pi_n(t, x)$ of functions with the property that the $\pi_n(t, x(t))$ are martingales, reducing in the case of the Brownian motion to the familiar martingale polynomials. It is finally shown that if a stochastic process x(t) is a martingale with continuous paths, with the additonal property that $\int_0^{x(t)} m(0, y]\, dy - t$ is a martingale, than x(t) is a diffusion with generator DmD^+ and natural boundaries at $\pm \infty$. This generalizes a martingale characterization given by Levy for the Brownian motion.

1828

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SYMPOSIUM: PHILOSOPHY AND LINGUISTICS. THE RELEVANCE OF LINGUSTICS TO PHILOSOPHY, by J. J. Katz. [1965] [14]p. (AFOSR-66-0551) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and National Science Foundation) AD 626364 Unclassified

Also published in Jour. Philos., v. 62: 590-602, Oct. 1965.

The relevance of linguistics to philosophy is defended on the grounds that linguistic theory incorporates solutions to significant philosophical problems. The defense shows that a number of philosophical problems can be represented as questions about the nature of language, and that, so represented, they can be solved by conceptual constructions found in linguistic theory. The justification of these solutions is provided by the same evidence that warrants the introduction of such conceptual constructions into linguistic theory. The thesis is not that the linguist's description of locutions from natural languages reveals philosophical insights that somewhat escape philosophers. It is rather that conceptual constructions, initially devised to enable linguistic theroy to state uniformities in natural languages systematically, also fulfill the conditions on solutions to certain ph losophical problems. If this defense proves successful, linguistics is not incidentally pertinent to philosophy in the way that philosophy of science bears upon the clarification of methodology and theory construction in linguistics, but is directly relevant in the same way that philosophical theories themselves are.

1829

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AN ADDITIONAL REALIZATION CYCLE FOR LC IMPEDANCES, by H. B. Lee. 1965 [3]p. incl. diagrs. (AFOSR-66-0553) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E)) Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 435-437, Sept. 1965.

A realization cycle for a lossless driving point impedance is introduced which yields an unsymmetrical bridged tee terminated in a simpler impedance. The cycle is appropriate for lossless impedances of the form $Z(s) = A[s(s^2 + \alpha_1^2)\cdots(s^2 + \alpha_{n-1}^2)]/(s^2 + B_1^2)\cdots(s^2 + B_n^2)$ and has associated with it a remainder function $Z_r(s) = H[s(s^2 + \gamma_1^2)\cdots(s^2 + \gamma_{n-3}^2)]/(s^2 + \delta_1^2)\cdots(s^2 + \delta_{n-2}^2)$. The cycle is canonic, achieving a coefficient simplification of the driving point function via the synthesis of a four element two port. The validity of the procedure is shown. Several variations of the basic cycle are discussed, e.g. a lossless driving point admittance of the form of Z(s) above is also realized as an unsymmetric bridged tee (dual to that realized for Z) and a simpler admittance.

1830

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THEORY OF SIDEBAND PRODUCTION IN SPECTROSCOPIC EXPERIMENTS, by J. D. Macomber and J. S. Waugh. [1965] [4]p. incl. table. (AFOSR-66-0554) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and National Science Foundation) Unclassified

Also published in Phys. Rev., v. 140: A1494-A1497, Nov. 29, 1965.

In many systems which are capable of coherent scattering of radiation, satellite lines appear at regular frequency intervals about the center (carrier) line in the spectrum. Well-known examples include the Zeeman sidebands in magnetic resonance spectra and the Stark sidebands employed in microwave spectroscopy. In this paper, a theory developed by Karplus to describe the latter case is generalized to cover a wider range of phenomena. The results are discussed from the point of view of nuclear magnetic resonance. (Contractor's abstract)

1831

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AN EXPERIMENTAL FACILITY FOR SEQUENTIAL DECODING, by C. W. Niessen. Sept. 13, 1965, 76p. incl. illus. diagrs. tables, refs. (Technical rept. no. 450; Lincoln Lab. technical rept. no. 396) (AFOSR-66-0978) (In cooperation with Massachusetts Inst. of Tech., Lincoln Lab., Cambridge) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 631240 Unclassified

This report describes the system design and implementation of a facility for the experimental study of sequential decoding that may be used at M.I.T. by graduate researchers in communications theory. Flexibility and ease of use are the primary requirements of this system. Thorough investigation of the characteristics of sequential decoding and likely problems to be studied led to a system based upon the Project MAC PDP-6 computer. A portable data-acquisition system, consisting of a digital tape recorder and analog-to-digital conversion equipment, is provided to make available to the computer the outputs of experimental demodulation equipment. The experimenter can decode the acquired data sequentially in accordance with an algorithm specified and easily written by him in a version of Fortran modified for this purpose. A display system is used for man-machine interaction. The system has been successfully implemented and tested, and experimental results are described.

1832

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DISCHARGE PATTERNS OF SINGLE FIBERS IN THE CAT'S AUDITORY NERVE, by N. Y.-S. Kiang, L. F. Clark and others. [1965] [166]p. incl. refs. (Special technical rept. no. 13; Research monograph no. 35) (AFOSR-66-1072) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 633419 Unclassified

The monograph represents a systematic attempt to describe in a quantitative manner the electrophysiological responses in the peripheral auditory nervous system. The purpose of this research was to discover how the mammalian auditory nerve describes sounds by examining the patterns of discharges in nerve fibers of the auditory nerve in response to controlled acoustic stimuli. The research itself was conducted on healthy adult cats but should have important bearing on the study of human hearing.

1833

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CONCATENATED CODES, by G. D. Forney, Jr. Dec. 1, 1965, 107p. incl. diagrs. tables, refs. (Technical rept. no. 440) (AFOSR-66-1083) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) Unclassified

Concatenation is a method of building long codes out of shorter ones; it attempts to meet the problem of decoding complexity by breaking the required computation into manageable segments. Theoretical and computational results bearing on the efficiency and complexity of concatenated codes, are presented. The major theoretical results are the following: (1) Concatenation of an arbitrarily large number of codes can yield a probability of error that decreases exponentially with the over-all block length, while the decoding complexity increases only algebraically; and (2) Concatenation of a finite number of codes yields an error exponent that is inferior to that attainable with a single stage, but is nonzero at all rates below capacity. Computations support these theoretical results, and also give insight into the relationship between modulation and coding. This approach illuminates the special power and usefulness of the class of Reed-Solomon codes. An original presentation of their structure and properties is given, from which one derives the properties of all BCH codes; one determines their weight distribution, and considers in detail the implementation of their decoding algorithm, which is extended to correct both erasures and errors and is otherwise improved. This shows that on a particularly suitable channel, RS codes can achieve the performance specified by the coding theorem. Finally, a generalization of the use of erasures in minimum-distance decoding is presented, and the appropriate decoding techniques, which constitute an interesting hybrid between decoding and detection is discussed.

1834

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PASSIVE RADIO OBSERVATIONS OF MERCURY, VENUS, MARS, SATURN, AND URANUS, by A. H. Barrett. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-1831) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), and National Aeronautics and Space Administration) AD 633794 Unclassified

Also published in Radio Science, v. 69D: 1565-1573, Dec. 1965.

The radio observations of Mercury, Venus, Mars, Saturn, and Uranus are reviewed and discussed in relation to knowledge of these planets acquired by other means. In the case of Mercury, it is shown that the radio observations imply a temperature of ~300°K for

the unilluminated hemisphere, a result which appears to be in sharp disagreement with infrared measurements of Mercury. Two detailed measurements of the Venus spectrum near 1-cm wavelength are presented and compared. (Contractor's abstract)

1835

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A COMPARISON OF OPTIMUM ANGLE MODULATION SYSTEMS AND RATE-DISTORTION BOUNDS, by H. L. Van Trees. 1965 [2]p. incl. diagrs. (AFOSR-66-2296) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 630494 Unclassified

Also published in Proc. IEEE, v. 53: 2123-2124, Dec. 1965.

The purpose is to point out an interesting comparison between 2 results in the area of analog message transmission. The first result concerns the design and performance of an optimum angle modulation system. The second result concerns a bound on the mean-square distortion error derived using the rate-distortion function of a continuous message source. The point of interest is that, except for a constant, the mathematical expressions obtained using these 2 diverse approaches are identical. (Contractor's abstract)

1836

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

SOME CONTROVERSIAL QUESTIONS IN PHONOLOGICAL THEORY, by N. Chomsky and M. Halle. [1965] [42]p. incl. refs. (AFOSR-66-2300) (Sponsored jointly by Air Force Electronic Systems Division; [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 630493 Unclassified

Also published in Jour. Linguistics, v. 1: 97-138, Oct. 1965.

This is a reply to an article by F. W. Householder (Jour. of Linguistics, v. 1: 13-34, 1965) which discusses 2 papers by the authors concerning the phonological component of a generative grammar. Mr. Householder's major criticisms are classified into 7 parts: goals of linguistic theory, independence of phonology, status of phonemes versus features, adequacy of Jakobson's theory with respect to natural classes, validity of procedures of taxonomic linguistics, and phonetic basis of phonemic analysis.

1837

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DENDRITIC FIELDS OF RETINAL GANGLION CELLS OF THE RAT, by J. E. Brown. [1965] [10]p. incl. illus. diagrs. tables, refs. (AFOSR-66-2301) (Sponsored jointly by Aeronautical Systems Division; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), Bell Telephone Laboratories, Inc., National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, Teagle Foundation, Inc.) AD 630488 Unclassified

Also published in Jour. Neurophysiol., v. 28: 1091-1100, Nov. 1965.

Retinal ganglion cells of the rat were stained in vivo with methylene blue. Two classes of ganglion cells were found, based on the morphologies of the dendrites of the stained cells. The dendrites of one class of cells ("tight") penetrated deep into the inner plexiform layer and had a sense arborization. The dendritic arborization of the other class ("loose") was more sparse and was found in a more shallow region of the inner plexiform layer. No multilayered cells were observed. Speculatively, these two classes were identified with receptive field types previously found by electrophysiological techniques. Tentatively the tight cells might be those units with no demonstratable surround regions, and the loose cells those which have a center-surround type of organization.

1838

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

RAT RETINAL GANGLION CELLS: RECEPTIVE FIELD ORGANIZATION AND MAINTAINED ACTIVITY, by J. E. Brown and J. A. Rojas. [1965] [18]p. incl. illus. diagrs. refs. (AFOSR-66-2302) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), Bell Telephone Laboratories, Inc., National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, and Teagle Foundation, Inc.) AD 630502 Unclassified

Also published in Jour. Neurophysiol., v. 28: 1073-1090, Nov. 1965.

The receptive field organization of single retinal ganglion cells of the rat was studied. A cell was stimulated by a variety of configurations of moving and stationary stimuli displayed on a screen 16 in. from the eye. The responses of the cell were recorded with a low-impedance metal microelectrode from the axon of the cell in the optic nerve or optic tract. Two types of units were found: units which had concentrically arranged receptive fields with a central region which responded either to an increase (on) or a decrease (off) of illumination and a surround region which antagonized

the responses of the central region, and units which had no demonstrable surround. In spite of extensive search no other types of receptive fields were found. The efficacy of the surround, when it was present, in antagonizing the center varied among the units. In addition, both on- and off-center units were either slow or fast in adapting to changes in illumination. The receptive field organization did not change very much with anesthetic doses of urethane and pentobarbital. The maintained activity of single retinal ganglion cells was studied in anesthetized and unanesthetized rats. In an unanesthetized rat the maintained activity of a single unit was more or less random. Under barbiturate anesthesia maintained activity characteristically showed a regular, repetitive bursting pattern: bursts of several spikes were recorded at rates between 12 and 16 times/sec. This repetitive, bursting activity was found to originate in the retina and was synchronized over a large part of the retina.

1839

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PHOTOELECTRON STATISTICS PRODUCED BY A LASER OPERATING BELOW THE THRESHOLD OF OSCILLATION, by C. Freed and H. A. Haus. [1965] [4]p. incl. diagrs. (AFOSR-66-2302) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E)) AD 630504 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 943-946, Dec. 20, 1965.

This paper deals with the theory and experimental verification of the probability distribution of photoelectron counts produced by a narrow-band Gaussian light source. By counting the rate of arrival of individual photoelectrons emitted from a photocathode when illuminated by a 6328A He-Ne laser operated just below the threshold level, theoretical equations for the statistics of this process have been verified experimentally. Using a counting time short compared with the inverse bandwidth of the light, the statistics followed closely the Bose-Einstein distribution to be expected for a source with a Gaussian amplitude distribution, but with a counting time longer than Δt, the statistics were of the form predicted by Glauber (Phys. Rev., v. 131: 2766, 1963).

1840

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PASSIVITY CONDITIONS, by P. Penfield, Jr. 1965, [3]p. (AFOSR-66-2304) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)) AD 630500 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12. 446-448, Sept. 1965.

A square, complex matrix S obeys the "passivity condition" if the matrix $(1 - S^{\dagger}S)$ is positive semidefinite. This condition is pertinent to circuit theory because the scattering matrix of a passive linear network, for any real frequency ω obeys this condition, as do many other matrices which can be derived from the scattering matrix. A set of necessary conditions for S to obey the passivity condition and one set of sufficient conditions are given. The chief virtue of these tests is that they are written entirely in terms of subdeterminants of the matrix S, and the matrix $(1 - S^{\dagger}S)$ need never by evaluated in order to apply the tests.

1841

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ONE-TAPE, OFF-LINE TURING MACHINE COMPUTATIONS, by F. C. Hennie. [1965] 26p. incl. diagrs. (AFOSR-66-2305) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health and National Science Foundation) Unclassified

Also published in Inform. and Control, v. 8 553-578, Dec. 1965.

This paper has two purposes. The first is to investigate the characteristics of a restricted class of Turing machines, and to develop a simple tool for describing their computations. The second is to present specific problems for which tight lower bounds can be found for the computation times required by Turing machines of this restricted class. (Contractor's abstract)

1842

Massachusetts Inst. of Tech. Research Lab of Electronics, Cambridge.

PCM PICTURE TRANSMISSION, by T. S. Huang. 1965 [7]p. incl. illus. diagrs. table, refs. (AFOSR-66-2309) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 630496 Unclassified

Also published in IEEE Spectrum, v. 2: 57-63, Dec. 1965.

This article briefly describes some of the research being carried on in PCM picture transmission. Research efforts on picture transmission by pulse code modulation falls into 2 categories: (1) Investigations on how the quality of the received picture depends on various system parameters, and (2) bandwidth compression techniques. Most of the studies have been done by digital computer simulation. The speed and memory capacity of present-day computers have limited the workers chiefly to considerations of monochrome still pictures

1843

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LONG-WAVE INFRARED SPECTRA OF ALKALI SALTS OF PLATINUM HALIDE COMPLEXES, by [illegible] and C. H. Perry. 1965. 6p. incl. illus., tables, refs. (AFOSR-66-2311) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research under DA 36 039 AMC-03200(E), and National Science Foundation) AD 630499 Unclassified

Presented at Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 15-19, 1964. Abstracts, p. 91-92.

Also published in Jour. Phys. and Chem. Solids, v. 26: 1773-1778, Dec. 1965.

The absorption spectra of a number of alkali salts of platinum metal halide complexes have been investigated using a vacuum far-infrared spectrometer. Lattice vibrations and the stretching and bending frequencies of the metal-halogen bonds have been observed in the range 40-360 cm^{-1}. The compounds, which are of the type R_2XY_4 (square planar anion), were examined both at room temperature and at liquid nitrogen temperature. The assignment of the normal modes has been made and the force constants of the vibrational motions have been calculated using a valence force field model. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

TEMPERATURE AND PRESSURE DEPENDENCE OF SELF-DIFFUSION IN LIQUID ETHANE, by C. G. Wade and J. S. Waugh. [1965] [3]p. incl. diagrs. refs. (AFOSR-66-2312) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), and National Institutes of Health) Unclassified

Also published in Jour. Chem. Phys., v. 43: 3555-3557, Nov. 15, 1965.

The self-diffusion coefficient of ethane has been measured by the spin-echo method in the liquid range between 155° and 298°K and at pressures between the vapor pressure and 2200 atm. The results, interpreted with the help of an approximately determined equation of state, are inconsistent with simple free volume and activated diffusion theories. (Contractor's abstract)

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

BASIC EQUATIONS AND CONSERVATION THEOREMS FOR THE ELECTROSTRICTION PHONON MASER, by H. A. Haus and P. Penfield, Jr. [1965] [5]p. incl. refs. (AFOSR-66-2317) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36 039-AMC-03200(E)]) AD 630497 Unclassified

Also published in Jour. Appl. Phys., v. 36: 3735-3739, Dec. 1965.

Brillouin scattering of light by phonons and the phonon maser are usually described in terms of an approximate set of linearized equations. The authors give a more exact set of equations for a lossless polarizable fluid, only relativistic effects are disregarded. When these equations are linearized and higher order terms in the ratio of sound speed to light speed are disregarded, they reduce to the customary set of equations. The more exact equations permit the derivation of the law of conservation of energy with a simple physical interpretation. From these equations, the Manley-Rowe relations and other conservation laws also follow relatively easily. (Contractor's abstract)

1846

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SPECULATIONS ON SMELL, by J. Y. Lettvin and R. C. Gesteland. [1965] [9]p. incl. diagrs. (AFOSR-66-2319) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), Bell Telephone Laboratories, Inc., National Aeronautics and Space Administration, and National Science Foundation) AD 633497 Unclassified

Also published in Cold Spring Harbor Symposia on Quantitative Biology, Cold Spring Harbor, N. Y. (June 4-11, 1965), ed. by L. Frisch. Cold Spring Harbor Laboratory of Quantitative Biology, v. 30: 217-225, 1965.

This paper complements the detailed account of the experiments in Journal of Physiology (v. 181: 525, Dec. 1965). Psychological questions associated with the phenomena of smell and quality of odors suggest that one function of smell is not to detect pure chemicals apart but to distinguish clearly between very similar mixtures. Physiological studies of olfactory receptors are discussed and electroosmogram responses are reported. The crude image of olfactory coding thus far constructed envisions receptors as having species of chemically sensitive traps which may have one or the other (or both) of 2 signaling actions on clasping a molecule. The actions of the molecular traps on a single receptor are not linearly combinatorial or else, if there is only one sort of trap for each receptor, then the action of odors on this trap is not simply combinational. The receptor sees pure odors and combinations of odors along a single dimension from most exalting to most depressing.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CHEMICAL TRANSMISSION IN THE NOSE OF THE FROG, by R. C. Gesteland, J. Y. Lettvin, and W. H. Pitts. [1965] [34]p. incl. diagrs. refs. (AFOSR-66-2323) (In cooperation with Scientific Engineering Inst., Waltham) (Sponsored jointly by Aeronautical Systems Division; [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), Bell Telephone Laboratories, Inc., Dearborn Foundation, National Aeronautics and Space Administration, National Institutes of Health, and National Science Foundation) AD 635421 Unclassified

Also published in Jour. Physiol., v. 181: 525-529, Dec. 1965.

An account is given of research conducted to determine what relation there is between the slow change in the potential difference measured across the mucosa, and activity in the olfactory nerve. Fibers of the olfactory nerve often have a continuous, but noisy, activity. They are inhibited by some odours, excited by others, unaffected by yet others, and sometimes show a response in which noisy base-line activity becomes more rhythmic. For any pair of compounds that excite or inhibit one fiber in the same way, with very little search one can find a fiber that is affected differently by the two. This observation applies so far only to the limited variety of compounds used. The slow potentials recorded grossly from the mucous surface over the olfactory epithelium are compounded of at least two processes that oppose each other. One kind of process tends to return the potential to a certain level or drives it positive; another kind displaces the potential in the negative direction. These two processes can be distinguished not only by linear and nonlinear interactions between slow potentials but by a crude measurement of impedance that, at a low frequency, identifies the positive-driving process with a change in phase, and the negative-driving process with a change in magnitude. The positive-driving, or resting-level-seeking process, is tentatively identified with an inhibitory action of active sites in the receptors, and the other is identified with excitatory action of active sites.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PAIN MECHANISMS: A NEW THEORY, by R. Melzack and P. D. Wall. [1965] [9]p. incl. illus. diagrs. refs. (AFOSR-66-2325) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E), Bell Telephone Laboratories, Inc., National Aeronautics and Space Administration, National Institutes of Health, National Science Foundation, and Teagle Foundation, Inc.) AD 633510 Unclassified

Also published in Science, v. 150: 971-979, Nov. 19, 1965.

It is proposed that the presence or absence of pain is determined by the balance between the sensory and the central inputs to the gate control system. In addition to the sensory influences on the gate control system, there is a tonic input to the system from higher levels of the central nervous system which exerts an inhibitory effect on the sensory input. Thus, any lesion that impairs the normal downflow of impulses to the gate control system would open the gate. Central nervous system lesions associated with hyperalgesia and spontaneous pain could have this effect. On the other hand, any central nervous system condition that increases the flow of descending impulses would tend to close the gate. Increased central firing due to denervation supersensitivity might be one of these conditions. A peripheral nerve lesion, then, would have the direct effect of opening the gate, and the indirect effect, by increasing central firing and thereby increasing the tonic descending influences on the gate control system, of closing the gate. The balance between sensory facilitation and central inhibition of the input after peripheral-nerve lesion would account for the variability of pain even in cases of severe lesion.

1849

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

BEAM-PLASMA DISCHARGE (Abstract), by R. Parker L. D. Smullin, and W. Getty. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 221, Feb. 25, 1965.

Recent experiments on a system with improved base pressure 10^{-8} Torr and with improved isolation of the electron gun from the plasma are described. Using 700-μsec pulses of about 10-15 kv and 10-20 A, virtually fully ionized plasmas of 10^{12}-10^{13} density are generated in an ambient hydrogen atmosphere of $1\text{-}3\times10^{-5}$ Torr By proper adjustment of the magnetic field, it is possible to eliminate gross instabilities during the pulse. The plasma electrons have a peculiar velocity distribution with an anomalously large high-energy component. When the beam is turned off, the low-energy electrons seem to disappear in 100 μsec, while the high-energy ones persist for 10-20 msec.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

DETERMINATION OF ELECTRON VELOCITIES BY THOMSON SCATTERING (Abstract), by T. S. Brown and D. J. Rose. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research

Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], Atomic Energy Commission and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 226, Feb. 25, 1965.

A formula has been derived that gives the complete velocity distribution function of electrons f(v) in a plasma if the spectral intensity $I(\Omega, \omega)$ of Thomson-scattered light is known in angle Ω and frequency ω. f(v) may be relativistic, but quantum-mechanical and correlation effects are all neglected. An expression giving $I(\Omega, \omega)$ in terms of f(v) is derived and inverted, but the lack of simplicity in the resulting mathematical expressions necessitates a more pragmatic approach. The scattered intensity I is calculated for a number of cases where f(v) is presumed to have some symmetry. A rudimentary library of typical spectra is shown. Different f(v) can be distinguished with the least difficulty via the wings of the spectrum I.

1851

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

EFFECT OF COMBINED d.c. AND rf MAGNETIC FIELDS UPON THE SKIN DEPTH OF GALLIUM (Abstract), by J. F. Cochran and C. A. Shiffman. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 110, Jan. 27, 1965.

The dependence upon static magnetic field of the skin depth of gallium single crystals was measured at 2 mc/sec and from 1° to 4°K, using a geometry in which the d.c. and rf fields are parallel. The skin depth displays marked oscillatory variations when the d.c. magnetic-field amplitude is less than, or comparable to, the rf-field amplitude. The authors have used rf magnetic fields up to 10 G and find that this effect does not depend upon specimen thickenss, but is a strong function of temperature in unstrained specimens. It is suggested that the experiment measures the average magnetoresistive effect due to the combined d.c. and rf fields acting on charge carriers that are moving predominantly parallel to the specimen surface in the skin layer.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

ELECTRON-BEAM INTERACTIONS WITH IONS IN A HOT ELECTRON PLASMA (Abstract), by R. N. Wallace, S. Puri, and A. Bers. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 221-222, Feb. 25, 1965.

Low-frequency instabilities supported in an electron-beam/plasma system enclosed by a waveguide structure uniform in the direction of a large applied magnetic field are investigated. This investigation is part of a continuing study to determine conditions under which plasma ions may gain appreciable energy through direct interaction with the electron beam. Different types of instabilities are identified and their growth rates evaluated, using recently developed stability criteria. Finite-temperature transport theory shows that an absolute (nonconvective) instability occurs slightly below the ion-plasma frequency when the conditions $T_c > V_0$ and $\omega_{pb} > \omega_{pi}$ are well satisfied. When either T_c or ω_{pb} is smaller than the value required to maintain the absolute instability, a convective instability having a spatial growth rate that is sharply peaked in frequency is predicted. In addition, for $T_c < V_0$, a convective instability with slowly varying spatial growth rate is predicted for frequencies from ω_{oi} to above ω_{pi}. The physical nature of the absolute instability is interpreted by considering power flow in the waves, which are supported by the beam-plasma system.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

INSTABILITIES IN PLASMAS WITH BEAM-TYPE DISTRIBUTIONS (Abstract), by A. Bers. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)]. and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 221, Feb. 25, 1965.

The stability of beam-type distributions, $f_0(p) = \delta(p_\perp - p_{0\perp})\delta(p_\parallel - p_{0\parallel})/2\pi p_{0\perp}$, using the linearized, relativistic, Vlasov and Maxwell equations is investigated. With the newly developed instability criteria, a complete analysis of the dispersion relation is carried out. In the zero-density limit, a "radiationlike" instability is found for transverse waves both along and across B_0; along B_0, it occurs for the right-polarized wave near ω_b, and across B_0 it occurs for the extraordinary wave near $n\omega_b$. As the density is increased, this

"radiationlike" instability is found to at first increase as $n_0^{\frac{1}{3}}$ and then rapidly decrease and disappear. The quasistatic waves ($k \| E$) across B_0 exhibit a similar instability. Stable "beam-type" distributions are found to have negative-energy wave characteristics. In the presence of another plasma (say, Maxwellian or also beam-type), these again become unstable.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

INTERACTIONS OF A PLASMA WITH A BEAM INJECTED ACROSS THE MAGNETIC FIELD (Abstract), by R. R. Bartsch and A. Bers. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 214, Feb. 25, 1965.

It is shown that a beam (of ions or electrons) injected with velocity v_0 into a plasma across its confining magnetic field B_0 induces 3 distinct types of slow-wave instabilities: (1) positional instability of the beam for displacements across both B_0 and v_0; (2) growth of short-wavelength perturbations across both B_0 and v_0; (3) growth of short-wavelength perturbations along B_0. The first is a displacement instability—a diocotron instability enhanced by the plasma. The second is a cyclotron instability induced by the reactive medium properties of the plasma at the extraordinary wave resonances. The third is analogous to the Burt-Harris instability. The complete interaction is described by a dispersion relation that contains the boundary conditions for a thin beam across B_0 in a plasma. Applications of this theory to ion-beam systems (DCX, Calutron) and electron-beam systems (Astron) are discussed.

1855

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LIVING MODELS FOR LIVELY ARTIFACTS, by W. S. McCulloch. [1965] [11]p. [Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-AMC-03200(E)] Unclassified

Published in Science in the Sixties; Tenth Anniversary AFOSR Scientific Seminar, Cloudcroft, N. M. (Jure 14-25, 1965), ed. by D. L. Arm. Albuquerque, New Mexico U. Office of Publications, 1965, p. 73-83.

The article presents a comparison of the central nervous system, the computer within man, with mechanical computers. The structure of the brain and spinal cord and the method by which they function and handle information is presented in some detail, and how they have inspired man to make devices to do similar things is considered. The history of logical machines and problems encountered in their engineering are reviewed. Nature has beaten man at miniaturizing by packing 10^{10} components in a single head so it can work "in parallel" and by having real neurons, not man's poor threshold devices, in truly anastomotic nets combatting noise. A theory is lacking for iterated decisional nets like the reticular core of the nervous system. Artificial neurons capable of composing properly anastomotic nets to compute correctly in the presence of almost every kind of noise are needed.

1856

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

MEAN FREE PATH OF ELECTRONS AND MAGNETOMORPHIC EFFECTS IN SMALL SINGLE CRYSTALS OF GALLIUM, by M. Yaqub and J. F. Cochran. [1965] [19]p. incl. illus., diagrs. refs. (Sponsored jointly by Advanced Research Projects Agency, and Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)]) Unclassified

Published in Phys. Rev., v. 137: A1182-A1200, Feb. 15, 1965.

The variation of electrical resistivity of 99.9999%-pure gallium has been investigated as a function of size in oriented single crystals for current flow along the C axis. The crystals were in the form of wires of square cross section and their dimensions varied from 1 to 0.1 mm. Analysis of the data based on the free-electron model, assuming diffuse scattering at the boundaries, yields a value of 8.11×10^{-11} Ω-cm^2 for $(\rho_b l_b)$ C axis and indicates that at 0 K the mean free path of the charge carriers in the bulk metal is considerably in excess of 1 cm. Within the accuracy of the measurements the ideal bulk resistivity at low temperature varies as T^2, indicating that the electron-electron collisions may be contributing to the resistive processes. For low values of a longitudinal magnetic field, all the crystals showed a large decrease in resistance followed by an increase due to bulk magnetoresistance, both at 4.2° and 1.2° K. For the same 2 temperatures these crystals also displayed a rather large magnetoresistance in transverse magnetic fields. Magnetomorphic effects for transverse fields were evidenced by the fact that the field dependence of magnetoresistance was less than quadratic for all crystals until the cyclotron radius of the charge carriers acquired a value much smaller than the cross-sectional dimensions of the specimens. The resistance of all the crystals was found to be a complicated function of the measuring current. Calculations based on certain simplifying assumptions show that for thin wires in which boundary scattering is predominant, the resistance decreases monotonically as a function of the current and is due to the trapping of the charge carriers in the magnetic field generated by the

current. The details of the experimental curves can be reproduced reasonably well if the fall in resistance due to the trapped particles is superimposed on the magnetoresistance caused by the self field. (Contractor's abstract)

1857

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

MEASUREMENT OF THE DIELECTRIC COEFFICIENTS OF DENSE PLASMAS AT SUBMILLIMETER WAVELENGTHS (Abstract), by D. T Llewellyn-Jones and S. C. Brown. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 218, Feb. 25, 1965.

The technique is an adaptation of interferometric spectroscopy. The plasma is placed in one arm of a wide-bandwidth, far infrared Michelson interferometer and the path difference varied by a moving mirror. The instrument operates at wavelengths between approximately 0.2 and 1.0 mm, and the technique is applicable at densities between 10^{12} and 10^{17} electrons cm^{-3}. The frequency spectrum is the Fourier transform of the spatial-interference pattern and is evaluated by a digital computer. The effect of the plasma is measured by comparing 2 transforms, one with and one without the plasma present. The instrument has been tested with the positive column of a dc glow discharge in argon. Measurements were made of the real part of the dielectric coefficient at wave lengths between 0.22 and 0.72 mm, and they corresponded to an electron density of 9×10^{12} electrons cm^{-3}.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

MICROWAVE MEASUREMENTS OF ELECTRON DIFFUSION IN A WEAKLY IONIZED FLOWING GAS (Abstract), by K. W. Gentle, G. A. Garosi and others. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc , Series II, v. 10: 212, Feb. 25, 1965.

The effects of axial gas flow on the ambipolar diffusion of room-temperature electrons diffusing radially across a cylindrical plasma column are reported. The effective diffusion coefficient was inferred from time-resolved measurements of electron density in the late afterglow of a pulsed microwave discharge in helium and argon. The electron density was obtained from the loading of a cylindrical microwave cavity operated in the TE_{111} mode, at a frequency of 3000 mc/sec. The gas-flow velocity was varied between zero and 10,000 cm/sec and the static gas pressure between 2 and 20 Torr. Measurements show a pronounced increase in the diffusion coefficient at gas velocities for which the flow is turbulent. The results are compared with observed effects of gas flow on microwave breakdown.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

PLASMA DISPERSION RELATIONS AND THE STABILITY CRITERIA (Abstract), by B. R. Kusse. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 222, Feb. 25, 1965.

Criteria developed by Briggs and Bers that predict the stability or instability of a plasma are outlined. To apply these stability criteria, the loci of the propagation constants k that satisfy the dispersion relation are investigated as the imaginary parts of critical frequencies are swept from large negative values to zero. From these loci in the complex k plane, the stability or instability of the plasma can be predicted. When kinetic theory is used to obtain the dispersion relations, they are in the form of singular integrals that result in nonanalytic functions in the complex ω and k planes. Care must be taken when these nonanalytic dispersion relations are used with the above stability criteria. In this paper, the kinetic-theory dispersion relation for longitudinal plane waves in an infinite plasma is discussed in connection with the stability criteria. The rules applying the stability criteria to kinetic-theory dispersion relations are presented. These techniques are then applied to investigate the instabilities of an infinite, one-dimensional plasma composed of hot contrastreaming electrons and cold, stationary ions.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

PULSED ELECTRON CYCLOTRON RESONANCE DISCHARGE (Abstract), by T. J. Fessenden and L. D. Smullin. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 207, Feb. 25, 1965.

A hydrogen discharge has been produced by 1-μsec, 100-kw pulses of microwave power at 2.8 Gc/sec. The discharge in a cylindrical metal box was operated at pressures from 10^{-6} to 10^{-3} Torr. A steady magnetic-mirror field placed along the axis of the box served to confine the discharge and to resonate the electrons with the microwave field. The principal effect of the short pulses of microwave energy is to heat electrons, already present, to large temperatures. Between pulses the energetic electrons produce many low-energy electrons by ionization, thereby replacing the particles lost from the magnetic mirror by scattering. The energetic electrons produce x-rays of energies up to 500 kev. The "temperature" of the x-rays, as determined by a pulse-height analyzer, was approximately 25 kev.

1861

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

REACTION OF ATOMIC HYDROGEN WITH PROPYLENE AT 77 °K AS STUDIED BY ELECTRON SPIN RESONANCE, by C. G. Hill, Jr., R. C. Reid, and M. W. P. Strandberg. [1965] [5]p. incl. diagr. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], and National Science Foundation) Unclassified

Published in Jour. Chem. Phys., v. 42: 4170-4174, June 15, 1965.

Hydrogen-atom reaction rates with thin solid propylene films were studied at 77°K. Propylene was deposited on the walls of a quartz resonance cavity of an ESR spectrometer and hydrogen-atom concentrations were monitored during reaction. The hydrogen atoms were produced in a 2450 mc/sec microwave discharge external to the cavity and either diffused into or were pumped through the reaction zone. The products of the reaction were found to be propane and 2,3-dimethylbutane. The ratio of propane to 2,3-dimethylbutane in the products increased as the average hydrogen-atom concentration in the reactor increased. The product distribution and the variation of this distribution with hydrogen-atom concentration are explained by a given sequence of reactions. The rate constant k_1 was found to be 1.8×10^6 cc/mol/sec at 77°K assuming that the monitored hydrogen-atom concentration was equal to that in the reaction zone. (Contractor's abstract, modified)

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

REFLECTION OF GUIDED WAVES FROM A PLASMA COLUMN IN AN AXIAL MAGNETIC FIELD (Abstract), by B. L. Wright and G. Bekefi. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 211, Feb. 25, 1965.

Microwave-reflection measurements were made from a plasma-filled waveguide in a longitudinal magnetic field. The observations were carried out in the afterglow of a pulsed dc discharge in argon at pressures between 0.1 and 2 Torr. The reflected power and the average electron density were monitored simultaneously. During the decay of electron density, several maxima in reflected power were seen whose position varied with magnetic field. At a fixed frequency $\omega = 3000$ mc/sec, the locus of a given maximum satisfies $\omega^2 = \omega_c^2 + A\omega_p^2$, where ω_c and ω_p are the electron cyclotron and plasma frequencies, respectively. Over the range of densities investigated, ($0.05 < \omega_p^2/\omega^2 < 0.9$), values of the constant A for the different maxima were found to lie between -20 and +7. The observations are interpreted in terms of constructive interference of electromagnetic waves in a cold plasma, reflected at different regions along the plasma column.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME ASPECTS OF THE WIENER THEORY OF NONLINEAR SYSTEMS, by Y. W. Lee and M. Schetzen. [1965] [6]p. incl. diagrs. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under DA 36-039-AMC-03200(E), National Aeronautics and Space Administration, and National Science Foundation) Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill., Oct. 25-27, 1965.

Also published in Proc. Nat'l. Electronics Conf., v. 21: 759-763, Oct. 1965.

A discussion of the Wiener theory and the Wiener method of analysis and synthesis of a nonlinear system is presented. The theory is extended to encompass orthogonal functionals by means of differential equations. Several extensive developments from the theory are examined. These areas included measurement of the

Wiener kernels, extension of the theory to the analysis of nonlinear systems when the input is not a Gaussian process, and a generalization of the error criterion.

1864

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

THE SUPERCONDUCTING TRANSITION WIDTH IN PURE LEAD, by J. E. Neighbor, J. F. Cochran, and C. A. Shiffman. [1965] [3]p. incl. diagrs. (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)]) Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. A) 479-481, 1965.

The temperature interval over which the transition from the superconducting to the normal state takes place in very pure lead has been measured. This transition width was determined from the temperature variation of the specific heat at the critical temperature and also from the variation of the magnetic-susceptibility. The specific heat data, which measure a bulk property of the specimen and the susceptibility data which measure a surface property of the specimen because the normal state skin depth at 20 cps is mm, both indicate a transition width of 3×10^{-4} K or less.

1865

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

THEORY OF TURBULENT PLASMA (Abstract), by T. H. Dupree. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], Atomic Energy Commission, and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 206, Feb. 25, 1965.

The convergence of "quasilinear" perturbation schemes for solving the Vlasov equation is investigated and shown to depend on the turbulent-mode spectrum and the zero-order stability in a complicated way. A statistical formulation of the Vlasov problem is proposed whose solution is nonperturbative and corresponds to infinite sums of certain "quasilinear" hierarchy equations.

1866

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

THOMSON SCATTERING FROM A HOLLOW-CATHODE ARC PLASMA (Abstract), by E. [T.] Gerry. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], Atomic Energy Commission, and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 226, Feb. 25, 1965.

Thomson scattering at 45° of a ruby-laser beam from a hollow-cathode arc plasma has been obtained. Langmuir-probe dc measurements of the argon plasma produced indicate a plasma density of 5×10^{13}/cc with an electron temperature of 4 v. Because of the high electron density, the temperature measurements were limited to the high-energy tail of the electron distribution. By calibrating the scattering system, using Rayleigh scattering from a known density of nitrogen, absolute-intensity measurements of the Thomson-scattered signal were obtained that indicated an electron density of 5×10^{13}/cc, in good agreement with the probe measurements. The Thomson-scattered spectrum was scanned by rotating a narrow-band (3A) interference filter, which yielded an electron temperature of approximately 1 v. This disagreement with the probe data probably arises from the fact that, while the probe was limited to sampling the high energy tail, the Thomson scattering measured the main body of the electron distribution.

1867

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

WEAK COLLISIONLESS SHOCK WAVES (Abstract), by J. M. Witting. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [DA 36-039-AMC-03200(E)], Atomic Energy Commission, and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 223, Feb. 25, 1965.

The shape of a class of finite-amplitude waves in a cold ($\beta \ll 1$) plasma is found. For angles of propagation that depart from perpendicular to the magnetic field by more than $(m_e / m_i)^{\frac{1}{2}}$, the electron inertia may be neglected, and is. Assuming some damping, weak shocks should have a laminar structure starting with essentially a solitary wave at the downstream edge and decaying to a

small-amplitude sine wave far upstream. Only a very small change in energy damped is required to change from a solitary wave to an almost sinusoidal wavetrain. Thus, electron Landau damping is sufficient for $\beta > m_e/m_i$ so that the wavetrain is almost sinusoidal all the way up to the shockfront. In terms of density and magnetic field (averaged over a period of the oscillation), the resulting shock thickness is of the order of the wavelength (~ion-gyro radius). The temperature rise varies over a large distance, approximately the length of the wavetrain.

1868

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

HYPERFINE STRUCTURE OF Hg^{193} AND Hg^{193m} BY THE LEVEL-CROSSING METHOD, by O. Redi and H. H. Stroke. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under [DA 36-039-sc-78108) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 456, Apr. 26, 1965.

Level crossings were observed in the $(6s6p)\ ^3P_1$ state. The measured field values at the crossing points (NMR frequency of protons in water, kc/sec) were: Hg^{193} 25108.68 ± 0.30 (F, m_F, F', m_F') - (5/2, 5/2; 3/2, 1/2), Hg^{193m} 34381.24 ± 0.40 (15/2, 15/2; 13/2, 11/2), 32376.7 ± 2.0 (13/2, 11/2; 13/2, 7/2), 31234. ± 5. (13/2, 9/2; 13/2, 5/2). The first Hg^{193m} crossing agrees with Smith and the 2 new crossings permit precise calculation of B. The Hg^{193} crossing disagrees with the hfs (I = ½, A > 0) deduced from incomplete optical spectroscopic data. Ar(Hg^{193}) was found to be negative. From this and the expected isotope shift, the spin I = 3/2 is indicated. Thus Ar(Hg^{193}) = -6133. ± 15. mc/sec, μ = -0.620 ± 0.002 nm where the uncertainty in B is considered. The Hg^{193} results support recent optical spectroscopic findings of Davis and Kleiman.

1869

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ULTRASONIC PROPAGATION IN SOLID METHANE, by A. A. Thiele, W. M. Whitney, and C. E. Chase. [1965] [4]p. incl. diagrs. (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under DA 36-039-sc-78108) Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. B): 1122-1125, 1965.

The results of Thomas, Alpert, and Torrey (Jour. Chem. Phys., v. 18: 1511, 1950) showing an anomalous peak at 20.4°K for the spin lattice relaxation time T_1 in solid CH_4, were analyzed over the temperature region above and below this peak by Tomita (Phys. Rev., v. 89: 429, 1953) who derived a relationship between T_1 and the average time τ_c spent by a molecule in one of its equivalent orientations in the lattice before it flips to another. Near T_λ, $\tau_c \sim 10^{-7}$ sec. corresponding to a frequency spectrum that extends over a range of several megacycles. This paper presents a preliminary account of the study of the velocity and attenuation of sound in solid methane, at frequencies of this order of magnitude, to obtain evidence of coupling between the rotational motions of the molecules and the vibrations of the lattice. It is shown that anomalies in both the velocity and absorption do in fact occur near the λ-point, and that the relaxation time characterizing the absorption is of the same order of magnitude as the molecular flipping time. However, the authors have not yet been successful in establishing a relationship between their results and those of the NMR investigations of Thomas et al.

1870

[Massachusetts Mental Health Center, Boston]

PSYCHOLOGICAL FACTORS MAXIMIZING RESISTANCE TO STRESS: WITH SPECIAL REFERENCE TO HYPNOSIS, by M. T. Orne. [1965] [43]p. incl. refs. (AFOSR-65-1161) (AF 49(638)728) AD 621386 Unclassified

Also published in The Quest for Self-Control, ed. by S. Z. Klausner, New York, Free Press, 1965, p. 286-328.

Hypnosis and other psychological factors are considered which maximize an individual's resistance to stress. A survey of hypnosis is presented reviewing present knowledge on hypnotically induced anaesthesia, physical capacity under hypnosis, hypnotically induced amnesia, hypnotizability, and posthypnotic suggestion. It is pointed out that hypnosis has its major effect in providing an increase in motivation. A number of other psychological factors which contribute to an individual's ability to tolerate stress are also instrumental in increasing motivation, in much the same way as the hypnotic situation. The entire question of which factors contribute more to the individual's ability to tolerate stress requires empirical clarification.

1871

[Massachusetts Mental Health Center, Boston]

VISUAL IMAGERY PRODUCED BY RHYTHMIC PHOTIC STIMULATION PERSONALITY CORRELATES AND

PHENOMENOLOGY, by S. J. Freedman and P. A. Marks. [1965] [18]p. incl. tables, refs. (AFOSR-65-0711) (In cooperation with Tufts U., Medford, Mass.) (AF AFOSR-62-11) AD 615698 Unclassified

Also published in Brit. Jour. Psychol., v. 56: 95-112, Feb. 1965.

This study is concerned with relationship between descriptions of visual imagery produced by rhythmic photic stimulation and a number of personality tests. Individuals who manifested the ability to suspend their generalized reality-orientation described more imagery; imagination and suggestability also seemed to be important. Subjects' expectations about what they would see influenced their reports, although comprehension of the experimental design, fatigue and motivation were not relevant. The correlated personality variables indicate a close relationship with other types of visual imagery; the phenomenology fits a synthesized description of sensory deprivation, mescaline, and hypnagogic imagery.

1872

[Massachusetts Mental Health Center, Boston]

SOCIAL CONTROL IN THE PSYCHOLOGICAL EXPERIMENT: ANTISOCIAL BEHAVIOR AND HYPNOSIS, by M. T. Orne and F. J. Evans. [1965] [12]p. incl. tables, refs. (AFOSR-65-1363) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-88 and Human Ecology Fund) AD 622628 Unclassified

Also published in Jour. Personality and Social Psychol., v. 1: 189-200, Mar. 1965.

Rowland and Young found that hypnotized subjects (Ss) were willing to carry out such apparently antisocial actions as grasping a dangerous reptile, plunging their hands into concentrated acid, and throwing the acid at an assistant. However, only informal attempts were made to show that the Ss perceived the acts as dangerous, or to demonstrate that the requested behavior exceeded the broad limits of social control implicit in the context of a psychological experiment. The experiment conducted by Young was replicated exactly, and his results confirmed. However, nonhypnotizable Ss simulating hypnosis to a "blind" E, and even normal, waking control Ss, complied with the same requests. Ss invariably reported they were convinced the activities were safe because they were participating in research conducted by competent, responsible scientists. It is concluded that the tasks were perceived by Ss as being within the limits of legitimate requests made in an experimental context. The present study does not answer the question whether antisocial behavior can be elicited under hypnosis. However, it demonstrates the nature of control groups essential for a valid test of the antisocial hypothesis, and illustrates the broad range of behavior legitimized in an experimental context. (Contractor's abstract)

1873

Massachusetts U., Amherst.

THE STUDY OF DYNAMIC BIREFRINGENCE OF POLYMERIC SOLIDS, by R. S. Stein. Final rept. Nov. 1, 1963-Apr. 30, 1965. June 8, 1965, 1v. incl. illus. diagrs. tables, refs. (AFOSR-65-1335) (AF AFOSR-63-168) Unclassified

A new method for measuring dynamic birefringence has been developed and applied to the study of polymer deformation. This method consists of vibrating a sample at frequencies between 0.001 and 1000 cps, and strain amplitudes between 0.1 and 2%, and at temperatures between -80°C and +200°C. Stress, strain and birefringence are simultaneously observed. From these data quantities can be obtained for characterizing the deformation mechanism of the polymer. A thorough study of the dynamic, mechanical and optical properties of low and nigh density polyethylene, polypropylene, polybutene-1 and nylon-6 has been made. Use of these results combined with those obtained through related techniques presents a new picture of the deformation of crystalline polymers, involving the rapid deformation of the crystalline superstructure as the sample is deformed, followed by a slower viscoelastic reorientation of the constituent crystals. Six publications and three reports resulting from this research are included.

1874

Massachusetts U., Amherst.

A HIGH SPEED STRETCHING APPARATUS FOR OPTICAL STUDIES ON POLYMER FILMS, by P. F. Erhardt, R. P. Fillmore and others. Apr. 25, 1965 [22]p. incl. illus. diagrs. refs. (ONR Technical rept. no. 81) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-168], Army Research Office (Durham), General Tire and Rubber Company, and Office of Naval Research) AD 619678 Unclassified

The report describes the design, calibration and operation of a pneumo-hydraulic high speed stretching apparatus in which a polymer film sample can be rapidly stretched from both ends. Provision is made for the concurrent measurement of stress and strain. The rise time of the piston velocity is approximately 4 msec and the linear range covers 85-90% of the piston travel. At the maximum operating pressure of 1500 psi, stretching rates in excess of 4000 in/min are obtainable. The apparatus is equipped to take low angle light scattering photographs during rapid extension of the sample and subsequent relaxation. A continuous wave gas laser is used as source and a high speed motion picture camera as the detector. With appropriate polarization of the light beam the system is readily adapted to investigate birefringence changes on stretching, using a photomultiplier as the intensity detector. Instructions for operating the high speed apparatus are appended.

1875

Massachusetts U., Amherst.

ON THE ORIENTATION MECHANISM OF CRYSTALLINE POLYMERS, by R. S. Stein and K. Sasaguri. [1965] [36]p. incl. diagrs. (Bound with its AFOSR-65-1335) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-168], Atomic Energy Commission, Office of Naval Research, and Petroleum Research Fund) Unclassified

The effect of chain unfolding or crystal rotation within the spherulite is considered as an approach to account for the variation of orientation functions with elongation. A detailed accounting of the orientation of individual crystal axes is presented. The model successfully accounts for the variation of birefringence and crystal orientation functions with elongation which is found experimentally.

1876

Massachusetts U., Amherst.

SOME OPTICAL AND MECHANICAL PROPERTIES OF POLYVINYL CHLORIDE, by A. Utsuo. Jan. 1965 [30]p. incl. diagrs. tables, refs. ([Office of Naval Research] Technical rept. no. 79) (Bound with its AFOSR-65-1335) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-168], Army Research Office (Durham), Office of Naval Research, and Petroleum Research Fund) AD 464060 Unclassified

The photoelastic properties of polyvinyl chloride (PVC) were subjected to preliminary investigation several years ago. Some of these measurements were repeated and extended during the past year. These measurements confirm previous observations and demonstrate the contribution of both distortional and orientational contributions to the birefringence. They also indicate the possibility of dichroism studies on partly decomposed PVC which will be described in a future report. Measurements of dynamic birefringence were also conducted indicating a negative strain-optical coefficient at room temperature consistent with a dominant distortional contribution.

1877

Massachusetts U., Amherst.

A TECHNIQUE FOR THE STUDY OF SPHERULITE DEFORMATION: LIGHT SCATTERING MOVIES, by P. Erhardt and R. S. Stein. [1965] [3]p. incl. illus. diagr. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-168], Army Research Office (Durham), and Office of Naval Research) Unclassified

Published in Polymer Ltrs., Pt. B, v. 3: 553-555, July 1965.

In order to study spherulite deformation, it has been found practical to take a nearly continuous set of light scattering photographs from a single sample by using a continuous wave gas laser as the source, and a high speed motion picture camera as the detector. The polarized beam from a Spectra Physics Model 130 CW Laser was passed through a suitable cutoff filter to eliminate the blue fluorescent light, and then through a pin hole. The sample was placed in a rapid stretching device. A polaroid sheet analyzer was placed between the sample and the photographic film. With a camera and a Model 115 gas laser as source, good scattering patterns have been obtained at camera speeds as high as 5400 frames/sec. Using the Model 130 laser, there was change in Hv scattering patterns on stretching medium density polyethylene. The pattern becomes extended in a direction perpendicular to the stretching direction within a time comparable with that required to stretch the sample. The interpretation, as indicated previously, is that spherulite deformation occurs almost instantaneously as is indicated by the change in shape of the scattering pattern, whereas internal rearrangements responsible for intensity changes occur over a longer period of time.

1878

Massachusetts U., Dept. of Chemistry, Amherst.

A STUDY OF PREFERENTIAL SOLVATION UTILIZING NUCLEAR MAGNETIC RESONANCE, by L. S. Frankel, T. R. Stengle, and C. H. Langford. [1965] [2]p. incl. diagr. table. (AFOSR-66-0059) (AF AFOSR-65-212) AD 629846 Unclassified

Also published in Chem. Commun., No. 17: Sept. 8, 1965.

Two new methods are reported for the study of preferential solvation utilizing: (1) the effect of solvents on the n. m. r. chemical shift of the solute and, (2) the effect of a paramagnetic solute on the n m r transverse relaxation time of nuclei in the solvent molecules. The interactions in both cases are short range. The assumptions involved in this analysis receive strong support from results on acetylacetone comp'exes. The most "preferred" solvents in the list are $CHCl_3$ and methanol, the only ones capable of hydrogen bonding. Preliminary temperature-dependence data confirm the expectation that solvation is less preferential at higher temperature.

1879

Massachusetts U. Dept. of Chemistry, Amherst.

THE OUTER COORDINATION SPHERE. I. NUCLEAR MAGNETIC RESONANCE RELAXATION TIME EFFECTS PRODUCED BY PARAMAGNETIC IONS WITH NONLABILE INNER COORDINATION SPHERES, by T. R. Stengle and C. H. Langford. [1965] [6]p. incl. diagrs. refs. (AFOSR-66-0781) (AF AFOSR-63-212) AD 633545 Unclassified

Also published in Jour. Phys. Chem., v. 69: 3299-3304, Oct. 1965.

The effects of various paramagnetic Cr(III) complexes with well-defined nonlabile inner coordination spheres on the transverse relaxation times of F^{19} nmr signals

from F^- and PF_6^- have been determined in aqueous solution. The effects of the paramagnetic ions on nuclei in the second coordination sphere are seen to be substantial. The chemical evidence (concentration dependence, structure, etc.) suggests that a consistent interpretation of the effects may be given in terms of relative outer-sphere coordinating tendencies. The interpretation emphasizes the importance of the interaction between inner-sphere ligands and solvent molecules.

1880

Massachusetts U. Dept. of Chemistry, Amherst.

SIMPLIFIED PURIFICATION OF ACETONITRILE FOR ELECTROANALYTICAL APPLICATIONS, by G. A. Forcier and J. W. Olver. 1965 [2]p. incl. table. (AFOSR-65-2385) (AF AFOSR-65-777) AD 627937
Unclassified

Also published in Anal. Chem., v. 37: 1447-1448, Oct. 1965.

Distillation of acetonitrile from sodium hydride following a short reflux period removes all traces of acrylonitrile as well as acidic impurities and water. If the sodium hydride treatment (basic) is followed by a reflux and distillation over an acid such as phosphorus pentoxide, sulfuric acid, etc., solvent suitable for acid-base work is obtained. Final distillation of the product from calcium hydride ensures dryness of the solvent. Solvent purified by this method contained no polarographically detectable traces of either unsaturated nitriles, or bases.

1881

Maudsley Hospital, London (Gt. Brit.).

SEXUAL DIFFERENTIATION OF THE BRAIN AND ITS EXPERIMENTAL CONTROL, by G. W. Harris and S. Levine. [1965] [25]p. incl. illus. diagr. tables, refs. (AFOSR-66-0787) (AF 61(052)454) AD 633284
Unclassified

Also published in Jour. Physiol. (London), v. 181: 379-400, Nov. 1965.

Studies were made on sexual behavior and on endocrine function in adult female rats treated with testosterone at 4 days of age, and in adult male rats treated with oestradiol at 4 days of age. For comparison with these animals other groups were studied—female rats injected with oestradiol at 4 days of age, and male rats injected with testosterone at 4 days of age, or with oestradiol at 14 days of age. Oil-injected controls were studied with each group of animals. Neonatal administration of testosterone to 4 day old female rats resulted in a complete loss of female type sexual behavior when adult. This was true even if the animals were ovariectomized when adult and given oestrogen-progesterone replacement therapy. However, if they were ovariectomized and given testosterone when adult, then a marked male type pattern of sexual behavior was observed. Neonatal treatment of female rats with oestrogen resulted in a slight disturbance of the normal female pattern of behavior. Neonatal administration of oestradiol to 4 day old male rats resulted in some loss of male sexual behavior, even after castration (when adult) and testosterone replacement therapy. Neonatal administration of testosterone to male rats did not affect their normal sexual behavior patterns when adult.

1882

Maudsley Hospital, London (Gt. Brit.).

CONTINUOUS RECORDING OF CHANGES IN MEMBRANE POTENTIAL IN MAMMALIAN CEREBRAL TISSUES IN VITRO; RECOVERY AFTER DEPOLARIZATION BY ADDED SUBSTANCES, by I. M. Gibson and H. McIlwain. [1965] [23]p. incl. diagrs. tables, refs. (AFOSR-65-2639) (AF EOAR-63-1) AD 628358
Unclassified

Also published in Jour. Physiol. (London), v. 176: 261-283, Jan. 1965.

Apparatus is described for maintaining slices of mammalian cerebral cortex under good metabolic conditions while continuous recordings were made of membrane potential, with micropipette electrodes. The average stable resting potential observed was 59 ± 10 mV (s.d.). Potentials recorded in media 2.6 mM in calcium were more stable than those in media containing 0.75 mM calcium. Measured amounts of KCl in about 1 ul. of fluid were applied to the tissue surface. They diminished the resting potential, which subsequently recovered. The course of this change was compared with changes in potassium concentration near the cell calculated to result by diffusion. Addition to the tissue surface of sodium glutamate in small volumes of fluid also resulted in depolarization of cell elements, followed by recovery; a similar comparison was made of glutamate concentration and potential change. The sodium, potassium and chloride of the tissues were determined before and after incubation; in some cases incubation media contained inulin and this also was determined.

1883

Max-Planck Inst. für Biologie, Tubingen (Germany).

INFORMATION PROCESSES IN BIOLOGICAL SYSTEMS, by W. E. Reichardt. Final rept. Mar. 31, 1965 [8]p. incl. refs. (AFOSR-65-1530) (AF EOAR-64-45) AD 623805
Unclassified

A summary is presented of the investigations conducted and the results obtained in one year under this contract. Investigations include: (1) Anatomically and physiologically determined visual fields of ommatidia in the complex eye of the fly musca; (2) The optical transfer properties of the compound eye in drosophila; (3) Motion perception of the fruitfly drosophila; (4) Human pupillary light reflex to sinusoidally changing brightness densities; and (5) Mechanoreceptors in the cuticle of the honey bee.

1884

Max-Planck Inst. für Verhaltensphysiologie, Erling-Andechs (Germany).

ENTRAINMENT OF CIRCADIAN RHYTHMS BY ZEITGEBERS, by J. Aschoff. Final rept. July 1[illegible], 1965 [1]p. (AFOSR-65-1564) (AF EOAR-64-68) AD 623809
Unclassified

A summary is presented of a study of the diurnal rhythmicity of perch-hopping in in finches kept in artificial light-dark cycles. It is found that with an increase of light-time, the activity-time of the bird increases. The phase angle difference, measured between midpoint of activity-time and midpoint of the light-cycle, follows the circadian rule, becoming more positive with an increase in light-time. The results are in agreement with 3 rules describing the activity cycles of wild birds in the field at different seasons.

1885

Mellon Inst., Pittsburgh, Pa.

HOMOGENEOUS MOTIONS OF INCOMPRESSIBLE MATERIALS, by B. D. Coleman and C. Truesdell. [1965] [5]p. (AFOSR-66-2631) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-728] and National Science Foundation) AD 643335
Unclassified

Also published in Zeitschr. Angew. Math. und Mech., v. 45: 547-551, 1965.

In a given homogeneous incompressible simple material, a homogeneous motion is dynamically possible if and only if it is circulation-preserving. Determination of the stress for every irrotational homogeneous motion suffices to specify the constitutive functional. (Contractor's abstract)

1886

Mellon Inst., Pittsburgh, Pa.

WAVES IN MATERIALS WITH MEMORY. III. THERMODYNAMIC INFLUENCES ON THE GROWTH AND DECAY OF ACCELERATION WAVES, by B. D. Coleman and M. E. Gurtin. [1965] [33]p. incl. refs. (AFOSR-66-2775) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under [AF AFOSR-65-728], and National Science Foundation) AD 644573
Unclassified

Also published in Arch. Rational Mech. and Anal., v. 19: 266-298, July 26, 1965.

A calculation was made of the velocity of one-dimensional acceleration waves in materials with memory and it is shown how the dissipative effects of heat conduction and internal mechanical damping affect the amplitude of such waves. The basic constitutive assumption is that the stress is determined by the history of the strain and the history of a thermodynamic variable, such as the temperature or entropy density.

1887

Mellon Inst., Pittsburgh, Pa.

WAVES IN MATERIALS WITH MEMORY. IV. THERMODYNAMICS AND THE VELOCITY OF GENERAL ACCELERATION WAVES, by B. D. Coleman and M. E. Gurtin. [1965] [22]p. incl. refs (AFOSR-66-2777) (Sponsored jointly by Advanced Research Projects Agency, Air Force Office of Scientific Research under [AF AFOSR-65-728], Office of Naval Research, and National Science Foundation) AD 644855
Unclassified

Also published in Arch. Rational Mech. and Anal., v. 19: 317-338, Sept. 28, 1965.

The classical theorems proved by Duhem and Hadamard for acceleration waves in elastic materials are extended to materials with memory. The principal result is a theorem to the effect that the "generalized stress relation" of Coleman implies that the acoustic tensor must be symmetric even in a material with memory. The theory of the acoustic tensor is developed in detail for homothermal and homentropic acceleration waves.

1888

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

RELATIVE INTENSITIES OF LYMAN-BIRGE-HOPFIELD BANDS IN ELECTRON IMPACT SPECTRUM OF NITROGEN, by E. N. Lassettre, V. D. Meyer, and M. S. Longmire. [1965] [3]p. incl. diagr. table, refs. (AFOSR-65-1102) (AF AFOSR-63-61) AD 619141
Unclassified

Also published in Jour. Chem. Phys., v. 42 807-809, Jan. 15, 1965.

The transition $X^1\Sigma_g^+ \rightarrow a\ ^1\Pi_g$ in N_2 gives rise to the forbidden Lyman-Birge-Hopfield bands Using a new electron spectrometer, the transition has been fully resolved and the relative intensities determined. A comparison of electron impact excitation potentials and relative intensities with spectroscopic data is made.

1889

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

ELECTRON-IMPACT SPECTRA, by A. Skerbele and E. N. Lassettre. Aug. 1964, 7p. incl. diagrs. tables, refs. (AFOSR-65-1103) (AF AFOSR-63-61) AD 620630
Unclassified

Also published in Jour. Chem. Phys., v. 42: 395-401, Jan. 1, 1965.

Electron-impact spectra at zero scattering angle are obtained for nitrogen, carbon monoxide, water, ammonia, and benzene. Vibrational structure are resolved for the $a\ ^1\Pi_g$ state in nitrogen and 2-Rydberg transitions in water spectra. The results are compared with ultraviolet absorption data. (Contractor's abstract)

1890

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

RELATIVE INTENSITIES OF TWO RYDBERG TRANSITIONS IN THE ELECTRON-IMPACT SPECTRUM OF WATER, by A. Skerbele, V. D. Meyer, and E. N. Lassettre. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-2175) (AF AFOSR-63-61) AD 627543 Unclassified

Also published in Jour Chem. Phys., v. 43: 817-820, Aug. 1, 1965.

The electron-impact spectrum of water has been determined using a higher-resolution electron spectrometer. The intensity distribution of 5 peaks in the spectrum which belong to 2 different Rydberg transitions has been investigated at zero scattering angle and electron kinetic energy of 200 v. Quantities proportional to the optical oscillator strengths for these excitations have been compared with absorption coefficients from ultraviolet spectra. The entire electron-impact spectrum in the region below the first ionization potential shows good agreement with ultraviolet absorption. (Contractor's abstract)

1891

[Mellon Inst. Dept. of Chemistry, Pittsburgh, Pa.]

GENERALIZED OSCILLATOR STRENGTHS AND ELECTRONIC COLLISION CROSS SECTIONS FOR NITROGEN AT EXCITATION ENERGIES ABOVE 10 EV, by S. M. Silverman and E. N. Lassettre. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-2176) (Sponsored jointly by Air Force Cambridge Research Laboratories; and Air Force Office of Scientific Research under AF AFOSR-63-61) AD 627564 Unclassified

Also published in Jour. Chem. Phys., v. 42: 3420-3429, May 15, 1965.

Collision cross sections and generalized oscillator strengths have been determined for each of 13 transitions in nitrogen whose excitation energies lie in the interval 10 to 83 ev. Only the generalized oscillator strengths have been reported since the collision cross sections can be calculated from these. Incident kinetic energy was approximately 500 v in each case.

1892

[Mellon Inst. Dept. of Chemistry, Pittsburgh, Pa.]

OSCILLATOR STRENGTHS OF SEVERAL PEAKS IN THE ELECTRON-IMPACT SPECTRUM OF CARBON DIOXIDE. SPIN-ORBIT COUPLING, by V. D. Meyer and E. N. Lassettre. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-2177) (Sponsored jointly by Air Force Cambridge Research Laboratories, and Air Force Office of Scientific Research under AF AFOSR-63-61) AD 627555 Unclassified

Also published in Jour Chem. Phys., v. 42: 3436-3441, May 15, 1965.

Electron-impact spectra of CO_2 have been obtained at incident kinetic energies of 150, 200, 300 and 400 v. Oscillator strengths of four transitions are calculated from the spectra and compared with other determinations. Assignment of term symbols is discussed.

1893

[Mellon Inst., Dept. of Chemistry, Pittsburgh, Pa.]

DETERMINATION OF MOLECULAR EXCITATION POTENTIALS BY ELECTRON IMPACT. AN ANOMALY IN THE N_2 SPECTRUM, by E. N. Lassettre, F. M. Glaser and others. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2178) (Sponsored jointly by Air Force Cambridge Research Laboratories; and Air Force Office of Scientific Research under AF AFOSR-63-61) AD 627554 Unclassified

Also published in Jour. Chem. Phys., v. 42: 3429-3435, May 15, 1965.

An improved monochromator is described which provides an electron beam sufficiently homogeneous in energy so that peak widths range from 0.28 v at 400-v kinetic energy to 0.13 v at 150-v kinetic energy. Using this device excitation potentials have been determined for CO_2 and N_2. The highest peak in the spectrum of N_2 occurs at an excitation potential of 12.93 v while the most intense transition in the ultraviolet absorption spectrum, according to Huffman, Tanaka, and Larrabee, occurs at 12.74 v. This discrepancy exceeds the experimental error in the determination and indicates a failure of the Born approximation.

1894

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

SELECTION RULES IN EXCITATION BY ELECTRON IMPACT, by E. N. Lassettre. [1965] [2]p. incl. diagr. (AFOSR-65-2179) (AF AFOSR-63-61) AD 627542 Unclassified

Also published in Jour. Chem. Phys., v. 42: 2971-2972, Apr. 15, 1965.

The selection rules on excitation by electron impact which arise in first order perturbation theory (the Born approximation) are shown to hold as well in the second order approximation if redundant terms (which will largely be canceled in higher order approximations) are discarded.

1895

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

INTENSITY DISTRIBUTION IN THE ELECTRON-IMPACT SPECTRUM OF CARBON MONOXIDE AT HIGH-RESOLUTION AND SMALL SCATTERING ANGLES, by

V. D. Meyer, A. Skerbele, and E. N. Lassettre. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR-65-2867) (AF AFOSR-63-61) AD 629613 Unclassified

An electron spectrometer, which provides velocity selection before scattering, is described; and the results of a study of relative intensities in the carbon monoxide spectrum are reported. The vibrational levels of the fourth positive band system have been resolved and relative intensities determined for the first nine. The relative intensities are compared with calculated Franck-Condon factors. The agreement is good at low vibrational quantum numbers but noticeable discrepancies are found for high-vibrational levels. The problem of calculating relative oscillator strengths from a fully resolved spectrum is considered and applied to data obtained in the present research. Relative oscillator strengths are compared with those obtained previously from unresolved spectra. If the Born approximation is valid, then the electron-impact and ultraviolet absorption spectra should be closely similar. This is actually observed for most of the spectrum but the transition at 12.79 v is an outstanding exception. The relative oscillator strength obtained from the electron-impact spectrum exceeds that from the ultraviolet absorption spectrum by almost a factor of 3. The reason for this anomaly is not known.

1896

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

INTENSITY DISTRIBUTION IN THE N_2 $k(b\,^1\Pi_u)$ - $X\,^1\Sigma_g$ TRANSITION, by V. D. Meyer, A. Skerbele, and E. N. Lassettre. [1965] [3]p. incl. diagrs. table, refs. (AFOSR-66-1251) (AF AFOSR-63-61) AD 643471 Unclassified

Also published in Jour. Chem. Phys., v. 43: 3769-3771, Nov. 15, 1965.

The electron impact spectrum of N_2 has been studied in the excitation energy range 12.2 to 13.6 ev using electrons with initial energy of 200 v. Resolution is high enough so that vibrational structure is resolved. Although the electron impact spectrum should closely resemble the ultraviolet absorption spectrum (if the Born approximation holds) in both peak position and intensity the two actually differ in relative intensity by more than a factor of 20. The relative intensities obtained in electron impact are in much better agreement with theory than are the relative intensities obtained by other investigators in the absorption of ultraviolet radiation. This suggests that the ultraviolet spectrum is in error. Reasons for the discrepancy are discussed.

1897

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

POWER SERIES REPRESENTATION OF GENERALIZED OSCILLATOR STRENGTHS, by E. N. Lassettre. [1965] [8]p. incl. diagrs. table, refs. (AFOSR-66-1261) (AF AFOSR-63-61) AD 641449 Unclassified

Also published in Jour. Chem. Phys., v. 43 4479-4486, Dec 15, 1965.

Expansion of generalized oscillator strengths in powers of the momentum change K (of the colliding electron) generally leads to series with finite radii of convergence. From a study of singularities of the function for complex values of k it is possible to transform the series into one which converges for all physically attainable values of K. The transformation depends on the ionization potential and the excitation energy, both of which can be determined experimentally. The transformed series should be useful in fitting experimental data and in the extrapolation of oscillator strengths It is especially useful, however, when applied to transitions for which a few terms of the series in inverse powers of K can be obtained. As an example the $1\,^1S - 2\,^1S$ transition in helium is treated. The mere determination of the degree of the first nonvanishing term in the inverse power series is enough to severely restrict the form of series and, in fact, to sum the first 6 terms These terms, which involve only one adjustable constant, fit the experimental data to within 3.5% and the deviation is mainly due to experimental error. (Contractor's abstract)

1898

[Mellon Inst. Dept. of Chemistry, Pittsburgh, Pa.]

COLLISION CROSS-SECTION STUDY OF CO_2, by E. N. Lassettre and J. C. Shiloff. [1965] [12]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Cambridge Research Laboratories; and Air Force Office of Scientific Research under AF AFOSR-63-61) Unclassified

Published in Jour. Chem. Phys., v. 43: 560-571, July 15, 1965.

Electron-collision cross-section determinations, as a function of scattering angle, for carbon dioxide are described. A weak transition at 9-V excitation energy is of special interest. The shape of the peak changes markedly with angle. The theory of the effect is discussed in general terms.

1899

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

THE ELECTRON-IMPACT SPECTRUM OF MOLECULAR NITROGEN, by V. D. Meyer and E. N. Lassettre. [1965] [3]p. incl. diagrs. (AF AFOSR-63-61) Unclassified

Published in Fourth Internat'l. Conf on Physics of Electronic and Atomic Collisions: Abstracts of Papers, Laval U., Quebec (Canada) (Aug. 2-6, 1965), New York, Science Bookcrafters, Inc. [1965] p. 397-399.

The electron-impact spectrum of molecular nitrogen has been studied using an electron spectrometer which provides for electrostatic velocity selection before and after scattering of an electron beam by a gas. Previous results which demonstrated that the most intense

peak (12.93 v) in the electron-impact spectrum does not correspond to maximum absorption (12.74 v) in the ultraviolet have been confirmed. At kinetic energies as high as 400 v, peaks at 12.28 and 11.86 and several peaks on the low-energy side of the Lyman-Birge-Hopfield band system were found. In the ultraviolet region, absorption on the $C^3\Pi_u - X^1\Sigma_g^+$ transition (11.03 v) is observed. The intensity distribution within the Lyman-Birge-Hopfield band system was not independent of the kinetic energy of the exciting electrons.

1900

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

ELECTRON-IMPACT STUDY OF THE VIBRATIONAL INTENSITIES IN THE $A^1\Pi - X^1\Sigma^+$ TRANSITION OF CO, by A. Skerbele, E. N. Lassettre, and V. D. Meyer. [1965] [2]p. incl. table. (AF AFOSR-63-61) Unclassified

Published in Fourth Internat'l. Conf. on Physics of Electronic and Atomic Collisions; Abstracts of Papers, Laval U., Quebec (Canada) (Aug. 2-6, 1965), New York, Science Bookcrafters, Inc. [1965] p. 400-401.

The $A^1\Pi - X^1\Sigma^+$ transition in CO has been studied at the electron kinetic energy of 200 v using a high-resolution electron spectrometer. Nine vibrational levels of this transition have been clearly resolved, and relative peak intensities have been determined for each level at small scattering angles ($\theta = 0$, 1, and 2). In excitation by the absorption of radiation, the intensity distribution among the vibrational levels of an electronic transition is determined by the Franck-Condon factor. The cross section for the excitation of a vibrational level is given by $\sigma_{v'} \propto \sigma_0 \left| \int_0 R_{v'} R_{v''}\, dr \right|^2 = \sigma_0 q_{v'v''}$ where σ_0 is the cross section for the electronic transition and $q_{v'v''}$ is the Franck-Condon factor. If the relative peak intensity determined from electron-impact spectra is related to the cross section for the transition, relative Franck-Condon factors can be calculated from the experimental data. As the data have been collected at a fixed scattering angle, a correction is introduced that allows comparison of relative intensities at the constant momentum change associated with the scattering process. The corrected and averaged data are then used to calculate Franck-Condon factors. The results are compared with the calculations of Nicholls (Jour. Quant. Spectra Radiative Transfer, v. 2: 433, 1962), agreement is good at low vibrational quantum numbers, but the deviation increases for v' greater than 5.

1901

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

NUCLEAR MAGNETIC RESONANCE, by A. A. Bothner-By. Final rept. Mar. 15, 1965, 5p. (AFOSR-65-0579) (AF AFOSR-63-199) AD 615438 Unclassified

Four results were obtained in the investigation (1) the perfection of methods of spectral analysis and the development of computer programs which would facilitate the process of deducing from the raw spectral data the magnetic parameters characteristic of the compound being examined; (2) the obtaining of detailed information on the relative stabilities of the conformers in numerous compounds; (3) the development of a theory which is of value in estimating the value of the coupling constant to be expected for any proposed structure; and (4) a review of data on anisotropy in the diamagnetism of electrons in localized bonds or orbitals in various remote parts of the molecule. A chronological bibliography of publications having appeared or anticipated is given.

1902

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

DIAMAGNETIC ANISOTROPY OF ELECTRON GROUPS, by A. A. Bothner-By and J. A. Pople. [1965] 24p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-199, and National Science Foundation) AD 649306 Unclassified

Also published in Ann. Rev. Phys. Chem., v. 16: 43-66, 1965.

A number of direct measurements of the anisotropy of diamagnetic susceptibility (x) were made some years ago by crystal and magnetic birefringence studies (Cotton-Mouton effect). Recently, new methods for measuring anisotropies of the shielding constant have become available. As the anisotropy of x of individual groups also plays an important part in predictive theories of the shielding constant, there is now considerable general interest in this area. In this review a survey is made of the existing literature on these aspects of anisotropy. Topics include: anisotropy of diamagnetic susceptibilities; anisotropies from crystal data; NMR methods for determining mean shielding; anisotropic shielding; predictive theories.

1903

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

GEMINAL AND VICINAL PROTON-PROTON COUPLING CONSTANTS IN ORGANIC COMPOUNDS, by A. A. Bothner-By. [1965] [122]p. incl. diagrs. tables, refs. (AF AFOSR-63-199) Unclassified

Published in Advances in Magnetic Resonance, ed. by J. S. Waugh. New York, Academic Press, v. 1: 195-316, 1965.

This review consists of a compilation of geminal and vicinal proton-proton coupling constants selected from values reported in the literature, chiefly in 1962 and 1963. Some values reported earlier are also included, and longer-range couplings are included for aromatic and heterocyclic systems.

1904

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

NUCLEAR SPIN COUPLING BETWEEN GEMINAL HYDROGEN ATOMS, by J. A. Pople and A. A. Bothner-By. [1965] [11]p. incl. diagrs. tables, refs. (AF AFOSR-63-199) Unclassified

Published in Jour. Chem. Phys., v. 42: 1339-1349, Feb. 15, 1965.

A molecular orbital theory of nuclear spin coupling between geminal hydrogen atoms is developed and found to give a satisfactory interpretation of substituent effects evident in experimental data. The theory suggests that the value of geminal coupling constants provides a means of distinguishing between inductive and hyperconjugative electron transfer. A number of geometrical rules are also proposed which should make these constants valuable in studies of molecular conformation.

1905

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

THE PROTON MAGNETIC RESONANCE SPECTRA OF OLEFINS. IV. 3-FLUOROPROPENES, by A. A. Bothner-By, S. Castellano, and H. Günther. [1965] [4]p. incl. diagr., table, refs. (AF AFOSR-63-199) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 2439-2442, June 5, 1965.

The high-resolution proton and fluorine magnetic resonance spectra of allyl fluoride, allylidene fluoride, and 3, 3, 3-trifluoropropene-1 have been obtained at 35 and -50° and have been analyzed in terms of chemical shifts and coupling constants, using a least-squares method. The temperature-sensitive coupling constants in allyl fluoride and allylidene fluoride indicate that the thermodynamically more stable rotamer is in each case the symmetrical one. The coupling constants in 3, 3, 3-trifluoropropene are at most only slightly temperature dependent. Information on the relative signs of the various coupling constants is given by the spectral analysis.

1906

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

ORGANOSULFUR DERIVATIVES OF THE METAL CARBONYLS. VI. MONOMERIC $CH_3SFe(CO)_2C_5H_5$ AND RELATED COMPOUNDS, by R. B. King and M. B. Bisnette. 1965 [4]p. incl. diagrs. table, refs. (AFOSR-65-1132) (AF AFOSR-64-580) AD 620476 Unclassified

Also published in Inorg. Chem., v. 4: 482-485, Apr 1965.

Brown monomeric $CH_3SFe(CO)_2C_5H_5$ has been obtained by the following 2 methods. (1) Treatment of a cold mixture of $NaFe(CO)_2C_5H_5$ and $(CH_3)_3CCl$ (i.e., $C_5H_5Fe(CO)_2H$ in situ) with dimethyl disulfide, (2) irradiation of $[C_5H_5Fe(CO)_2]_2$ with dimethyl disulfide at room temperature. Methyl iodide reacts readily with $CH_3SFe(CO)_2C_5H_5$ to give yellow crystalline ionic $[C_5H_5Fe(CO)_2S(CH_3)_2]I$. Ethanolic mercuric chloride reacts with $CH_3SFe(CO)_2C_5H_5$ to form the orange adduct $CH_3SFe(CO)_2C_5H_5 \cdot HgCl_2$. On pyrolysis at 70 $CH_3SFe(CO)_2C_5H_5$ readily loses carbon monoxide to form the previously reported dimeric $[CH_3SFeCOC_5H_5]_2$, for which an improved preparation from $[C_5H_5Fe(CO)_2]_2$ and dimethyl disulfide is also described. Treatment of di-t-butyl disulfide with $Fe_3(CO)_{12}$ of $[C_5H_5Fe(CO)_2]_2$ gives red $[(CH_3)_3CSFe(CO)_3]_2$ or brown $[(CH_3)_3CSFeCOC_5H_5]_2$, respectively. (Contractor's abstract)

1907

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

ORGANOSULFUR DERIVATIVES OF THE METAL CARBONYLS. VII. REACTIONS BETWEEN CHLOROALKYL SULFIDES AND METAL CARBONYL ANIONS, by R. B. King and M. B. Bisnette. 1965 [8]p. incl. diagrs. tables, refs. (AFOSR-65-1133) (AF AFOSR-64-580) AD 621316 Unclassified

Also published in Inorg. Chem., v. 4: 486-493, Apr. 1965.

Treatment of $NaMo(CO)_3C_5H_5$ with chloromethyl methyl sulfide at room temperature gives the yellow crystalline tricarbonyl σ-$CH_3SCH_2Mo(CO)_3C_5H_5$. Upon heating or ultraviolet irradiation this tricarbonyl is converted to a yellow-orange crystalline dicarbonyl π-$CH_3SCH_2Mo(CO)_2C_5H_5$, with the CH_3SCH_2 group bonded to the metal atom both by metal-carbon and yellow liquid π-$CH_3SCH_2Mn(CO)_4$ may be obtained from chloromethyl methyl sulfide and $NaW(CO)_3C_5H_5$ or $NaMn(CO)_5$ respectively, at 65-85 Treatment of $NaFe(CO)_2C_5H_5$ with chloromethyl methyl sulfide at room temperature gives brown liquid σ-$CH_3SCH_2Fe(CO)_2C_5H_5$ Treatment of $NaFe(CO)_2C_5H_5$ with 2-chloroethyl methyl sulfide gives yellow-brown liquid $CH_3SCH_2CH_2Fe(CO)_2C_5H_5$. Irradiation of this compound in benzene solution gives the red crystalline isomeric acyl compound $CH_3SCH_2CH_2COFeCOC_5H_5$ as well as the known compounds $[CH_3SFeCOC_5H_5]_2$, $CH_3SFe(CO)_2C_5H_5$, and $[C_5H_5Fe(CO)_2]_2$. Treatment of $NaMn(C)_5$ with 2-chloroethyl methyl sulfide in boiling tetrahydrofuran gives the yellow crystalline acyl compound $CH_3SCH_2CH_2COMn(CO)_4$. The structures of the new compounds are discussed. (Contractor's abstract)

1908

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

REACTIONS OF ALKALI METAL DERIVATIVES OF METAL CARBONYLS. VI. SOME REACTIONS OF ANIONS PREPARED FROM INDENYLMOLYBDENUM TRICARBONYL DIMER AND AZULENEDIMOLYBDENUM HEXACARBONYL, by R. B. King and M. B. Bisnette. 1965 [7]p. incl. diagrs. tables, refs. (AFOSR-65-1134) (AF AFOSR-64-580) AD 622904 Unclassified

Also published in Inorg. Chem., v. 4: 475-481, Apr. 1965.

Indenylmolybdenum tricarbonyl dimer, $[C_9H_7Mo(CO)_3]_2$, is reduced by sodium amalgam in tetrahydrofuran to give a brown solution containing the $[C_9H_7Mo(CO_3]^-$ anion. This solution reacts with methyl iodide to form the expected yellow-orange tricarbonyl $CH_3Mo(CO)_3C_9H_7$. However, allyl chloride and chloromethyl methyl sulfide react with the $[C_9H_7Mo(CO)_3]^-$ anion in tetrahydrofuran solution at room temperature to form the yellow dicarbonyls σ-$C_3H_5Mo(CO)_2C_9H_7$ and σ-$CH_3SCH_2Mo(CO)_2C_9H_7$, respectively, in unusually facile decarbonylation reactions. Treatment of $[C_9H_7Mo(CO)_3]_2$ with iodine in dichloromethane solution gives a brown dicarbonyl iodide $C_9H_7Mo(CO)_2I$ rather than the expected tricarbonyl iodide. Azulenedimolybdenum hexacarbonyl, $C_{10}H_8Mo_2(CO)_6$, reacts with sodium amalgam in tetrahydrofuran to give a yellow-brown solution which gives yellow dimeric $[C_{10}H_8Mo(CO)_3CH_3]_2$ on treatment with methyl iodide. (Contractor's abstract)

1909

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

SOME OCTAMETHYLOXAMIDINIUM SALTS OF METAL CARBONYL ANIONS, by R. B. King. 1965 [3]p. incl. diagr. tables, refs. (AFOSR-65-2390) [AF AFOSR-64-580] AD 626522 Unclassified

Also published in Inorg. Chem., v. 4. 1518-1520, Oct. 1965.

This paper describes reactions between tetrakis(dimethylamino)-ethylene and various metal carbonyl derivatives. New octamethyloxamidinium salts of metal carbonyl anions are thus formed. The infrared spectra of the salts were obtained and their chemical properties were investigated.

1910

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

METHOXYCARBONYL DERIVATIVES OF THE CYCLOPENTADIENYL METAL CARBONYLS, by R. B. King M. B. Bisnette, and A. Fronzaglia. [1965] [2]p. incl. diagrs. (AFOSR-66-0314) (AF AFOSR-64-580) AD 629804 Unclassified

Also published in Jour. Organometal. Chem., v. 4: 256-257, Sept. 1965.

A report is given on the preparation of methoxycarbonyl derivatives of the cyclopentadienylmetal carbonyls of iron and manganese and on preliminary studies of their chemical properties.

1911

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

NEW OLEFINIC AND ACETYLENIC COMPLEXES OF TUNGSTEN, by R. B. King and A. Fronzaglia. [1965] [2]p. incl. table, refs. (AFOSR-66-0315) [AF AFOSR-64-580] AD 629809 Unclassified

Also published in Chem. Commun., No. 21: 548-549, Nov. 10, 1965.

Tris(acetonitrile)tricarbonyl tungsten has been found to be an excellent intermediate for the preparation of olefin complexes of tungsten carbonyl. $(MeCN)_3W(CO)_3$ (0.003M) in 50 ml hexane reacts readily with cyclic olefins (2-3 ml) containing at least 3 double bonds. The color, melting point, and yield of 6 olefin complexes obtained from different olefins are given. Treatment of $(MeCN)_3W(CO)_3$ with hexafluorobut-2-yne gave $[(CF_3)_2C_2]_3W(NCMe)$ instead of the expected product.

1912

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

ORGANOSULFUR DERIVATIVES OF THE METAL CARBONYLS. VIII. NEW ASPECTS OF THE CHEMISTRY OF METHYLTHIO DERIVATIVES OF IRON CARBONYL, by R. B. King and M. B. Bisnette. 1965 [3]p. incl. diagrs. refs. (AFOSR-66-0321) (AF AFOSR-64-580) AD 629810 Unclassified

Also published in Inorg. Chem., v. 4: 1663-1665, Nov. 1965.

The methylthio iron carbonyl $(CH_3S\text{-}Fe(CO_3)_2(I)$ was synthesized with 60% yield by heating pentacarbonyl iron with dimethyl disulfide (II) in the presence of CO under pressure. In the absence of CO, the polymeric $(CH_3\text{-}S\text{-}Fe\ (CO)_3)n$ was the major reactant product. I reacts with excess II at atmospheric pressure to form an unindentified pyrophoric solid, with bicyclo [2. 2. 1] heptadiene-2, 5 to form $(CH_3\text{-}S)_2\text{-}Fe_7(CO)_4\text{-}C_7H_8$, with cyclooctatetraene to form small amounts of $C_8H_8\text{-}Fe(CO)_3$; and with bromine or iodine to form complex mixtures. The ultraviolet spectra of a number of $[RSFe(CO)_3]_2$ compounds are reported.

1913

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

A PROPERTY OF ALGEBRAIC HOMOGENEITY FOR LINEAR FUNCTION-SPACES, by A. Sobczyk. [1965] 4p. (AF 49(638)1055) Unclassified

Published in Amer. Math. Monthly, v. 72: 28-31, Jan. 1965.

Let T be a nonvoid set, n a positive integer, and N(T) an n-dimensional linear space of real-valued functions on T. Then T contains n points $t_1, \ldots, t_n$ such that for every real sequence $(\alpha_1, \ldots, \alpha_n)$ there is a $\Phi \in N(T)$ such that $\Phi(t_j) = \alpha_j$. Comments about completely regular topologies on T are also made. (Math. Rev. abstract)

1914

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

RANK-SETS AND RANK-SPACES IN LINEAR FUNCTION-SPACES, by A. Sobczyk. [1965] [4]p. (AF 49(638)1055) Unclassified

Published in Amer. Math. Monthly, v. 72: 31-34, Jan. 1965.

Let S be a set containing at least 2 points and D(S) a linear space of real-valued functions on S. For BCS, consider the following 2 properties: (1) the only function in D(S) vanishing on B is 0; (2) there is a minimal linear subspace K of D(S) such that for all $f \in D(S)$, there is a $g \in K$ such that $f(x) = g(x)$ for all $x \in B$. A typical theorem: Property (1) and property (2) with $K = D(S)$ are equivalent. A number of like results are also obtained. (Math. Rev. abstract)

1915

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

BROWN'S METHOD OF EXTENDING FIXED POINT THEOREMS, by J. D. McKnight, Jr. [1965] [4]p. (AFOSR-65-1024) (AF 49(638)1215) AD 61843 Unclassified

Also published in Amer. Math. Monthly, v. 72 152-155, Feb. 1965.

Two theorems were previously presented by A. B. Brown to extend the Brouwer fixed point theorem. In this paper some of the essential ingredients of Brown's proofs are displayed by a sequence of simple propositions, and the technique used by Brown is illustrated by a larger class of concrete examples. For the latter, 2 theorems of the well-known type and 1 lemma of the classroom type are used. Finally a distinction is made between compact absolute retracts and absolute extensors for a class K of spaces.

1916

Miami U. [Dept. of Mathematics] Coral Gables, Fla

CONVERGENCE OF COMPLEX LAGRANGE INTERPOLATION POLYNOMIALS ON THE LOCUS OF THE INTERPOLATION POINTS, by J. H. Curtiss. [1965] [18]p. incl. refs. (AFOSR-65-2355) (AF AFOSR-63-358) AD 629626 Unclassified

Also published in Duke Math Jour., v. 32 187-204, June 1965.

This paper studies certain convergence properties of $L_n(f,z)$ for z on C, where C is a simple closed curve in the complex z-plane f is a continuous function from C to the complex numbers, and $L_n(f,z)$ is the polynomial of degree at most n found by interpolation to f at the points S_n ($S_n = z_{n0}, z_{n1}, \ldots, z_{nn}$ denotes for each positive integer n a set of n + 1 distinct points on C). In particular, 2 theorems are proven. The basis of analysis for both theorems is a set of theorems of Riemann-Lebesgue type for certain "Taylor-Lagrange coefficients" which appear in the circle case. In the general case, the study involves the replacement of L_n after the mapping given by $z = \omega(\omega)$ by certain asymptotically equivalent but simpler functions which seem to be of some interest for themselves alone. The Faber polynomials play a significant role in the reduction of the problem.

1917

Miami U. [Dept. of Physics] Coral Gables, Fla.

A NON-TECHNICAL REPORT ON THE SECOND CORAL GABLES CONFERENCE ON SYMMETRY PRINCIPLES AT HIGH ENERGY, Jan. 20-22, 1965, by B. Kursunoğlu. [1965] [11]p. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-823, Atomic Energy Commission, National Aeronautics and Space Administration, and National Science Foundation) Unclassified

This nontechnical report on the second conference on symmetry principles at high energy first presents a brief background of the unitary symmetry concept up to the time of the first conference when an attempt was made to unite the unitary and Einsteinian symmetry theories of the features of particles. Before the second conference, the mathematical SU_3 was doubled into SU_6, but was not quite in accord with the requirements of the special theory of relativity. At the second conference, the new symmetry group U(12) was introduced. The author briefly discusses the contributions of the various speakers and presents the theoretical and experimental approaches in the research.

1918

Miami U. [Dept. of Physics] Coral Gables, Fla.

SYMMETRY PRINCIPLES AT HIGH ENERGY; SECOND CORAL GABLES CONFERENCE, Miami U., Coral

Gables, Fla. (Jan. 20-22, 1965), ed. by B. B Kursunoğlu, A. Perlmutter, and I. Sakmar. San Francisco, W. H. Freeman and Co., 1965, 438p. incl. diagrs. tables, refs. (AFOSR-65-1555) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-823], Atomic Energy Commission, National Aeronautics and Space Administration, and National Science Foundation) Unclassified

Nineteen papers from the conference are presented. A major part of the discussion concerns the extension and development of the proposal that SU(6) be accepted as a possible symmetry group of hadrons. Other symmetry groups such as SU(3), U(6), and U(12) are considered. Higher symmetry groups are discussed as well as strong interaction symmetries, multiparticle resonance decays, internal symmetries, the Lorentz group, non-compact groups, symmetries in the bootstrap program, high energy scattering, the Poincare group, field theory, weak interactions, and PC violation. Such problems are the extension of SU(6) symmetry to relativistic quantum theory are examined.

1919

Miami U. [Dept. of Physics] Coral Gables, Fla.

INJECTION AND TRAPPING OF PLASMA VORTEX STRUCTURES (Abstract), by D. R. Wells. [1965] [1]p. (Bound with AFOSR-65-1266; AD 622527) (AF AFOSR-65-844) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles Calif., Apr. 29-30, 1965.

Injection of high density plasma into a magnetic mirror has been accomplished by generating plasma vortex structures. The structures move from the peak field region under the mirror coils toward the center of the mirror and collide. Trapped magnetic fields in the structures produce a field reversal at the center of the mirror. Plasma is trapped inside the mirror for times of the order of msec. The ion temperature is of the order of 100 ev. Plasma volume is approximately 1000 cc. Confining field is 10 kgauss with a mirror ratio of 1.2. The vortex structures are generated by conical theta-pinch coils placed in the peak field regions of the mirror. Two separate experiments will be discussed. In the first of these, the guns were fired with argon at a static pressure of 200 microns filling the vacuum chamber. The plasmoids moved through a cold neutral background gas In the second series of experiments the background pressure was 3×10^{-6} torr and the cold gas was injected into the vacuum system by means of a pulse gas valve.

1920

Miami U Dept of Physics, Coral Gables, Fla.

MAGNETOFLUIDDYNAMIC VORTICES CREATION AND INTERACTION, by R Benach [1965] 61p. (AFOSR-65-2088) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-844 and Atomic Energy Commission) AD 617783 Unclassified

Also published in Plasma Phys. Bull., v. 5. 1-61, June 1965.

An investigation is made of the creation and interaction of magnetofluiddynamic vortex structures. The case is considered of axially symmetric and colinear flow in a incompressible fluid, and the vorticity creation terms are explicitly secured. Both the 2-dimensional and 3-dimensional cases are considered and a physical interpretation is given for the interaction of a corotating and a contrarotating vortex ring of the same dimensions.

1921

[Michigan State U., Dept. of Physics and Astronomy, East Lansing]

TRANSPORT PROPERTIES OF SOLIDS, by [F. J. Platt]. Final technical rept. Feb. 28, 1965, 4p. (AFOSR-65-1596) (AF 49(638)70) AD 623337 Unclassified

A review is presented of research on the transport properties of solids; specifically calculations on resistivity, thermoelectric power, and related properties of metals and dilute alloys; and also calculations on the properties of electrons in semiconductors. The residual resistivity of noble metal alloys and the resistivity of thin metallic wires are studied, as well as the effect of the distortion of the Fermi surface on the magnetic susceptibility of metals. Also considered are the thermoelectric power of pure metals at low temperatures and in strong magnetic fields, the transport properties of dilute alloys, and field emission from a metal in a strong magnetic field.

1922

Michigan State U. [Dept. of Physics and Astronomy] East Lansing.

LOCALIZED LATTICE VIBRATION MODES DUE TO SUBSTITUTIONAL MASS DEFECTS IN SODIUM IODIDE, by S. S. Jaswal. [1965] [2]p. incl. diagrs. (AFOSR-65-0779) [AF AFOSR-62-37] AD 616058 Unclassified

Also published in Phys. Rev., v. 137· A302-A303, Jan. 4, 1965.

Frequencies for local modes due to mass defects in NaI are computed on the deformation-dipole model for the perfect lattice. In this crystal, local modes occur within the gap between the optical and acoustic branches of the frequency spectrum, as well as above the optical branches. Frequencies are computed for impurity ions of both signs, and of masses both greater and less than that of the host ions. (Contractor's abstract)

1923

Michigan State U. [Dept. of Physics and Astronomy] East Lansing.

APPLICABILITY OF THE LORENTZ MODEL TO THE ABSORPTION OF INFRARED RADIATION BY LITHIUM

FLUORIDE (Abstract), by C. M. Randall, R. M. Fuller, and D. J. Montgomery. [1965] [1]p. (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under [AF AFOSR-62-37]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 129, Jan. 27, 1965.

Transmission spectra of thin films of lithium fluoride with controlled isotopic composition for the lithium were obtained for a number of temperatures between 50° and 300°K. These films were formed by evaporation in high vacuum on substrates of high-density polyethylene. With the aid of a CDC 3600 high-speed digital computer, the dispersion frequency ω_0, and reduced damping constant γ/ω_0, as well as the thickness of the film were obtained from the experimental curves by means of a least-squares-fitting procedure. The dependence of the resulting parameters are then compared with the predictions of simple theory. The agreement obtained indicates both the suitability of the least-squares-fitting procedure and that the Lorentz oscillator with constant damping is a suitable model for limited portions of the spectrum near the dispersion frequency, though, of course, more-realistic models indicate a frequency-dependent damping.

1924

Michigan State U. Dept. of Physics and Astronomy, East Lansing.

MAGNETIC TRANSITIONS IN $Ni[(NH_2)_2]_6Br_2$, by H. Forstat, N. D. Love, and J. McElearney. [1965] [5]p. incl. diagrs. tables. (AFOSR-65-1962) (AF AFOSR-63-430) AD 626502 Unclassified

Also published in Jour. Chem. Phys., v. 43. 1626-1630, Sept. 1, 1965.

Heat-capacity measurements have been made on single crystals of $Ni[(NH_2)_2CS]_6Br_2$ in the temperature range 1.3° - 17.4°K. Two λ-type anomalies were observed at 1.96° and 2.25°K and are associated with paramagnetic-antiferromagnetic transitions. The total entropy change associated with these transitions is 2.24 cal/mol deg and differs by approximately 2% from the expected value of R log (2S + 1), where S = 1 for the Ni^{++} ion. Approximately 78% of this total entropy change occurs above 2.25°K. A calculation based on the simple molecular field theory provided an estimate of the exchange integral as well as the temperature dependence of the sublattice magnetization. These are compared with the results from the magnetic susceptibility and nuclear magnetic resonance. (Contractor's abstract)

1925

Michigan State U. Dept. of Physics and Astronomy, East Lansing.

SPECIFIC HEAT OF $Fe_3(PO_4)_2 \cdot 8H_2O$, by H. Forstat, N. D. Love, and J. McElearney. [1965] [3]p. incl. diagrs. (AFOSR-65-2572) (AF AFOSR-63-430) AD 628742 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 32, Jan. 27, 1965.

Also published in Phys. Rev., v. 139: A1246-A1248, Aug. 16, 1965.

Specific-heat measurements have been made on a single crystal of $Fe_3(PO_4)_2 \cdot 8H_2O$ in the temperature range 1.8-25°K. Two λ-type anomalies were observed at 9.60° and 12.40°K and are associated with paramagnetic-antiferromagnetic transitions. The 6 iron ions per unit cell are not equivalent, giving rise to a two-step antiferromagnetic transition as observed in the 2 anomalies, and indicating a ratio of 2 for the entropy changes associated with the 2 sets of nonequivalent ions. The total entropy change associated with these transitions is 9.58 cal/mole deg, which differs by 1% from 3R ln(2S + 1), where S = 2 for Fe^{++}, with approximately 27% of this entropy gained above 12.40°K. By using the simple molecular-field theory, an estimate of the magnitude of the exchange integral was obtained as well as the temperature dependence of the sublattice magnetization. (Contractor's abstract)

1926

Michigan State U. Dept. of Physics [and Astronomy] East Lansing.

MAGNETIC AND CALORIC PROPERTIES OF K_3MoCl_6, by P. A. van Dalen, H. M. Gijsman and others. [1965] [4]p. incl. diagrs. (AFOSR-66-1632) [AF AFOSR-63-430] AD 641549 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. B): 888-891, 1965.

The susceptibility of powdered K_3MoCl_6 has been measured in the temperature range of 1° - 300 K. The salt was commercially obtained and had a purity of about 98%. Calorimetric experiments were made on a sample of the same origin. Above 15°K, the susceptibility follows a Curie-Weiss law $x = \frac{Ng^2S(S+1)\beta^2}{3k(T-\theta)}$ with S = 3/2, g = 1.87, and θ = -5°K, the magnetic moment of the Mo^{3+} ion being 3.61 Bohr magnetons. The experiments were made at 8 different temperatures between 15°K and room temperature. The g-value of the salt,

obtained from resonance experiments at room temperature, was found to be 1.92. The specific heat vs temperature curve gives some more information about the complicated behavior of the material in the temperature range of 4°-10°K.

1927

Michigan State U., Dept. of Physics and Astronomy, East Lansing.

ANTIFERROMAGNETIC TRANSITIONS IN SOME THIOUREA COORDINATED COMPOUNDS, by R. Au, A. Cowen and others. [1965] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-430] and Army Research Office (Durham)) AD 644324 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. B): 877-879, 1965.

The low-temperature study of the transition metal chlorides and bromides coordinated with thiourea was undertaken in order to determine the nature of any observable magnetic ordering transition. Each of the 3 studied exhibits an antiferromagnetic transition in the behavior of both the proton magnetic resonance and the magnetic susceptibility in the temperature range 0.4° to 4.2°K. The preliminary report summarizes the data taken up to the present time and gives some indications of the nature of the ordered spin states of these materials.

1928

Michigan State U. [Dept. of Physics and Astronomy] East Lansing.

MAGNETIC TRANSITION IN LUDLAMITE (Abstract), by N. D. Love, J. McElearney, and H. Forstat. [1965] [1]p. (AF AFOSR-63-430) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 473, Apr. 26, 1965.

Specific-heat measurements of ludlamite [$Fe_3(PO_4)_2 \cdot 4H_2O$] in the temperature region 2.7°-60°K indicated a magnetic transition at ~15.4°K. This suggests the possible existence of an antiferromagnetic state below 15.4°K, which agrees with the nuclear magnetic resonance work of Van Agt and Poulis. These specific-heat measurements appear to be quite similar to those for vivianite [$Fe_3(PO_4)_2 \cdot 8H_2O$], reported earlier. These results are discussed in connection with the NMR data.

1929

Michigan State U. [Dept. of Physics and Astronomy] East Lansing.

PROTON RESONANCE IN ANTIFERROMAGNETIC $CoCl_2X[(NH_2)_2CS]_4$ (Abstract), by R. D. Spence, V. Nagarajan, and R. Au. [1965] [1]p. [AF AFOSR-63-430] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 75, Jan. 28, 1965.

Below the Néel temperature (0.91°K), $CoCl_2[(NH_2)_2CS]_4$ exhibits a complicated proton-resonance spectrum. Fifty-six different local fields ranging from 680 to 1750 G at 0.4°K have been observed both with and without an applied field. Eight other local fields are indicated by the applied-field data but have not yet been observed in zero field. The local fields occur in groups of eight with the the same magnitude but with different orientations determined by the magnetic point group of the crystal. In addition, there are certain relations between the magnitudes of the local fields that, appear to be dictated by the symmetry of the molecule rather than the magnetic point group. The crystal has a chemical space group $4_2/n$ and the sublattice magnetization lies along the fourfold axis. These faces, coupled with information concerning the magnetic point group obtained from the proton resonance experiment, lead to a set of permitted spin arrangements for the antiferromagnetic state.

1930

Michigan Technological U. [Dept. of Metallurgical Engineering] Houghton.

DEFECT BEHAVIOR IN PLASTICALLY DEFORMED SEMICONDUCTORS, by L. A. Heldt. Final rept. Mar. 17, 1965, 4p. (AFOSR-65-0663) (AF AFOSR-62-290) AD 614842 Unclassified

This research is concerned with the behavior of defects during plastic deformation and the relation of this behavior to observed plastic properties. The experimental program is concerned with the semiconductor elements, for which rather direct means of investigation are applicable. The study involves carefully controlled determinations of the plastic properties of material deformed under constant stress. The effects of: (1) heavy doping, (2) specimen orientation and type of deformation, and (3) an impurity precipitated along the dislocation lines are measured. The results obtained are used to determine the relation of dislocation motion to the production of point defects, the effect of the density of dislocation intersections on dislocation motion, and the effects of an impurity precipitated along dislocation lines upon dislocation motion.

1931

Michigan Technological U. Dept. of Metallurgical Engineering, Houghton.

DIFFUSION OF ANTIMONY IN GERMANIUM DURING PLASTIC STRAINING, by C. D. Calhoun and L. A. Heldt. [1965] [2]p. incl. table, refs. (AFOSR-65-2560) (AF AFOSR-62-290) AD 627748 Unclassified

Also published in Acta Metall., v. 13: 932-933, Aug. 1965.

Research was conducted in order to determine the effect of plastic straining during the diffusion anneal upon diffusion in Ge. A p-n junction penetration method was used to determine the diffusivity of antimony in the p-type germanium used. Experimental runs were made over a range of temperatures and strain rates. For each specimen, penetration of the p-n junction was measured in the direction parallel to the bend axis. Junction depths were found to be uniform across the beveled surfaces of all specimens, even though the strain across this section varied from zero at the neutral axis to a maximum at the outer surfaces. The results reveal no measurable effect of plastic straining on the diffusion of Sb in Ge.

1932

Michigan U. Acoustics and Seismics Lab., Ann Arbor.

ANALYSIS OF VARIABLE-DENSITY SEISMOGRAMS BY MEANS OF OPTICAL DIFFRACTION, by P. L. Jackson. [1965] [19]p. incl. illus. diagrs. refs. (AFOSR-65-2908) (AF 49(638)1078) AD 614867 Unclassified

Presented at Thirty-third Internat'l. Meeting of the Society of Exploration Geophysicists, New Orleans, La., Oct. 23, 1963.

Also published in Geophysics, v. 30: 5-23, Feb. 1965.

Variable-density seismograms were originally developed in exploration work to aid in the visualization of strata formations. They can also be directly analyzed by means of optical diffraction. When a plane wave of spatially coherent monochromatic light passes through a variable-density seismogram, a diffraction pattern can be formed which defines the seismic frequencies. The seismogram is placed so that it affects the incident light in the same manner as a diffraction grating in a conventional spectroscopic apparatus. Resulting diffraction patterns reveal continuous energy-density spectra over a range of about nine octaves. The spectra are normally 2-dimensional. When variable-density profiles are used, the second dimension of the spectra is wavenumber, which is expressed as the diffraction caused by density variations across the data channels. The spectra can be made one-dimensional by inserting a cylindrical lens so that an image of the seismograms is formed in one direction in the same plane that Fraunhofer diffraction occurs in a perpendicular direction. By this means multichannel spectral analysis is performed. An additional lens is used to image the seismogram after the light has passed through the diffraction plane. The image can be filtered as to frequency, wavenumber, or propagation velocity, when obstructions are placed in the diffraction plane.

1933

Michigan U. Communication Sciences Lab., Ann Arbor.

RESEARCH ON SPEECH COMMUNICATION. AUTOMATIC SPEECH RECOGNITION, by G. E. Peterson. Final rept. Jan. 15, 1964-Jan. 14, 1965. Feb. 1, 1965, 28p. (AFOSR-65-0512) (AF AFOSR-64-595) Unclassified

A set of logical procedures has been developed for converting the acoustical parameters of speech to a discrete code for automatic speech recognition. These procedures are now in a form which can be converted to a computer program. The major portion of these procedures is concerned with converting from acoustical parameters to sets of phone types, and these phone types may be further converted to phonemes by reference to an allophonic environmental statement for the various phonemes. A preliminary statement of the allowable phoneme sequences within a dialect has been constructed, based on the computer processing of a large dictionary. A second dictionary which is in a special coded form and which can be stored for rapid reference in a digital computer has been constructed to separate the phoneme sequences into words. Grammatical structures may also provide a valuable reference in the future in automatic speech recognition.

1934

Michigan U. [Dept. of Aeronautical and Astronautical Engineering] Ann Arbor.

ITERATIVE COMPUTATION PROCEDURES FOR AN OPTIMUM CONTROL PROBLEM, by P. S. Fancher. [1965] [4]p. incl. diagr. (AFOSR-67-0830) (AF 49(638)-1318) AD 650452 Unclassified

Also published in IEEE Trans. Automatic Control, v AC-10: 346-348, July 1965.

The control problem treated here may be stated as follows: Given $\dot{x} = A(t)x + b(t)u(t)$ and an initial condition $x(0)$ and a control function $u(t)$ such that $|u(t)| \leq 1$ for $0 \leq t \leq T$ and such that the inner product $[x(T), x(T)]$ is a minimum. A theoretical basis for describing iterative procedures used for computing the solution to this problem is developed. A new computational procedure which does not require storing the control function from one iteration to the next is specified. The hybrid computer mechanization of this procedure is described and analog computer results illustrating the practicality of the method are presented. (Contractor's abstract)

1935

Michigan U. [Dept. of Aeronautical and Astronautical Engineering] Ann Arbor.

A GENERAL THEORY OF MINIMUM-FUEL SPACE TRAJECTORIES, by L. W. Neustadt. [1965] [40]p. incl. refs. (AFOSR-67-0840) (AF 49(638)1318) AD 649990 Unclassified

Also published in SIAM Jour. Control, Ser. A, v. 3: 317-356, 1965.

This paper is concerned with the trajectories of vehicles moving in free space, i.e., of vehicles that are subject only to gravitational and propulsive forces. The following problem is fundamental in the control of such trajectories: given the vehicle position, velocity, and mass at a specified initial time, find a propulsion program that brings the vehicle to a prescribed terminal state (in a terminal time which may be free or fixed) with a minimum expenditure of fuel. Such a program will be called optimal. The problem described is clearly a variational one. In order to permit impulses, and yet have a precise mathematical formulation, it is necessary to place the problem in a somewhat unorthodox framework, and thereby arrive at a nonclassical variational problem. It is shown that thisframework is a reasonable one by proving both an existence theorem for solutions of the resultant variational problem and an approximation theorem which states that solutions of the unorthodox variational problem can be approximated by conventional thrust programs to any desired degree of accuracy. Necessary conditions that an optimum thrust program and associated trajectory must satisfy are derived.

1936

Michigan U. Dept. of Aeronautical and Astronautical Engineering, Ann Arbor.

[RELAXATION TIMES OF A DILUTE PLASMA], by R. S. B. Ong. Final rept. Jan. 1, 1964-Jan. 1, 1965. Jan. 26, 1965 [2]p. (AFOSR-65-206) (AF 49(638)1319) Unclassified

The ultimate objective of the research is to derive the macroscopic or hydrodynamic equations for a hot plasma of low density described by the Balescu-Lenard kinetic equation. An initial attempt has been made to study the relaxation phenomenon of such a plasma. The Balescu-Lenard equation is linearized with respect to the equilibrium Maxwell-Boltzmann distribution. It was observed that the Balescu-Lenard operator has the form of a differential operator in contrast to the classical Boltzmann integral operator, and the essentially one-dimensional analysis performed gives all indications that the approach to equilibrium requires an extremely long time. In the analysis of the linearized Balescu-Lenard equation, it is assumed that the dielectric constant is nonvanishing, and that the equation is similar to the Fokker-Planck equation. The case of the Fokker-Planck equation for a Lorentz gas is studied. The macroscopic conservation equations can also be derived directly from the B - B - G - K - Y hierarchy without making use of the kinetic equation. The results constitute a set of general conservation laws incorporating the 2 particle distribution function for a dilute, fully ionized plasma.

1937

Michigan U. Dept. of Aeronautical and Astronautical Engineering, Ann Arbor.

THE GENERAL CONSERVATION LAWS IN A DILUTE PLASMA, by R. S. B. Ong. [1965] 14p. (AFOSR-65-2478) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1319 and Michigan Phoenix Memorial Project) AD 628292 Unclassified

Also published in Nuovo Cimento Series X, v. 38: 1835-1848, Aug. 16, 1965.

The macroscopic conservation equations for a dilute, fully ionized plasma are derived directly from the B-B-G-K-Y hierarchy instead of from the kinetic equation involving only the single-particle distribution function. In this way it is possible to exhibit clearly the role which the two-particle correlation functions plays in the various macroscopic quantities. (Contractor's abstract)

1938

Michigan U. [Dept. of Aeronautical and Astronautical Engineering] Ann Arbor.

FREE RADICAL PRODUCTION BY LASER PHOTOLYSIS (Abstract), by J. F. Verdieck. [1965] [1]p. [AF 49-(638)1319] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 86, Jan. 27, 1965.

The deep-blue compound 2-chloro-3-nitroso-2,3-dimethyl butane was photolyzed by ruby laser flash. Following the light absorption, the radical NOH is produced and dimerizes to form $H_2N_2O_2$. The second-order rate constant for the latter process was determined by following the time dependence of the absorption of NOH at 8000A. Initial concentration of NOH was estimated from the absorbance difference in the parent compound before and after several laser flashes. The value found for the rate constant is 3×10^3 liter $mole^{-1}$ sec^{-1}. Both normal-burst and Q-switched laser pulses were observed to produce the free radical, but only the former gave a large enough signal to measure with any precision. The normal pulse had a nominal energy of 1 J. The method is compared with conventional flash photolysis techniques. Advantages and further applications are discussed.

1939

Michigan U. [Dept. of Aeronautical and Astronautical Engineering] Ann Arbor.

RELAXATION OF A HOT, STABLE SPATIALLY HOMOGENEOUS PLASMA (Abstract), by R. S. B. Ong. [1965] [1]p. [AF 49(638)1319] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 235, Feb. 25, 1965.

An initial study is made of the relaxation phenomenon in a hot, spatially homogeneous hydrogen plasma. The

Balescu-Guernsey-Lenard equation for the electrons is linearized with respect to the initial equilibrium Maxwell-Boltzmann distribution. The ions are assumed to form a neutralizing background having a Maxwell-Boltzmann at all times. Assuming an isotropic perturbation, the nondimensionalized kinetic equation is put into the form of a partial differential equation, first order in time and second order in the velocity. The Coulomb radius is used as a cutoff parameter and a stable plasma is assumed, i.e., with nonvanishing dielectric constant. The associated eigenvalue problem of the kinetic equation is of a singular Sturm-Liouville type in the velocity variable, which has an infinite domain. After transforming the eigenvalue equation into a 1-dimensional Schrödinger-type equation, the following properties may be shown (a) the linearized B-G-L operator is a self-adjoint differential operator, (b) zero is not an eigenvalue and all eigenvalues must be positive, indicating a decay of the perturbation, (c) the spectrum of eigenvalues is continuous, however, metastable states may possibly exist.

1940

[Michigan U. Dept. of Astronomy, Ann Arbor]

SATURATION EFFECTS IN STELLAR ATMOSPHERIC ABSORPTION LINES, by D. Mugglestone and B. F. O'Mara. [1965] [10]p. incl. diagrs. tables, refs. (AF 49(638)807) Unclassified

Published in Monthly Notices Roy. Astronom. Soc., v. 129: 41-50, 1965.

The influence of saturation effects upon atmospheric abundances derived from faint and medium-strong stellar absorption lines is considered. A physical interpretation is made of how saturation occurs and how the magnitude of the saturation is influenced by broadening mechanisms, atmospheric turbulence, elemental abundances etc. The influence of saturation on the determination of the abundances of solar atmospheric nitrogen and oxygen is considered, and strong disagreement is expressed with the results found by Neven for these 2 elements. Saturation effects are found which lead to abundances smaller (by a factor of the order of 10 for the medium-strong lines considered than those obtained by Neven (Contractor's abstract)

1941

Michigan U. Dept. of Chemical and Metallurgical Engineering, Ann Arbor.

POLYMERIZATION OF VINYLCYCLOHEXANE WITH $TiCl_3$-$Al(C_2H_5)_3$ CATALYSTS, by W. H. McCarty and G. Parravano. [1965] [18]p. incl. diagrs. tables, refs. (AFOSR-67-2644) [AF 49(638)606] Unclassified

Also published in Jour. Polymer Sci. Pt. A, v. 3, 4029-4046, Dec. 1965.

The polymerization of vinylcyclohexane was followed dilatometrically in cyclohexane and n-heptane solvents with $TiCl_3$-$Al(C_2H_5)_3$ as catalyst. In n-heptane, constant rates were obtained, while in cyclohexane a slow change of the initial rate to a lower steady-state value was found. Polymerization rates were first order to 'TiCl$_3$' and 'monomer' for concentrations < 0.80 mol/l, and second order for monomer concentrations > 0.80 mol/l. The rate was highest at [$Al(C_2H_5)_3$] 0.005 mol/l (Al/Ti = 0.28). Polymer intrinsic viscosity increased with time, with increasing monomer concentration, and with decreasing temperature. It was independent of [$Al(C_2H_5)_3$]. A kinetic model which can account for these observations involves the alkylation of the $TiCl_3$ surface by reaction with $Al(C_2H_5)_3$ as the site-generating step. It is also suggested that monomer molecules partake in the site-generating step by reaction with the partially reduced $TiCl_3$ surface. This possibility demands a rate of polymerization dependent upon the monomer concentration to a power between 1 and 2. The lower the liquid phase monomer concentration the higher the exponent of the monomer concentration in the rate expression. The melting point of the polymer was 280 -285 C. The solubility of polyvinylcyclohexane was investigated for 15 paraffinic and aromatic hydrocarbons. Only 2 polymer fractions exhibited amorphous x-ray spectra, and both of these occurred at [$Al(C_2H_5)_3$] 0.005 mol/l.

The rate of polymerization of vinylcyclohexane is compared with that of propylene, pentene-1, and styrene on similar catalyst (Contractor's abstract)

1942

Michigan U. Dept. of Electrical Engineering, Ann Arbor.

PATTERN RECOGNITION AND INFORMATION PROCESSING, by W. P. Tanner, Jr. Final rept. Jan. 1965, 5p. (AFOSR-65-0242) (AF AFOSR-63-367) AD 611135 Unclassified

In the area of machine learning, work was initiated in applying techniques developed by Medyessy (1961) to unsupervised adaptive pattern recognition. Medgyessy's univariated techniques were extended to the multivariate normal case, and preliminary work was begun on devising techniques to handle approximations to such functions. The classification of information-processing systems was studied, with special attention given to the measurement of information processing capacity. An investigation was initiated for the study of current flow in the central nervous system, the first phase of which was concerned with the impedance of the dorsal columns of the spinal cord. The initial studies indicate that the voltage fell off more rapidly in depth and across the dorsal columns than it did longitudinally. Accordingly, the resistance to current flow was less in the longitudinal direction than it was in the transverse direction which meant that the dorsal columns were anisotropic. Another phase of this investigation measured the frequency dependence of the specific impedance of this same section of nervous tissue.

1943

Michigan U. Dept. of Electrical Engineering, Ann Arbor.

MONOTONE CONGRUENCE ALGORITHMS, by R. F.

Arnold and D. L. Richards. Apr. 1965, 23p (Technical rept. no. ISL-65-2) (AFOSR-65-1736) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-367, National Science Foundation, and Rome Air Development Center) AD 625046
Unclassified

Also published in Inform. and Control, v. 9: 285-297, June 1966.

Given an associative system in which each element is assigned a cost and in which an equivalence relation obtains between elements, it is often of interest to ask the question: what is the least costly word equivalent to a given word? The case in which the equivalence relation is a 2-sided congruence relation is studied here, one example being the problem of optimizing a type of computer program. Such optimizing processes may be formalized as Markov normal algorithms. A general result concerning order relations on finite alphabets is established first. Then, the properties of a class of Markov normal algorithms are investigated. It is shown that each such algorithm must always terminate, and that every class of mutually equivalent algorithms contains a unique minimal algorithm which can be obtained by applying any algorithm of the class to itself. (Contractor's abstract)

1944

Michigan U. Dept. of Electrical Engineering, Ann Arbor.

THE SPECIFIC IMPEDANCE OF THE DORSAL COLUMNS OF CAT AN ANISOTROPIC MEDIUM, by J. B. Ranck, Jr., and S. L. BeMent. [1965] [13]p. incl. diagrs., refs. (AFOSR-65-1166) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-367 and National Institutes of Health) AD 620527
Unclassified

Also published in Exper. Neurol., v. 11: 451-463, Apr. 1965.

Low frequency, nonstimulating current was passed from a small electrode on the surface of the dorsal columns in the cervical cord of cats. A glass microelectrode was used to record the voltage at distances of 0.5 to 2 mm from the current electrode. The voltage fell off more rapidly in depth and across the dorsal columns than it did longitudinally- the resistance was lower in the longitudinal direction. Accordingly, the dorsal columns are anisotropic An approximate equation is presented which describes the data fairly well and which is consistent with the anatomy. From this equation, the resistivity in the longitudinal direction was 138 to 212 ohm-cm and in the transverse direction, 1,211 ohm-cm. These values are shown to be consistent with the view that the anisotropy is primarily due to current flowing longitudinally in axons. The frequency dependence of the specific impedance was also measured. Some features of this frequency dependence have no clear explanation, but some of them are consistent with a nodal membrane having a time constant of roughly 50 μsec

1945

Michigan U. Dept. of Mathematics, Ann Arbor.

GENERAL THEORY OF SIMPLE WAVES IN RELAXATION HYDRODYNAMICS, by N. Coburn. [1965] [29]p. incl. refs. (AFOSR-66-1507) (AF AFOSR-63-20)
AD 641441
Unclassified

Also published in Jour. Math. Anal. and Appl., v. 11: 102-130, July 1965.

Sufficient conditions are determined for existence of simple waves in one-dimensional, non-steady, non-magnetic, relaxation hydrodynamics and theory is applied to the flow of a dissociating gas. The theory of characteristic manifolds is discussed for 2 types of relaxation scalars: (1) K is not constant and is a function of class C^1 of the density, relaxation variable and entropy; and (2) K is not constant and is a function of class C^1 of the space and time variables. If a regularity condition is satisfied and if as K approaches the limiting speed c_∞, then the characteristic manifolds for the above 2 types of K satisfy the same partial equation as in the case where K is constant. For proper given data, the corresponding Cauchy problem is shown to possess a solution with 2 branches for any unitial manifold of class C^1 Finally, a special case of non-equilibrium hydrodynamics does exist which shows all the properties of discontinuity theory in equilibrium hydrodynamics.

1946

Michigan U. Dept. of Mathematics, Ann Arbor.

A PROBLEM OF BING, by R. L. Wilder. [1965] [5]p. (AFOSR-65-2626) [AF AFOSR-63-373] AD 627975
Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 54: 683-687, Sept. 1965.

R. H. Bing established and used in his proof of the side approximation theorem (Ann. Math., v. 77: 145, 1963), a lemma to the effect that if $\{A_i: i = 1, 2, \ldots, m\}$ and $\{B_j: j = 1, 2, \ldots, t\}$ are finite collections of disjoint disks in E^3 and p and q are points separated by $\bigcup A_i \cup \bigcup B_j$, then there exist integers h and k, $1 \leq h \leq m$, $1 \leq k \leq t$, such that $A_h \cup B_k$ separates p and q. Bing raises the question whether this remains true if the A_i's and B_i's are contractible continua. This paper shows that the affirmative answer to this question is an immediate corollary to the following theorem. In S^n, $n \geq 2$, let $\{A_i: i = 1, 2, \ldots, m\}$ and $\{B_j: j = 1, 2, \ldots, t\}$ be finite disjoint, non-empty, $(n-r-2)$-acyclic closed sets, where r is a fixed integer such that $0 \leq r \leq n-2$. If a cycle Z_1 links $\bigcup A_i \cup \bigcup B_j$, then there exist integers h and k such that Z_r links $A_h \cup B_k$. Analogous theorems for non-closed sets and for infinite collections are proved. Examples are given to show the necessity of the hypotheses of the theorems. (Math. Rev. abstract)

1947

Michigan U. [Dept. of Mathematics] Ann Arbor.

GENERALIZATION OF THE CONCEPT OF CONTINUOUS FUNCTIONS AND HOMEOMORPHISM, by R. G. Lintz. [1365] [20]p. (AFOSR-65-2637) [AF AFOSR-63-373] AD 629604 Unclassified

Also published in Ann. Math. Pura Appl., v. 67: 215-234, 1965.

The generalization given of the concept of a continuous function and homeomorphism seems to be useful in some questions of topology. For instance, applications are given to separation theorems and to Cech homology theory.

1948

Michigan U. [Dept. of Mathematics] Ann Arbor.

A BOUNDARY VALUE PROBLEM ASSOCIATED WITH THE TRICOMI EQUATION, by A. E. Heins. [1965] [15]p. [15]p. incl. refs. (AFOSR-66-1989) [AF AFOSR-65-374] AD 643072 Unclassified

Also published in Ann. Scuola Norm. Super. Pisa, Series III, v. 19: 465-479, 1965.

A boundary value problem associated with the generalized Tricomi equation is solved. The approach is essentially an extension and variation of the method of R. Carleman, utilizing analytic function theory. An integral representation is formulated and solved.

1949

Michigan U. [Dept. of Mathematics] Ann Arbor.

AXIALLY-SYMMETRIC BOUNDARY-VALUE PROBLEMS, by A. E. Heins. [1965] [22]p. incl. refs. (AFOSR-66-1990) [AF AFOSR-65-374] AD 643073 Unclassified

Also published in Bull. Amer. Math. Soc., v. 71: 787-808, Nov 1965.

The axially-symmetric boundary value problems are considered for geometries in which the problems can be expressed in terms of boundary information of a 2-dimensional harmonic function. Both the Poisson and Helmholtz integral representations are used. A lens problem is solved.

1950

Michigan U. Dept. of Mathematics, Ann Arbor.

THE POWER GROUP OF TWO PERMUTATION GROUPS, by F. Harary and E. Palmer. [1965] [3]p. (AFOSR-66-0194) (AF AFOSR-65-754) AD 631380 Unclassified

Also published in Proc. Nat'l. Acad Sci., v 54 680-682, Sept. 1965.

This investigation presents a natural group theoretic setting for deBruijn's generalization (Neder l. Akad Wetensch. Proc Ser. A, v. 62: 59-69, 1959) of Polya's classical enumeration theorem (Acta Math., v 68: 145-254, 1937). This is accomplished by applying Polya's method to the power group, B^A, obtained by a new operation on 2 given permutation groups A and B. If A and B act on disjoint sets X and Y, respectively, then B^A acts on Y^X, the set of all functions f from X into Y. The permutations in B^A are the collection of all ordered pairs, written $(\alpha;\beta)$, of permutations $\alpha \in A$, $\beta \in B$, whose action on any function $f \in Y^X$ is given by the equation $(\alpha;\beta)f(x) = \beta f(\alpha x)$, for all $x \in X$. Thus, 2 functions $f, g \in Y^X$ are equivalent with respect to the group B^A, provided there exist $\alpha \in A$ and $\beta \in B$ such that for all $x \in X$, $g(x) = \beta f(\alpha x)$. A method for determining the number of equivalence classes of such functions was first provided by deBruijn. An alternative method which only involves the cycle index of the power group is presented.

1951

Michigan U., Dept. of Psychology, Ann Arbor.

HUMAN INFORMATION-PROCESSING CONCEPTS FOR SYSTEM ENGINEERS, by R. W. Pew. [1965] [17]p. incl. diagrs. table, refs. (AFOSR-67-1799) (AF 49-(638)1235) AD 656533 Unclassified

Also published in System Engineering Handbook, ed by R. E. Machol. New York, McGraw-Hill Book Co., 1965. p. 31-3 - 31-19.

A design philosophy is presented for utilizing information about human performance capacities and limitations in the design of man-machine systems. Specific data concerning man's capabilities for psychophysical judgement, speeded information processing, memory storage and perceptual-motor skills are surveyed and described in engineering terms where applicable. The view as a single channel limited capacity information processing system is advocated.

1952

Michigan U. Dept. of Psychology, Ann Arbor.

THE EFFECTS OF FAMILIARITY ON THE PERCEPTUAL RECOGNITION AND CATEGORIZATION OF VERBAL INFORMATION, by E. Smith. Dec 1965, 68p incl. diagrs. tables, refs. (Technical rept. no. 05823-9-T) (AFOSR-67-1806) (AF 49(638)1235) AD 656715 Unclassified

A comparison of the data for the tasks on "perceptual recognition" and "meaningful categorization" indicated that these functions reflected a memory process that follows recognition, rather than the recognition process itself. It was this memory process rather than recognition, which seemed to be sensitive to familiarity. In the latter task it appeared that familiarity affected both the retrieval and testing of the stored information about the meanings of the stimulus words.

1953

Michigan U. Dept. of Psychology. Ann Arbor.

EFFECTS OF S-R CODING ON THE RATE OF GAIN OF INFORMATION, by J. R. Peterson. Dec. 1965, 59p. incl. diagrs. tables, refs. (Technical rept. no. 05823-8-T) (AFOSR-67-1807) (AF 49(638)1235) AD 656711 Unclassified

It has been held that the function relating reaction time (RT) and the amount-of-information-transmitted-per-response (H_t) was a linear one. As a linear function, it could be expressed in the slope-intercept form: $RT = a + bH_t$ where a and b are the intercept and the slope constants. From the results of experimentation conducted, it appears likely that the magnitudes of the slope and intercept constants are dependent upon factors inherent in the experimental situation but that a and b are not affected in the same way. The purpose of the experiments reported here was to examine the probable validity of 3 hypotheses: (1) RT vs. H_t relationship is linear; (2) The intercept constant, a, is unaffected by variations in S-R coding rules; and (3) The slope constant, b, is highly dependent upon variations in S-R coding rules. The results of the present experiment are. (1) The RT vs H_t relationships were found to depart significantly from linearity for several of the S-R coding schemes studied, (2) The intercept constant, a, was found to be relatively insensitive to the S-R coding rules which were used; and (3) The slope constant, b, was found to be greatly affected by the S-R coding rules which were used.

1954

Michigan U. Dept of Psychology, Ann Arbor.

EFFECT OF SIZE AND LOCATION OF INFORMATIONAL TRANSFORMS UPON SHORT-TERM RETENTION, by M. I. Posner and E. Rossman. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-67-1811) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1235 and Wisconsin U. Research Committee) AD 656536 Unclassified

Also published in Jour. Exper. Psychol., v. 70: 496-505, Nov. 1965.

This series of studies investigates the effect of informational transformations of various levels of difficulty, as indicated by the amount of information reduction required, upon material in short-term storage at the time of the transform. Experiment I shows that with number and similarity of interpolated items held constant, the greater the difficulty of a transform the more forgetting will result from it. Experiments II and III show that these effects cannot be attributed entirely to increases in the time an item remains in store. Rather, time in store and difficulty of transform both contribute to determining the amount of forgetting. Experiment IV shows that the loss of material in store is a decreasing function of its distance prior to the transform, but that the transformed material itself shows no decline in retention.

1955

Michigan U. [Dept. of Psychology] Ann Arbor.

TRANSFER OF VERBAL PAIRED ASSOCIATES, by E. Martin. [1965] [17]p. incl. diagr. tables, refs. (AFOSR-67-1812) (AF 49(638)1235) AD 656979 Unclassified

Also published in Psychol. Rev., v. 72: 327-343, 1965.

From the current literature it is possible to identify 2 processes underlying the acquisition of verbal paired associates: response learning and association formation. It is also apparent from the literature that a complete treatment of association formation must take into account association directionality. Altogether, then, 3 "things" are seen to evolve during the acquisition of a paired-associate list: response availability, forward associations, and backward association. The thesis of the present research is that what is transferred from the 1st to the 2nd task in a paired-associate transfer situation is some combination of these 3 effects.

1956

Michigan U. Dept. of Psychology, Ann Arbor.

ON THE NATURE OF SHORT-TERM MEMORY ENCODING BY THE DEAF, by R. Conrad and M. L. Rush. [1965] [7]p. incl. tables. (AFOSR-67-1813) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1235 and National Institutes of Health) AD 656532 Unclassified

Also published in Jour. Speech and Hearing Disorders, v. 30: 336-343, Nov. 1965

A pilot attempt was made to examine the kind of imagery used by severely deaf children in short-term memory storage of visually presented consonant sequences. Subjects, both deaf and hearing controls, read briefly exposed 5-consonant sequences and, at the end of each exposure, wrote down what they could recall. Error matrices for the 2 groups were examined. Hearing subjects made a number of systematic recall errors which could be shown to be acoustically similar to the correct letters. The error of deaf subjects were not acoustically related to correct letters. The consistency of errors made by the deaf implies a consistent encoding procedure which is at present obscure.

1957

Michigan U. [Dept. of Psychology] Ann Arbor.

IDENTIFICATION OF SEQUENTIAL AUDITORY AND VISUAL STIMULI, by A. S. Kamlet. [1965] [2]p. incl. diagr. (AFOSR-67-1815) (AF 49(638)1235) AD 656652 Unclassified

Also published in Psychonom. Sci., v. 3: 419-420, 1965.

The Ss identified pairs of 15 msec. one-bit auditory and visual stimuli when the interval between the stimuli varied from 0 to 500 msec. The auditory judgments were better when the auditory visual signals were separated by 500 msec. than when the 2 signals were presented simultaneously, and were also better when the auditory stimulus followed the visual stimulus than when the visual stimulus was delayed. (Contractor's abstract)

1958

Michigan U. Dept. of Psychology, Ann Arbor.

ACOUSTIC FACTORS VERSUS LANGUAGE FACTORS IN SHORT-TERM MEMORY, by R. Conrad, P. R. Freeman, and A. J. Hull. [1965] [2]p. incl. refs. (AFOSR-67-1822) (AF 49(638)1235) AD 656651 Unclassified

Also published in Psychonom. Sci., v. 3: 57-58, July 15, 1965.

Forty-five Ss recalled 6-consonant sequences immediately after letter by letter visual presentation. The main factor contributing to ease of recall was within-sequence acoustic confusability. Language habits were relatively unimportant. Single-letter language frequency was unrelated to recall, second order effects made a small but significant contribution. (Contractor's abstract)

1959

Michigan U. Dept. of Psychology, Ann Arbor.

RECENT PSYCHOLOGICAL RESEARCH RELEVANT TO THE HUMAN FACTORS ENGINEERING OF MAN-MACHINE SYSTEMS, by R. W. Pew. [1965] [5]p. incl. illus. refs. (AFOSR-67-1824) (Sponsored jointly by Advanced Research Projects Agency, Air Force Office of Scientific Research under AF 49(638)1235, and Air Force Systems Command) AD 656653 Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill., Oct. 25-27, 1965.

Also published in Proc. Nat'l. Electronics Conf., v. 21: 678-682, Oct. 1965.

This report surveys a body of psychological theory and illustrates a specific area in which the theory and associated empirical data are relevant to system design problems. Within the framework describing man as a single-channel information processor at least, there are other equally relevant bodies of data. For example, research on the functional characteristics of the memory subsystem, especially short-term memory are available to allow relatively precise specifications of tolerable memory load, given the nature of the material to be remembered. This literature would also suggest information format and coding for optimum recall or retrieval. Similarly, the accumulating body of data focused on engineering descriptions of man as a controller in feedback systems are available for those with problems in this area. This paper suggests that one should not retreat to the comfort of his armchair and its associated intuitive design techniques without first making a conscientious effort to talk to psychologists about his particular design problem and to seek out the applicable literature.

1960

Michigan U. Dept. of Psychology, Ann Arbor.

THE RANSCHBURG PHENOMENON: FAILURES OF IMMEDIATE RECALL CORRELATED WITH REPETITION OF ELEMENTS WITHIN A STIMULUS, by R. G. Crowder and A. W. Melton. [1965] [2]p. incl. diagr. (AFOSR-67-1829) (AF 49(638)1235) AD 656543 Unclassified

Also published in Psychonom. Sci., v. 2: 295-296, May 15, 1965.

Seven-consonant stimuli were recalled immediately. When the cosonant in position 2 was repeated in position 5, 6, or 7, an increase in errors occurred at the latter position, as compared with control stimuli involving no repetition. Confirmation of the Ranschburg Phenomenon does not occur, however, when the repeated-element position are 2 and 4. Nor was there an increased error rate for elements following a repeated element. These observations support the importance of intrastimulus interference in immediate memory, but leave uncertain the associative mechanism responsible for such interference. (Contractor's abstract)

1961

Michigan U. [Dept. of Psychology] Ann Arbor.

S-R COMPATIBILITY AND INFORMATION REDUCTION, by P. M. Fitts and I. Biederman. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-67-1830) (AF 49-(638)1235) AD 656655 Unclassified

Also published in Jour. Exper. Psychol., v. 69: 408-412, Apr. 1965.

S-R compatibility effects were examined in 4 information-processing tasks (1-bit information conserving, 2-bit conserving, 2 to 1 bit filtering, and 2 to 1 bit condensing) in combination with 2 sets of responses (2 or 4 fingers of 1 hand only vs 1 or 2 fingers of both hands). Eight different groups of 10 Ss each were used, 1 under each condition, and tested for 2 sessions. One-bit conserving and 2 to 1 bit filtering were accomplished about equally well, under both response codes. The other 4 tasks involved significantly more time and errors. When a compatible (2-hand) response code was used, 2-bit information conserving was more efficient than 2 to 1 bit information condensing, notwithstanding the fact that the former involved twice as many alternative responses, these relation were reversed when a less compatible (1-hand) response code was used. These results indicate the importance of response coding in interpreting studies of different information-handling processes. (Contractor's abstract)

1962

Michigan U Dept. of Psychology, Ann Arbor.

CONCEPT UTILIZATION, by E. Martin. [1965] [43]p. incl. diagr. table, refs. (AFOSR-67-1831) (AF 49-(638)1235) AD 656656 Unclassified

Also published in Handbook of Mathematical Psychology ed. by R. D. Luce, R. R. Bush and E. Galanter. New York, John Wiley and Sons, Inc., v. 3: 205-247, 1965.

Four speculations as to what subjects do in a concept-utilization task are considered. None of these speculations is testable by direct observation. In each case, however, the speculation is formulated with sufficient precision to allow the deduction of new statements which are testable by direct observation. The several theorists involved hypothesize variously that concept utilization can be viewed as paired-associative learning, as cue conditioning, as strategy selection, and as a combination of selection and conditioning. Making comparisons among the 4 models, one cannot help but detect a special emphasis on the utility of models which (1) make a firm contact with both the stimulus situation and response classes and (2) allow for the operation of more than one process at a time. Restle's strategy selection is poor in contact and is a single-process model, and consequently poor in verification. The 2 most successful models, Bourne and Restle's cue-conditioning model and Bower and Trabasso's selection-conditioning model, both make good contact and postulate multiple processes.

1963

Michigan U. [Engineering Psychology Group] Ann Arbor.

SEEKING INFORMATION TO REDUCE THE RISK OF DECISIONS, by W. Edwards and P. Slovic. [1965] [10]p. incl. diagrs. tables. (AFOSR-65-2203) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-192 and Dept. of the Army) AD 625542 Unclassified

Also published in Amer. Jour. Psychol., v. 78: 188-197, June 1965.

Undergraduate Ss (10 men) were asked to perform 528 information-seeking tasks of 2 types. In standard tasks, S paid for looks at the cells of a 16-cell matrix and was rewarded if he found the unique cell. In inverse tasks, S was fined for finding the unique cell and rewarded for each cell investigated which was not the unique one. The basic dependent variable, strategy-score, was the number of cells S looked at for tasks in which he did not find the unique cell. For tasks in which he did find it, elaborate rules were used to infer what he would have done had he not found it. The Ss performed remarkably well; about half the strategies used were optimal or approximately so, and serious divergences from the optimum were very rare. Performance was less good on standard than on inverse tasks, and slightly less so on tasks with more complex costs and pay-offs than on tasks with simpler costs and pay-offs. Half the Ss were too cautious and half were too incautious in tasks for which both were possible. Individual Ss usually were consistent in being cautious or incautious.

1964

Michigan U., Inst. of Science and Tech., Ann Arbor.

DIRECTIONAL AND WIDE-BAND VELOCITY FILTERING, by P. L. Jackson. [1965] [2]p. (AFOSR-65-2907) (AF 49(638)1078 and AF 49(638)1170) AD 618782 Unclassified

Also published in Geophysics, v. 30: 279-280, Apr. 1965.

It is pointed out that the condition of monochromatic illumination in obtaining a 2-dimensional Fourier transform by optical means may be relaxed for wide-band velocity filtering, and for the directional filtering of any 2-dimensional structure such as a contour map. Similar considerations hold for 2-dimensional Fourier transforms obtained by any means.

1965

Michigan U. Inst. of Science and Tech., Ann Arbor.

ATTENUATION OF P_n FROM OFFSHORE MAINE EXPLOSIONS, by G. E. Frantti. [1965] [7]p. incl. diagrs. (AFOSR-65-2310) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1170 and Air Force Technical Applications Center) AD 628275 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 417-423, Apr. 1965.

The attenuation of P_n based on seismic energy density in a 3-sec time window was examined as a function of frequency in the distance range $204.0 \leq \Delta \leq 346.4$ km for underwater explosions in the Gulf of Maine. The diffracted P wave contained energy in the approximate frequency interval 1.25 to 20 cps and attenuation over this portion of the spectrum exhibited an unusual frequency-dependence with little scatter in the data. Dissipation constants are estimated from these observations. Integration of the extrapolated energy spectrum suggests empirically that the seismic source efficiency is about 8%. (Contractor's abstract)

1966

Michigan U. Inst. of Science and Tech., Ann Arbor.

DIFFRACTIVE PROCESSING OF GEOPHYSICAL DATA, by P. L. Jackson. [1965] [9]p. incl. illus. diagrs. refs. [AF 49(638)1170] AD 614759 Unclassified

Published in Appl. Opt. v. 4: 419-427, Apr. 1965.

Processing of geophysical data can be accomplished by optical diffraction. The data are in the form of transmissive recordings, environmental photographs, or drawings. Five analyses can be performed at or near the Fraunhofer diffraction plane with single diffraction, three analyses through spatial filtering with double diffraction, and one (correlation) with triple diffraction. Primary emphasis is on the processing of variable-

density seismograms, for which a special recorder has been constructed. Spatial filtering has also been applied to cloud cover pictures and contour maps.

1967

Michigan U., [Research Center for Group Dynamics] Ann Arbor.

STIMULUS GENERALIZATION AS A FUNCTION OF DRIVE SHIFT, by R. B. Zajonc and D. V. Cross. [1965] [6]p. incl. diagrs. tables. (AFOSR-65-2156) (AF 49(638)367) AD 629034 Unclassified

Also published in Jour. Exper. Psychol., v. 69. 363-368, Apr. 1965.

Six pigeons reduced to 70% and 6 reduced to 90% of their body weight were trained to discriminate a 10-mm. circular spot from 4- and 16-mm. spots. Following training, Ss in the 1st group were raised to 90% and Ss in the 2nd dropped to 70% of their body weight. All birds were tested for generalization to spots 6, 8, 10, 12, and 14 mm. in diameter. Following brief discrimination retraining the birds were returned to their original body weights and again tested for generalization. The generalization gradients were found to shift toward larger stimuli when drive level was raised and toward smaller stimuli when it was lowered.

1968

Microwave Electronics Corp., Palo Alto, Calif.

STUDY OF PHONON-OPTICAL INTERACTIONS, by F. A. Olson and V. R. Johnson. Final rept. Nov 1965, 41p. incl. illus. diagrs. refs. (AFOSR-65-2467) (AF 49(638)1330) AD 628020 Unclassified

Exploratory research is described concerning phonon-photon interactions in optical sources. These include a theoretical description of Bragg and Raman-Nath scattering caused by propagation of a plane acoustic wave through the path of a laser beam. This interaction is considered for intracavity operation with possibilities of modulation, frequency translation and output coupling. The conditions for synchronous mode operation are also described. Modulation of an injection laser is considered on a theoretical basis with suggestions as to what results are to be attained and how the concept may be tested. Because boundary conditions are indeterminate for the injection laser, it was felt that experimental research should first deal with the intracavity modulation and coupling in an optically pumped laser. Thus experimental work proceeded to test the interaction in a ruby laser. Several experimental difficulties were encountered. The prime problem being associated with strains set up by the thermal shock created when the laser was operated in a pulsed mode. During the latter part of this study, however, 850 Mc acoustic wave interaction was observed in the laser, its magnitude being slightly above the noise level. Suggestions are made as to how some of the experimental problems may be overcome and how significant output coupling and modulation may be best appreciated. (Contractor's abstract)

1969

Midwest Research Inst., Kansas City, Mo.

DETERMINATION OF MIXED VIRIAL COEFFICIENTS, by J. Brewer Final technical rept. Dec. 1965, 35p. incl. diagrs. tables, refs. (AFOSR-66-0411) (AF 49-(638)1190) AD 628889 Unclassified

An experimental apparatus has been constructed and developed and with it the interaction second virial coefficients have been measured from -125° to 50°C in 25°C increments for the following systems: N_2-Ar, Ar-H_2, Ar-He, Ne-Ar, N_2-H_2, N_2-He, Ne-H_2, H_2-He, Ne-H_2 and Ne-He. The excess and interaction second virial coefficients were determined usually within 0.1 cc/mole corresponding to an error in the ratio $\Delta P/P$ of 5×10^{-6}, by measuring the pressure change of mixing 2 pure gases at constant temperature and volume. This precision corresponds to about one part in 200,000 for conventional PVT experiments. The comparison between experimental values and those calculated by the Kihara potential was considered good at the higher temperatures and fair to poor at the lower temperatures where it was as much as 8 cc/mole. In the temperature range of -125° to 50°C, the excess quantity, E, was empirically correlated to the absolute temperature by the relation, $E = aT^b$ where the value of b was essentially the same for most of the binary mixtures.

1970

Milan U. Inst. of General Chemistry (Italy).

TRICARBONYL- AND HYDRIDETRICARBONYLBISTRIPHENYLPHOSPHINERPHENIUM, by M. Freni, D. Giusto, and V. Valenti. [1965] [2]p. (AFOSR-65-0685) (AF EOAR-64-9) AD 615356 Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 27: 755-75F, 1965.

Pentahydridetristriphenylphosphinerhenium, ReH_5L_3 [$L = P(C_6H_5)_3$], reacts with carbon monoxide at high pressure to form a crystalline, air stable, white solid, hydridetricarbonylbistriphenylphosphinerhenium which in turn reacts under a vacuum to form tricarbonylbistriphenylphosphinerhenium. The latter 2 compounds are briefly analyzed.

1971

Milan U. [Inst. of General Chemistry] (Italy).

TRIPHENYLPHOSPHINE-GOLD(0)GOLD(I) COMPOUNDS, by L. Malatesta, L. Naldini and others. [1965] [2]p. (AFOSR-65-2396) [AF EOAR-64-9) AD 629303 Unclassified

Also published in Chem. Commun., No. 11: 212-213, June 9, 1965.

$Au_5L_4Cl, 3{\cdot}5H_2O$ (I), where L = Ph_3P, was prepared by the reaction of chlorotriphenylphosphinegold(I) with $NaBH_4$ in EtOH, $LiAlH_4$, or ethanolic KOH. Au_5L_4Cl, $4CH_3OH$ (II) was prepared when (I) was digested in cold MeOH. The behavior of the compounds suggested 1 atom of Au had an oxidation number of 1 and the other 4 an oxidation number of 0. The compounds are ionic and exhibit diamagnetism.

1972

Milan U. Inst. of General Chemistry (Italy).

COMPLEX HYDRIDES AND ZEROVALENT DERIVATIVES OF TRANSITION METALS, by L. Malatesta. Final rept. Nov. 1, 1965, 46p. incl. diagrs. tables, refs. (AFOSR-65-2717) (AF EOAR-64-9) AD 627812
Unclassified

The research on complex hydrides and zerovalent derivatives of transition metals has resulted in the following 6 publications which are presented in whole or in summary as the text of this report: (1) Hydrido Complexes of Transition Metals, (2) Basic Behavior of Some Platinum (O) Derivatives, (3) Tricarbonyl and Hydridotricarbonylbistriphenylphosphinerherium, (4) Novel Rhenium Triphenylphosphine Compounds; (5) Triphenylphosphine Gold(O)Gold(I) Compounds, and (6) New Triphenylphosphine Iridium Compounds.

1973

Milan U. [Inst. of General Chemistry] (Italy).

TRIPHENYLPHOSPHINE GOLD(O)GOLD(I) COMPOUNDS, by L. Malatesta, L. Naldini and others. [1965] [15]p. incl. tables, refs. (Bound with its AFOSR-65-2717, AD 627812) [AF EOAR-64-9]
Unclassified

The preparation and properties of the compounds $[Au_5L_4]X$ (L = $P(C_6H_5)_3$, and X = Cl, NO_3, ClO_4, $B(C_6H_5)_4$, $SnCl_3$ and Au_3L_2A (X = I, CN, SnI_3) are described and discussed. From the infrared frequencies reported, other information about the anion symmetry stretching of these compounds was deduced.

1974

Milan U. Inst. of General Chemistry (Italy).

NEW TRIPHENYLPHOSPHINE-IRIDIUM COMPOUNDS, by L. Malatesta, G. Caglio, and M. Angoletta. [1965] [10]p. incl. diagrs. tables, refs. [AF EOAR-64-9]
Unclassified

Published in Jour. Chem. Soc. (London), Dec. 1965, p. 6974-6983.

The preparation and properties of the unsaturated hydride $IrH_3(PPh_3)_2$ and of the carbonyl hydrides $IrHCO(PPh_3)_2$ and $IrH_3CO(PPh_3)_2$ are reported. From these, with perchloric acid, $IrH_2CO(PPh_3)_2$ has been obtained, which by action of CO gives $Ir(CO)_3(PPh_3)_2ClO_4$. This perchlorate with alkaline methanol forms the novel organometallic methoxycarbonyl compound $Ir(CO_2Me)(CO)_2(PPh_3)_2$. Tentative structures, deduced from infrared spectra and electric moments in solutions, are assigned to these compounds and to some of their derivatives.

1975

Milan U. Inst. of Physics (Italy).

EVIDENCE FOR SPACE CHARGE POLARIZATION IN PURE KCl AT LOW TEMPERATURES, by C. A. Bucci and S. C. Riva. [1965] [9]p. incl. diagrs. refs. (AFOSR-65-1893) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-27 and Consiglio Nazionale della Ricerche) AD 625705
Unclassified

Presented at Forty-ninth Symposium of the Italian Physical Society (S. I. F.), Bari (Italy), Nov. 1963.

Also published in Jour. Phys. and Chem. Solids, v. 26: 363-371, 1965.

A study is carried out on the polarization effects in KCl crystals of different purity in the range of temperatures between LNT and 250°C. It is shown that the effects of dielectric relaxation of dipolar nature are present together with nonlinear polarization phenomena. The presence of the latter has been studied by means of a careful testing of Ohm's law, of the superposition principle and by means of the method of ionic thermoconductivity (ITC). The ITC method allows a qualitative and quantitative discrimination of the different polarization processes. The results show that part of the current decay, observed when the static electrical field is applied to a KCl single crystal, is due to dipolar orientation, but part of it cannot be imputed to linear dielectric relaxation; an interpretation in terms of ionic space charge formation is shown to be more realistic. (Contractor's abstract)

1976

[Milan U.] Inst. of Physics (Italy).

PHOTOSTIMULATED THERMOLUMINESCENCE IN POTASSIUM CHLORIDE SINGLE CRYSTALS, by B. Bosacchi, R. Fieschi, and P. Scaramelli. [1965] [6]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-27, and Consiglio Nazionale delle Richerche)
Unclassified

Published in Phys. Rev., v. 138: A1760-A1765, June 14, 1965.

Thermoluminescence photostimulated over the spectral range 230-1000 mμ is investigated in KCl single crystals in the temperature range 90-270°K. The glow peaks are stimulated by rigorously monochromatic

light of wavelength corresponding to the F, to the L, and to the tail of the K band. No V band stimulation is found; only electron traps are therefore involved in the process. Comparison of the stimulation spectra with the corresponding absorption and photoconductivity curves found by other authors shows that, besides the usual trapping through capture of photoelectrons from the conduction band, a second process takes place, namely tunneling from excited F centers; this happens for the glow band centered at ~215°K. The trap giving rise to the above band is assigned to F' centers, according to other works; further evidence is presented to support this identification. (Contractor's abstract)

1977

[Milan U. Inst. of Physics (Italy)]

ISOTOPE EFFECTS INDUCED BY LOCAL MODES IN THE U BAND, by G. Baldini, E. Mulazzi, and N. Terzi. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-66-1777) (In cooperation with Rochester U., N. Y.) (AF EOAR-65-5) AD 639842 Unclassified

Also published in Phys. Rev., v. 140: A2094-A2101, Dec. 13, 1965.

The experimental investigation in the temperature range from 4 to 400°K of the ultraviolet U band in KCl, KBr, and RbCl crystals containing H^- and D^- ions has revealed the following isotope effects: (a) The half-width of the U_H band is from 4 to 8% larger than that of the U_D band, and (b) The U_H band occurs at energies ~0.02 ev smaller than those of the U_D band. In order to describe these results, the method of moments, in the harmonic and Condon approximations, has been applied. From the symmetry of the defect it is shown that only the vibrational modes which transform according to the Γ 15$^-$ representation of the full cubic point group can be responsible for the isotope effects these modes are just those active in the infrared. It is found that during optical transitions, allowed in depole approximation, the Γ 15$^-$ modes suffer, via the electron-phonon interaction, only a frequency shift, and that only the local mode has to be taken into account in order to predict the observed isotope effects, since the contribution coming from the Γ 15$^-$ continuum is negligible. Finally, the local-mode frequency of the excited U center has been estimated. (Contractor's abstract)

1978

Milan U. [Inst. of Physics] (Italy).

DIELECTRIC RELAXATION IN POTASSIUM CHLORIDE IN THE RANGE OF TEMPERATURE L. N. T. -500°K (Abstract), by C. Bucci and R. Fieschi. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF EOAR-65-7] and Consiglio Nazionale delle Ricerche) Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10, 348, Mar. 24, 1965.

The temperature-dependent polarization in KCl both pure and containing divalent metallic impurities has been investigated by means of the method of ionic thermoconductivity (ITC). The ITC has been recently introduced for studying the polarization in dielectrics: the depolarization current, at linearly increasing temperature, is characterized by bands each of them representing a different polarization process. In KCl, with a warming rate of nearly 0.1°K sec^{-1}, a band at 230 K has been recognized as the orientation of the dipolar complexes composed by metallic impurities and potassium vacancy and their dynamic parameters, in the case of Sr and Ca, have been measured. A broad band at temperatures higher than 450°K has been attributed to the release of space charge. Three bands in partial superposition, located between 350° and 420 K, have been investigated and the results are discussed and compared with the dc measurements of A. S. Nowick and P. H. Sutter and with the ac measurements at higher temperatures of P. V. Sastry and T. M. Srinivasan.

1979

Minnesota U. Dept. of Aeronautics and Engineering Mechanics, Minneapolis.

VIBRATIONS OF DYNAMICAL SYSTEMS WITH QUADRATIC NONLINEARITIES, by P. R. Sethna. [1965] [7]p. incl. diagrs. (AFOSR-65-2337) (AF AFOSR-62-275) AD 630334 Unclassified

Presented at ASME Applied Mechanics and Fluids Engineering Conf., Washington, D. C., June 7-9, 1965.

Also published in Jour. Appl. Mech., v. 32: 576-582, Sept. 1965.

General 2-degree-of-freedom dynamical systems with weak quadratic nonlinearities are studied. With the aid of an asymptotic method of analysis a classification of these systems is made and the more interesting subclasses are studied in detail. The study includes an examination of the stability of the solutions. Depending on the values of the system parameters, several different physical phenomena are shown to occur. Among these is the phenomenon of amplitude-modulated motions with modulation periods that are much larger than the periods of the excitation forces.

1980

Minnesota U. Dept. of Aeronautics and Engineering Mechanics, Minneapolis.

NONLINEAR OSCILLATIONS OF A GYROSCOPIC PENDULUM WITH AN OSCILLATING POINT OF SUSPENSION, by P. R. Sethna and G. W. Hemp. [1965] [17]p. incl. diagrs. refs. (AFOSR-65-2342) (AF AFOSR-62-275) AD 629568 Unclassified

Also published in Colloq. Internationaux du Centre Nat'l. de la Recherche Scientifique; Les Vibrations

Forces dans les Systems Non-lineaires, Marseille (France) (Sept. 7-12, 1964), Paris CNRS, No. 148: 375-391, 1965.

The effects of vertical oscillatory motions of the point of suspension on the motion of a gyroscopic pendulum are studied for all values of the frequency of support motion; no restrictions are made on the spin of the gyroscope. Nonlinear resonant motions and their stability are discussed for motions in the neighborhood of steady precession motions. The asymptotic effect of high frequency support oscillations are investigated.

1981

Minnesota U. [Dept. of Chemical Engineering] Minneapolis.

THE METHOD OF WEIGHTED RESIDUALS AND ITS RELATION TO CERTAIN VARIATIONAL PRINCIPLES FOR THE ANALYSIS OF TRANSPORT PROCESSES, by B. A. Finlayson and L. E. Scriven. [1965] [10]p. incl. diagrs. refs. (AFOSR-65-2207) (AF AFOSR-63-219) AD 625551 Unclassified

Also published in Chem. Eng. Sci., v. 20: 395-404, 1965.

The approximation scheme entitled method of weighted residuals is extended to systems of differential equations and vector differential equations. The variational principles proposed by Rosen, Chambers and Biot for unsteady-state heat transport are all shown to be applications of the method of weighted residuals. The von-Karman-Pohlhausen method and the method of moments are also shown to be special cases. The method is illustrated by application to the problem of unsteady heat transfer to a fluid in ideal stagnation flow. (Contractor's abstract)

1982

Minnesota U. [Dept. of Chemical Engineering] Minneapolis.

GALERKIN'S METHOD AND THE LOCAL POTENTIAL, by B. A. Finlayson and L. E. Scriven. [1965] 6p. (AFOSR-66-0286) (AF AFOSR-63-219) AD 628582 Unclassified

Also published in Non-Equilibrium Thermodynamics; Variational Techniques and Stability; Proc. of a Symposium, Chicago U., Ill. (May 17-19, 1965), ed. by R. J. Donnelly, R. Herman, and I. Prigogine. Chicago U. Press, 1966, p. 291-294. (AFOSR-66-1685)

The advantages of viewing the local potential method as an application of Galerkin's method are threefold: (1) Variational formalism is avoided by using Galerkin's method, a conceptually simple, straightforward approximating scheme; (2) convergence proofs and other useful mathematical information are sometimes available for Galerkin's method, and (3) inasmuch as Galerkin's method is actually only one member of a family of weighted-residual methods for direct approximation using trial functions with adjustable parameters, the way is plain to alternative direct methods for attacking a problem. From the standpoint of fluid mechanics and transport theory there is considerable need for careful and systematic comparisons of these more-or-less well-established schemes and for increased attention to them by mathematicians or numerical analysts.

1983

Minnesota U. [Dept. of Electrical Engineering] Minneapolis.

A COMPUTATIONAL TECHNIQUE FOR OPTIMAL SYSTEMS, by E. B. Lee. [1965] [2]p. (AFOSR-65-2339) (AF AFOSR-64-571) AD 629855 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10: 368-369, July 1965.

One of the remaining difficulties in the application of optimal controllers is an effective computational method to use in online determination of control function. This correspondence shows that the known properties of the set of attainability provides the proof of convergence of a computational scheme described here for certain control problems. The established results depend on the geometric concepts of the set of attainability. The results presented are generalizations of the results for the discrete case as considered by E. B. Lee.

1984

Minnesota U. Dept. of Electrical Engineering, Minneapolis.

TEMPERATURE DEPENDENCE OF CONDUCTIVITY EFFECTIVE MASS OF HOLES IN GERMANIUM, by K. S. Champlin, D. B. Armstrong and others. [1965] [3]p. incl. diagrs. refs. (AFOSR-65-2537) (AF AFOSR-64-606) AD 629847 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 547-549, Apr. 5, 1965.

An extension of the Benedict-Shockley microwave experiment is used to determine the conductivity effective mass of holes in germanium throughout the temperature range between 90° and 250°K. In this interval, the mass was observed to be significantly larger than the value 0.23 m_o calculated from cyclotron resonance data and to increase markedly with temperature. If this observation is correct, the enigmatic $T^{-2.33}$ temperature dependence of the conductivity of p-type germanium actually indicates a much less severe temperature dependence of relaxation time. The optical-mode scattering mechanism that has been proposed to explain this phenomenon would thus be neither justified nor necessary.

1985

Minnesota U., Dept. of Mathematics, Minneapolis.

SINGULARITIES OF SOLUTIONS OF NONLINEAR

EQUATIONS, by J. Serrin. [1965] [21]p. incl. refs. (AFOSR-66-0247) (AF AFOSR-63-372) AD 630584 Unclassified

Also published in Proc. Symposia Appl. Math., v. 17: 68-88, 1965.

The behavior of solutions of non-linear second-order partial differential equations near isolated singularities is studied. The equation is assumed of the form (1) div $A(x, u_x) = 0$, where $A(x, u_x)$ is a given continuous real n-vector valued function of $x = (x_1, x_2, \ldots, x_n)$ and $u_x = (u_{x1}, u_{x2}, \ldots, u_{x_n})$ satisfying the following conditions for some $a \geq 1$, $b \geq 0$, $\alpha > 1$: (2) $|A(x,p)| \leq a|p|^{\alpha-1} + b^{\alpha-1}$, (3) $p \cdot A(x,p) \geq |p|^{\alpha} - b^{\alpha}$, (4) $(p-q) \cdot (A(x,p) - A(x,q)) > 0$, $p \neq q$ (monotonicity), (5) the Dirichlet problem is solvable for smoothly bounded domains and given continuous boundary data. Let $K = -(1/\omega_n) \oint A \cdot n \, ds$, where the integral is taken over any smooth non-intersecting closed surface in $0 < |x| < 1$ containing the origin in its interior, and n denotes the outer normal to this surface. Theorem 1: Let u(x) be a positive solution of equation (1) in the domain $0 < |x| < 1$. Then u tends to a (finite or infinite) limit u_0 as $x \to 0$. The origin is a removable singularity if and only if $K = 0$. If the singularity is not removable, then u_0 is infinite if $\alpha \leq n$ and finite if $\alpha > n$, moreover, in the neighborhood of the origin one has $u \approx r^{(\alpha-n)/(\alpha-1)}$ if $\alpha < n$, $u - u_0 \approx \pm r^{(\alpha-n)/(\alpha-1)}$ if $\alpha > n$. For $\alpha = n$, $u \approx \log 1/r$. (Here $f \approx g$ means the ratio is bounded away from 0 and ∞.) Theorem 2 deals with the case of solutions in a neighborhood of infinity. (Math. Rev. abstract)

1986

Minnesota U. [Dept. of Mathematics] Minneapolis.

ISOLATED SINGULARITIES OF SOLUTIONS OF QUASI-LINEAR EQUATIONS, by J. Serrin. [1965] [22]p. (AFOSR-66-0259) (AF AFOSR-63-372) AD 641521 Unclassified

Also published in Acta Math., v. 113: 219-240, 1965.

In a previous paper (Acta Math., v. 111: 247-302, 1964), the author studied the local behavior of the solutions of certain second-order, quasi-linear equations div $A(x, u, u_x) = B(x, u, u_x)$, the nature of removable singularities and, in the special case $B = 0$, the behavior of positive solutions near an isolated singularity. In the present paper, the condition $B \equiv 0$ above is proved to be superfluous, some of the other results are improved and a few errors are corrected. The new proofs are essentially refinements of the proofs given in the original paper. An interesting new remark is that if a solution $u \geq L$ has a nonremovable singularity at 0, then div $A(x, u, u_x) = B(x, u, u_x) = K\delta(0)$ in the sense of distributions. (Math. Rev. abstract)

1987

Minnesota U. [Dept.] of Mathematics, Minneapolis.

REMOVABLE SINGULARITIES OF SOLUTIONS OF ELLIPTIC EQUATIONS. II, by J. Serrin. [1965] [7]p. incl. refs. (AFOSR-66-0265) [AF AFOSR-63-372] AD 641520 Unclassified

Also published in Arch. Rational Mech. and Anal., v. 20: 163-169, 1965.

The author proves 3 theorems to the effect that if u is a weak solution of the equation div $\mathfrak{A}(x, u, u_x) = \mathfrak{B}(x, u, u_x)$ on D−Q, where D is open and Q is compact with Hausdorff (n-1)-measure 0, then u can be defined on Q so that the extended function is a solution in all of D. It is assumed in all cases that $\mathfrak{A}$ is continuous, $|\mathfrak{A}(x, u, u_x)| \leq a$, and $|\mathfrak{B}(x, u, u_x)| \leq f(x)$ along the solution where $f \in L_n(D)$, and additional hypotheses are given as follows for each theorem. Theorem 3: The conclusion above holds in case $p \cdot \mathfrak{A}(x, u, p) \geq |p| - d|u| - g$, where d and $g \in L_{n+\epsilon}(D)$. Theorem 1: If $\mathfrak{A} = \mathfrak{A}(p)$ and $\mathfrak{B} = \mathfrak{B}(u)$, the solution u is continuous and $\mathfrak{A}$ and $\mathfrak{B}$ satisfy $(p-q) \cdot (\mathfrak{A}(p) - \mathfrak{A}(q)) > 0$ for $p \neq q$ and $(u-v) \cdot (\mathfrak{B}(v) \geq 0$, then u can be extended to be continuous on D (and to be a weak solution on D). Theorem 2: If $\mathfrak{A} = \mathfrak{A}(p)$, $\mathfrak{B} = \mathfrak{B}(u)$, $\mathfrak{A}$ and $\mathfrak{B}$ are of class C^2, $\mathfrak{B}_u \geq 0$, $\mathfrak{A}_{i,k}\xi_i\xi_k > 0$ if $|\xi| > 0$, and u is of class C^2 on D−Q, then u may be defined on Q so that u is of class C^2 on D. (Math. Rev. abstract)

1988

Minnesota U. [Dept. of Mathematics] Minneapolis.

ON THE BEHAVIOR OF SOLUTIONS OF QUASI-LINEAR ELLIPTIC EQUATIONS, by H. Jenkins. [1965] [10]p. (AFOSR-66-0723) (AF AFOSR-63-372) AD 632747 Unclassified

Also published in Trans. Amer. Math. Soc., v. 119: 407-416, Sept. 1965.

Some earlier results of the author (Arch. Rational Mech. and Anal., v. 16: 402-410, 1964) and of R. Finn: (Jour. Analyse Math., v. 14: 139-160, 1965) are generalized to a class of quasi-linear equations in n-variables. This is accomplished by extending the method of constructing radially symmetric super-solutions which was developed previously for equations in 2-variables, to an analogous class in n-variables. It turns out, however, that the radially symmetric super-solutions so constructed, remain super-solutions when all but $j \geq 2$ of the variables are suppressed. The strongest results are then obtained by using the super-solutions arising by taking $j = 2$.

1989

Minnesota U. Dept. of Mathematics, Minneapolis.

CONVERGENCE OF WEIGHTED AVERAGES OF

INDEPENDENT RANDOM VARIABLES, by B. Jamison, S. Orey, and W. Pruitt. [1965] [5]p. (AFOSR-65-2818) [AF AFOSR-63-381] AD 629602
Unclassified

Also published in Zeitschr. Wahrscheinlichkeitstheorie, v. 4: 40-44, 1965.

Let X_k be a sequence of independent, identically distributed random variables and w_k a sequence of positive numbers. Define $S_n = \sum_1^n w_k X_k$ and $W_n = \sum_1^n w_k$. The paper studies the convergence properties of $S_n W_n$. The restriction of the type of process permits consideration of a much larger class of weights.

1990

Minnesota U. [Dept. of Mathematics] Minneapolis.

TRANSLATION-INVARIANT CONES OF FUNCTIONS ON SEMI-SIMPLE LIE GROUPS, by H. Furstenberg. [1965] [56]p. incl. refs. (AFOSR-65-2619) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-381] and Army Research Office (Durham)) AD 629600 Unclassified

Also published in Bull. Amer. Math. Soc., v. 71: 271-326, Mar. 1965.

Let G be a noncompact connected semisimple Lie group with a finite center, and let X be a homogeneous G-space. A non-zero positive real-valued continuous function s on G x X is called a multiplier on G x X if $s(g_1g_2, \xi) = s(g_1, g_2\xi)s(g_2, \xi)$. If H is a closed subgroup of G, and if s is a multiplier on G x X such that $s(h, \xi) = 1$ for all $h \in H$, $\xi \in X$, then s is called an H-multiplier. The set of all H-multipliers is denoted by $M_H(X)$. If $H = \{e\}$, then each multiplier is an H-multiplier. The set of all multipliers is denoted by M(X). If $s \in M_H(X)$, and $\xi \in X$, the function $g \to s(g, \xi)$ is called an H-multiplier function on G. The class of H-multiplier functions is denoted by $E_H(X)$ by E(X) if $H = \{e\}$). The author shows how, by making an appropriate choice for X and H, the functions in $E_H(X)$ may be made to play a role analogous to the role played by exponential functions on the real line in classical harmonic analysis. Many results in harmonic analysis may be viewed as results on decomposition of each function in a certain class in terms of extremals of that class, and classically these extremals often turn out to be exponentials. The author's main concern is with results of this nature in the above setting. (Math. Rev. abstract)

1991

Minneosta U. [Dept. of Mathematics] Minneapolis.

EIGENVALUES OF MODULUS 1, by B. Jamison. [1965] [3]p. (AFOSR-65-2623) [AF AFOSR-63-381] AD 627981 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 375-377, June 1965.

In this paper B is a (complex) Banach space, T is a bounded linear operator on B, and C is the set of unimodular complex numbers with the usual topology. The following theorem is proven: If B is separable, and if $T^n \leq M < \infty$ for all $n = 1, 2, \ldots$, then T cannot have an uncountable number of eigenvalues of modulus 1.

1992

Minnesota U. [Dept. of Mathematics] Minneapolis.

ERGODIC DECOMPOSITIONS INDUCED BY CERTAIN MARKOV OPERATORS, by B. Jamison. [1965] [13]p. incl. refs. (AFOSR-65-2625) [AF AFOSR-63-381] AD 628439 Unclassified

Also published in Trans. Amer. Math. Soc., v. 117: 451-468, May 1965.

Transition probability operators P (x, E) are considered on a compact metric space which satisfy a rather strong condition (uniform stability in mean). An ergodic decomposition is obtained. It is essentially a sharpening of a decomposition of Yosida's valid under less stringent conditions. The behavior is discussed of sample paths of the Markov processes themselves relative to the ergodic decomposition. Examples are given of transition probability operators which are uniformly stable in mean.

1993

Minnesota U. [Dept. of Mathematics] Minneapolis.

STRONG RATIO LIMIT PROPERTY FOR R-RECURRENT MARKOV CHAINS, by W. E. Pruitt. [1965] [5]p. (AFOSR-65-2638) [AF AFOSR-63-381] AD 627835
Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 196-200, Apr. 1965.

A Markov chain has the strong ratio limit property (SRLP) if there exist positive constants γ, π_i, τ_i $i = 0, 1, 2, \ldots$, such that $\lim_{n\to\infty} p_i^{(m+n)}/p_{kh}^{(n)} = \gamma^m \tau_i \pi_j/(\tau_k \pi_h)$, $m = 0, \pm 1, \pm 2, \ldots$. A markov chain is called R-recurrent or R-transient if $P_{ij}(z) = \Sigma_n p_i^{(n)} z^n$ diverges or converges for $z = R$. The author proves that if a Markov chain is R-recurrent and if for some integer $d > 0$, $\lim \sup_{n\to\infty} u_{(n+1)d}/u_{nd} = R^{-d}$, then the SRLP holds, where $u_n = p_{00}^{(n)}$ for $n \geq 1$ and $u_0 = 1$. The proof is analytic. A note added in proof indicates the result may be obtained probabilistically as a consequence of a theorem by Orey (Bull. Amer. Math. Soc., v. 67: 571-574, 1961). (Math. Rev. abstract)

1994

[Minnesota U. Dept. of Mathematics, Minneapolis]

A GENERAL ERGODIC THEOREM WITH WEIGHTED AVERAGES, by G. Baxter. [1965] [12]p. (AF AFOSR-63-381) Unclassified

Published in Jour. Math. and Mech., v. 14: 277-288, Mar. 1965.

A generalization of the ergodic theorem is given in the following form: Define a sequence $\{u_k: 0 \leq k < \infty\}$ recursively by $u_n = \omega_1 u_{n-1} + \omega_2 u_{n-2} + \ldots + \omega_n u_0$, $u_0 = 1$, where ω_k, $1 \leq k < \infty$, are given non-negative numbers such that $\sum_{k=1}^{\infty} \omega_k = 1$. Let T be a positive linear norm-contracting operator from L, (X, B, m) into itself. The result is that if f, $p \in L$, (X, B, m), $p \geq 0$, then $\lim_{n\to\infty} \sum_{k=0}^{n-1} u_k T^k f / \sum_{k=0}^{n-1} u_k T^k p$ exists almost everywhere on the set where $p > 0$. (Math. Rev. abstract)

1995

Minnesota U. Dept. of Mathematics, Minneapolis.

TRANSMISSION PROBLEMS FOR HOLOMORPHIC FIBER BUNDLES, by H. Rohrl. [1965] [28]p. incl. diagrs. refs. (AFOSR-65-1414) [AF AFOSR-64-625] AD 622839 Unclassified

Also published in Proc. Conf. on Complex Analysis, Minneapolis, Minn. (Mar. 16-21, 1964), ed. by A. Aeppli, E. Calabi, and H. Rohrl. Berlin, Springer-Verlag, 1965, p. 215-242.

Transmission problems for holomorphic fiber bundles in high-dimensional complex spaces are considered. Topological preparations pertaining to the notion of boundary values on a hypersurface by approach from various sides are first carried out. Certain analytic preparations are made, which are mainly concerned with holomorphic bundles of complex Lie groups acting on holomorphic fiber bundles. The transmission problems are then stated. To each holomorphically correct transmission function, a holomorphic fiber bundle $\mathcal{B}_\tau$ is constructed such that the set of solutions of the transmission problem τ corresponds bijectively to the set of holomorphic sections in $\mathcal{B}_\tau$. Topologically correct transmission functions are discussed and related to homology theory. Holomorphically correct transmission functions are then considered.

1996

Minnesota U. Dept. of Mathematics, Minneapolis.

PROCEEDINGS OF THE CONFERENCE ON COMPLEX ANALYSIS, Minneapolis, Minn. (Mar. 16-21, 1964), ed. by A. Aeppli, E. Calabi, and H. Rohrl. Berlin, Springer-Verlag, 1965, 308p. incl. diagrs. table, refs. (AFOSR-65-1592) [AF AFOSR-64-625] AD 620225 Unclassified

The 26 papers presented at the Minnesota Conference on Complex Analysis included the following topics: Stein manifolds; polynomial convexity; quasi-conformal mappings; Kleinian groups; uniform algebras; complex Lie groups; analytic spaces; holomorphic fiber bundles; point modifications; pseudogroup structures; linear topological spaces; Riemann surfaces; complex manifolds; holomorphic mappings; projective geometry; several complex variables; Siegel space; and Teichmuller spaces.

1997

Minnesota U. [Dept. of Mathematics] Minneapolis.

FINITE SETS ON CURVES AND SURFACES, by H. Guggenheimer. [1965] [9]p. (AFOSR-66-1214) (AF AFOSR-64-661) AD 641883 Unclassified

Also published in Israel Jour. Math., v. 3: 104-112, June 1965.

A complete proof is given for Schnirelmann's theorem on the existence of a square in C^2 Jordan curves. The following theorems are then proved, using the same method: (1) On every hypersurface in R^n, C^3-diffeomorphic to S^{n-1}, there exist 2n points which are the vertices of a regular 2^n-cell C_n; (2) Every plane C^1 Jordan Curve can be C^1 approximated by a curve on which there are 2N distinct points which are the vertices of a centrally symmetric 2N-gon (angles π not excluded); and (3) on every plane C^2 curve there exist 5 distinct points which are the vertices of an axially symmetric pentagon with given base angles a, $\pi/2 \leq a < \pi$. (The angle at the vertex on the axis of symmetry might be π). (Contractor's abstract)

1998

Minnesota U. [Dept. of Mathematics] Minneapolis.

PSEUDO-MINKOWSKI DIFFERENTIAL GEOMETRY, by H. Guggenheimer. [1965] [66]p. incl. diagrs. refs. (AFOSR-66-1215) [AF AFOSR-64-661] AD 641884 Unclassified

Also published in Ann. Mat. Pura Appl., v. 70: 305-370, 1965.

The method of moving frames is applied to finite dimensional Banach spaces with smooth but unsymmetric unit spheres. The results obtained present a far reaching generalization of Euclidean methods. A complete theory of curvature is given. The theorems associated with the 4-vertex-theorem are reduced to a general theorem on differential equations with periodic orbit. Integral geometry is shown to depend on the group of the Hadwiger-Glur theorem only, not on the rotation group. The power of this approach is demonstrated in many detailed formulas. The theory of space curves and surfaces

is developed along similar lines. Here significant departures from the Euclidean case do appear. Surface area is defined as a function in Grassmann-space, not as a set function. The foundations of Finsler geometry are given.

1999

Minnesota U. Dept. of Mathematics, Minneapolis.

GAUSSIAN PROCESSES AND GENERALIZED SCHROEDINGER EQUATIONS, by J. A. Beekman. [1965] [18]p. incl. refs. (AFOSR-66-1193) [AF AFOSR-65-331] AD 641071 Unclassified

Also published in Jour. Math. and Mech., v. 14: 789-806, Sept. 1965.

In "a family of integrals serving to connect the Wiener and Feynman integrals", Jour. Math. and Phys., v. 39: 126-140, 1960, and "the Ilstow and Feynman integrals", Jour. D'Analyse Math., v. 10: 287-361, 1962-1963, R. H. Cameron has defined several special integrals connected with the Wiener integral, and has studied the existence and properties of those integrals. Under certain hypotheses on the integrand, these integrals are connected with R. P. Feynman's function space integral in the one dimensional case. These "Feynman" integrals of certain classes of functionals serve as solutions to the Schroedinger equation. The present paper extends these ideas from the Wiener stochastic process to Gaussian Markov stochastic processes. Another problem considered is an existence theorem for a partial differential equation which plays the role for Gaussian Markov processes that the generalized heat flow equation does for the Wiener process.

2000

Minnesota U. [Dept. of Mathematics] Minneapolis.

THE ISOPERIMETRIC INEQUALITY FOR MULTIPLY-CONNECTED MINIMAL SURFACES, by J. C. C. Nitsche. [1965] [3]p. (AFOSR-66-0214) (AF AFOSR-65-883) AD 631376 Unclassified

Also published in Bull. Amer. Math. Soc., v. 71: 750-752, Sept. 1965.

The proof is presented for the theorem which states that if a doubly-connected minimal surface of area A is bounded by a pair of distinct Jordan curves C_k of L_k, then $(L_1 + L_2)^2 > 4A$. (Math. Rev. abstract, modified)

2001

Minnesota U. [Dept. of Mathematics] Minneapolis.

ON THE NON-SOLVABILITY OF DIRICHLET'S PROBLEM FOR THE MINIMAL SURFACE EQUATION, by J. C. C. Nitsche. [1965] [10]p. incl. diagrs. refs. (AFOSR-66-0215) (AF AFOSR-65-883) AD 631378 Unclassified

Also published in Jour. Math. and Mech., v. 14: 779-788, Sept. 1965.

Let C be the boundary of a bounded plane domain D. The Dirichlet problem for the maximal surface equation consists in finding a solution of that equation in the domain D which takes on prescribed values on C. It was first proved by Radó that if D is convex, then a solution exists for any continuous boundary values on C. The present paper is devoted to a discussion of cases in which no solution exists. If C is a certain non-convex quadrilateral and if one assigns continuous boundary values to be zero on two sides and linear on the other two sides, then the Dirichlet problem has no solution in the domain D bounded by C. The paper also contains an extensive discussion of the previous literature on the subject starting with a paper of Bernstein, who first noted that there exist non-convex domains for which Dirichlet's problem is not in general solvable, and concluding with the recent paper of Finn (Jour. Analyse Math., v. 14: 139-160, 1965), in which it is shown that for every non-convex domain there exist continuous boundary values for which Dirichlet's problem is not solvable. (Math. Rev. abstract)

2002

[Minnesota U. Dept. of Mathematics, Minneapolis]

THE ISOPERIMETRIC INEQUALITY FOR MULTIPLY-CONNECTED MINIMAL SURFACES, by J. C. C. Nitsche. [1965] [6]p. incl. diagr. refs. (AFOSR-66-0216) (AF AFOSR-65-883) AD 631377 Unclassified

Also published in Math. Ann., v. 160: 370-375, 1965.

Let S be a minimal surface of the type of the circular annulus of (finite or infinite) area A. Suppose S is bounded by 2 distinct rectifiable Jordan curves of (finite or infinite) lengths L_1 and L_2. It is shown that S has finite area, and that $(L_1 + L_2)^2 - 4A > 0$. The method of proof is said to yield the analogous theorem for multiply connected minimal surfaces. (Math. Rev. abstract)

2003

Minnesota U. [Dept. of Mathematics] Minneapolis.

ON DIFFERENTIAL EQUATIONS OF MODE 2, by J. C. C. Nitsche. [1965] [7]p. incl. refs. (AFOSR-66-0263) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-883 and Office of Naval Research) AD 631621 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 902-908, Oct. 1965.

The author considers quasi-linear elliptic equations of the form $L[z] = a(x, y, p, q)r + 2b(x, y, p, q)s + c(x, y, p, q)t = 0$, $ac - b^2 > 0$, $a > 0$. Putting $F_1 = ap^2 + 2bpq + cq^2$, $F_2 = (a + c)(p^2 + q^2)$, the mode of such an equation

is defined to be $\mu_2 - \mu_1$, where μ_1, μ_2 are, respectively, the orders of growth of F_1, F_2 as p, q tend to infinity. For equations of positive mode, and more generally, for equations satisfying the condition $\int^{\infty} (dw/wQ(w)) < \infty$,

$$\text{where } Q(w) = \min_{p^2+q^2=w^2} \left\{ \inf_{(x,y)} \left(\frac{F_2}{F_1} - 1 \right) \right\},$$

the author proves that solutions are bounded near isolated singularities; more precisely, they satisfy the following extended maximum principle. Let $z(x, y)$ be a solution in the punctured disc $0 < x^2 + y^2 < 1$ such that $m \leq \liminf z(x, y)$, $\limsup z(x, y) \leq M$.

$$x^2+y^2 \to 1 \qquad x^2+y^2 \to 1$$

Then $m < z(x, y) < M$ everywhere. The proof is accomplished by constructing a family of radially symmetric super solutions $\Phi(r;a)$ in the annulus $0 < a < r < 1$ such that $\Phi'(r;a) \to -\infty$ as $r \to a$, and $\Phi(r;a) \to 0$ as $a \to 0$. (Math. Rev. abstract)

2004

Minnesota U. [Dept.] of Mathematics, Minneapolis.

[AN INCLUSION THEOREM FOR MINIMAL SURFACES] Ein EinschlieBungssatz fur Minimal flachen, by J. C. C. Nitsche. [1965] [5]p. (AFOSR-66-2598) (AF AFOSR-65-883) AD 643369 Unclassified

Also published in Math. Ann., v. 165: 71-75, 1965.

Suppose K_1 and K_2 are 2 circles in R^3 lying in parallel planes, and Γ_i is a Jordan curve in the plane containing K_i which is interior to K_i in that plane ($i = 1, 2$). The author shows that if Γ_1 and Γ_2 bound a minimal surface of the type of the annulus, then so do K_1 and K_2. (Math. Rev. abstract)

2005

Minnesota U. [Heat Transfer Lab.] Minneapolis.

LONGITUDINAL FLOW OVER A CIRCULAR CYLINDER WITH SURFACE MASS TRANSFER, by D. J. Wanous and E. M. Sparrow. 1965 [3]p. incl. diagrs. table. (AFOSR-65-0992) [AF AFOSR-64-17] AD 617624 Unclassified

Also published in AIAA Jour., v. 3: 147-149, Jan. 1965.

This note considers axisymmetric laminar boundary-layer flow longitudinal to a circular cylinder with continuously-distributed mass injection (blowing) or mass removal (suction) at the surface. Solutions are sought for 2 distributions of the surface mass transfer velocity: (1) $v_\omega \sim x^{-1/2}$, and (2) v_ω = constant. A graphical presentation of the local skin-friction results is given, from which it is seen that the skin-friction coefficient for the cylinder is always greater than that for a flat plate. The investigation also points out that the general effect of blowing is to decrease the skin friction, whereas suction increases the skin friction, though the effect of either is not as great for the cylinder as for the flat plate. From this it is concluded that surface mass transfer and transverse curvature oppose one another.

2006

Minnesota U. Heat Transfer Lab., Minneapolis.

UNIFORM AIR INJECTION INTO A TURBULENT BOUNDARY LAYER FLOW OVER AN AXIAL CIRCULAR CYLINDER, by V. K. Jonsson and C. J. Scott. July 1965, 86p. incl. diagrs. tables. (Technical rept. no. 63) (AFOSR-65-2290) (AF AFOSR-65-17) AD 621888 Unclassified

An experimental study was made of the effects of uniform air injection into the turbulent boundary layer flowing on an axial circular cylinder with a nominal free stream velocity of 120 fps. The blowing rate parameter divided by the free stream flow rate varied from 0 to 21×10^{-5} while the Reynolds number based on free stream conditions varied from 4.0×10^5 to 10.6×10^5. The data for velocity profiles were inserted into the momentum equation and the distribution of turbulent shear stress and eddy viscosity was obtained. The correlation of eddy viscosity with both Reynolds number and injection rate was obtained by dividing by the product of the maximum shear stress velocity and boundary layer thickness. Furthermore, the results for the universal velocity profile correlate better when the maximum shear stress velocity is used rather than wall shear stress velocity. When some of the results are compared with previous experiments, the use of the maximum friction factor rather than wall friction factor in the blowing rate parameter produces better correlation between these various experiments. (Contractor's abstract)

2007

Minnesota U. Heat Transfer Lab., Minneapolis.

HOT-WIRE ANEMOMETER STUDY OF A TURBULENT BOUNDARY LAYER ON A POROUS AXIAL CIRCULAR CYLINDER WITH UNIFORM AIR INFECTION, by V. K. Jonsson and W. D. Batton. Sept. 1965, 93p. incl. illus. diagrs. tables, refs. (Technical rept. no. 65) (AFOSR-65-2724) (AF AFOSR-65-17) AD 628083 Unclassified

The report deals with a hot-wire anemometer study of a turbulent boundary layer on a porous axial cylinder with a free stream velocity of 120 fps. The variations through the boundary layer of the transverse and longitudinal fluctuating velocity components, the Reynolds stress, the turbulent friction coefficient, and the correlation coefficient were obtained at axial Reynolds numbers of 4×10^5, 6×10^5, and 9×10^5. Two cases of injection with air were studied in addition to the case of no injection. The value of the dimensionless injection rate was zero, 84×10^{-6}, and 20×10^{-5}. (Contractor's abstract)

2008

Minnesota U. Heat Transfer Lab., Minneapolis.

EXPERIMENTS ON THE DIFFUSION THERMO EFFECT IN A BINARY BOUNDARY LAYER WITH INJECTION OF VARIOUS GASES, by E. M. Sparrow, C. J. Scott and others. [1965] [8]p. incl. diagrs. refs. (AFOSR-66-0331) [AF AFOSR-65-17] AD 631371 Unclassified

Presented at ASME Winter Annual Meeting, New York, N. Y., Nov. 29-Dec. 3, 1964.

Also published in Jour. Heat Transfer, v. 88: 321-328, Aug. 1965.

The free convection heat and mass transfer about a porous horizontal cylinder are investigated experimentally. Various gases, which are either preheated or precooled, are injected through the porous cylinder into an otherwise quiescent air environment. The gases include hydrogen, helium, carbon dioxide, and Freon-12; the first 2 of these have molecular weights less than that of air while the latter 2 have molecular weights greater than that of air. It is found that for the condition of no net heat transfer at the surface, the temperature of the surface differs from the temperature of the environment. The existence of the aforementioned adiabatic wall temperature is due to the diffusion thermo effect. When hydrogen or helium is the injected gas, the adiabatic wall temperature exceeds the ambient temperature by as much as 100°F. On the other hand, when carbon dioxide or Freon-12 is the injected gas, the deviation between adiabatic wall and ambient temperatures is both much smaller and of opposite sign relative to that noted previously. (Contractor's abstract, modified)

2009

Minnesota U. [Heat Transfer Lab.] Minneapolis.

MASS-TRANSFER COOLING OF A FLAT PLATE WITH VARIOUS TRANSPIRING GASES, by E. M. Sparrow, W. J. Minkowycz, and E. R. G. Eckert. [1965] [2]p. incl. diagrs. [AF AFOSR-65-17] Unclassified

Published in AIAA Jour., v. 3: 1341-1343, July 1965.

Supplementary information is given for stagnation flows, consisting of mass-transfer cooling results for a flat plate. Consideration is given to laminar boundary-layer flow into which are injected various gases including hydrogen, helium, water vapor, argon, carbon dioxide and xenon. The molecular weights of the aforementioned transpiring gases range from 2.016 to 131.3. In all cases, the main-stream gas is air. The distribution of the surface mass transfer is such that similarity solutions of the boundary layer equations are possible, i.e., the injection velocity v_w varies as $x^{-1/2}$, where x is the distance from the leading edge.

2010

Minnesota U. [School of Chemistry] Minneapolis.

OSCILLATIONS OF THE He II FILM, by F. I. Glick and J. H. Werntz, Jr. [1965] [5]p. incl. diagrs. table. (AF AFOSR-62-301) Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. A): 214-218, 1965.

An experiment is performed in which oscillations of the He II film have been studied. Basically, the apparatus consists of 2 concentric annular reservoirs separated by a stainless steel vacuum jacket. The outer reservoir is bounded by a thin-walled brass can; thus the liquid in it will have the temperature and stability of the temperature-regulated bath in which the apparatus is submerged. The stainless steel plug is lapped to the conical seat at the top of the inner reservoir where the 2 walls of the vacuum jacket are joined together and can be raised or lowered during an experiment; with the plug raised, isothermal experiments are performed, while with the plug seated, adiabatic experiments are performed. In the isothermal experiments, heat is transported between the reservoirs by distillation. It was found from the isothermal experiments, that for a fixed temperature the isothermal oscillation frequency varied as an inverse power of the barrier height. In the present film flow experiment, the relation predicted by Robinson (Phys. Rev., v. 82: 440, 1951) between the oscillation frequencies under adiabatic and isothermal conditions is verified within ±5%. However, the adiabatic damping predicted, using the observed heat conduction decay times, couldn't explain the observed adiabatic damping. The excess of the damping observed in an adiabatic experiment over that predicted was equal to the damping observed under isothermal conditions for the same barrier height, within the accuracy of the results. Values of the entropy defect of the superfluid were determined.

2011

Minnesota U. School of Chemistry, Minneapolis.

THEORY OF RESONANCE ABSORPTION LINE SHAPES IN MONATOMIC GASES, by G. P. Reck, H. Takebe, and C. A. Mead. [1965] [16]p. incl. diagrs. tables, refs. (AFOSR-65-0679) (AF AFOSR-63-13) AD 616493 Unclassified

Also published in Phys. Rev., v. 137: A683-A698, Feb. 1, 1965.

It is pointed out that the usual theories of pressure broadening disagree with direct experimental measurements of the widths of resonance-broadened alkali doublet lines, although the theories are at least qualitatively confirmed for the wings of resonance lines and for foreign-gas broadening. There are also 2 conflicting sets of experimental data (both in strong disagreement with theory). Some qualitative arguments are given for doubting the validity, near the center of a

resonance line, of the "2-body" approximation generally used in theoretical treatments, and some formal objections to the usual procedure are also presented. The basic equation relating the susceptibility to a resolvent operator matrix element is derived from a more fundamental point of view than usual; the result contains in principle all effects due to translational motion, to the quantized nature of the radiation field, and to "spatial dispersion." In the limit of large absorber mass it is proved rigorously that the 2-body approximation can never be valid near the center of a line, even for very low densities. By using different approximations for the wings and the line center, satisfactory agreement is obtained with experiments in both regions for the alkali doublet lines. Also it is possible for one to decide between the 2 conflicting experiments, favoring the square-root density dependence of the line-width observed by Lauriston and Welsh. (Contractor's abstract)

2012

Minnesota U. School of Chemistry, Minneapolis.

USE OF RETARDED GREEN'S FUNCTIONS IN EXCITON THEORY, by C. W. Deutsche and C. A. Mead. [1965] [11]p. incl. refs. (AF AFOSR-63-13) Unclassified

Published in Phys. Rev., v. 138· A63-A73, Apr. 5, 1965.

It is pointed out that the usual treatment of excitons in interaction with radiation with spatial dispersion does not obviously satisfy causality in all cases, and it is shown explicitly that certain paradoxes and ambiguities can appear even in simple cases. In particular, it is shown for a simple special case that an apparently reasonable choice of boundary condition leads to a reflection coefficient greater than unity, and also that in some cases one must make rather arbitrary and inconsistent requirements in order to get the right number of boundary conditions to determine a solution. The theory is reformulated in a way that is manifestly causal, with both field and polarization being generated by retarded Green's functions. Umklapp processes are also included. This formulation confirms the results of the usual treatment in the cases in which the latter are unambiguous and acceptable, but avoids the difficulties mentioned above. The model used is essentially classical and one dimensional, but nevertheless sufficiently general for the treatment of these problems.

2013

Minnesota U. School of Chemistry, Minneapolis.

THE EFFECT OF STRUCTURE ON ACID-INDUCED DEOXYMERCURATION RATES. VARIATION IN THE ALCOHOL COMPONENT, by M. M. Kreevoy and M. A. Turner. 1965 [3]p. incl. diagrs. tables, refs. (AFOSR 65-0686) (AF AFOSR-63-16) AD 616187 Unclassified

Also published in Jour. Org. Chem., v. 30. 373-375, 1965.

The aqueous acid induced deoxymercuration rates of 14 oxymercurials $ROCH_2CH_2HgI$, have been measured and combined with 2 rate constants obtained previously. The rates cover a range of a factor of over 20. No over-all correlation with the Taft σ^* is obtained, but a very limited correlation suggests a ρ^* of ~ -1.4. Steric factors and possibilities for internal hydrogen bonding also seem to influence the rates. (Contractor's abstract)

2014

Minnesota U. School of Chemistry, Minneapolis.

EFFECT OF MOLECULAR ACID-BASE DISSOCIATION OF SALTS ON CONDUCTOMETRIC TITRATION CURVES IN ACETONITRILE, by I. M. Kolthoff and M. K. Chantooni, Jr. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-0880) (AF AFOSR-63-28) AD 618442 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87· 1004-1011, Mar. 5, 1965.

Salts of weak acids and primary, secondary, and tertiary amines are subject to molecular acid-base dissociation in acetonitrile. When the acid has a large homoconjugation constant K_2 and the molecular formation constant K_f of the salt is less than infinity, the conductance of the salt may be much greater than that which corresponds to the calculated value from the ionic dissociation constant of the salt K_d, being $< K_2$ because of homoconjugation. With known values of K_f, K_d, and K_2, equations are derived which allow the calculation of conductometric titration curves of an acid with an amine under the previous conditions. Such curves exhibit a maximum in conductance. A relation is derived which allows the calculation of K_f from the location of the maximum and of K_d from the conductance at the maximum. A relation is also derived which allows the calculation of K_dK_f from the early portion of the titration curves

2015

Minnesota U., School of Chemistry, Minneapolis.

CALIBRATION OF THE GLASS ELECTRODE IN ACETONITRILE. SHAPE OF POTENTIOMETRIC TITRATION CURVES. DISSOCIATION CONSTANT OF PICRIC ACID by I. M. Kolthoff and M. K. Chantooni, Jr. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-0043) (AF AFOSR-63-28) AD 629614 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87 4428-4436, Oct. 1965.

An equation was derived for the calculation of pa_H in the neutralization with tetraalkylammonium hydroxide in acetonitrile of a weak acid with known dissociation constant K_{HA} and homoconjugation constant K_{HA2^-}. The

assumption was made that the tetraalkylammonium salts of the acid are completely dissociated. At 50% neutralization $pa_H = pK_{HA}$. When the product of initial acid concentration and K_{HA2^-} is greater than about 10, the buffer capacity has a pronounced minimum at 50% neutralization. Equations are derived to calculate K_{HA} and K_{HA2^-} from pa_H measured with the glass electrode in mixtures of an acid and its tetraalkylammonium salt. pK_{HA} and $pK_{2(HA)}$ of methanesulfonic acid (I) and 2,5-dichlorobenzenesulfonic acid (II) were determined by various methods and the following values were found. 10.0 and 3.8 for I and 6.2 and 2.65 for II, respectively. The glass electrode in AN was calibrated in mixtures of I and of II with their tetraethylammonium salts and in mixtures of o-nitroaniline and perchloric acid. pK_{HA} of picric acid was determined potentiometrically and a value of 11.0 ± 0.1 was found. (Contractor's abstract)

2016

Minnesota U., School of Chemistry, Minneapolis.

SPIN STATES OF TRIVALENT CHROMIUM WITH TETRAGONAL SYMMETRY IN MgO, by P. V. Auzins and J. E. Wertz. [1965] [4]p. incl. diagrs. table. (AFOSR-66-0237) (AF AFOSR-63-200) AD 629658 Unclassified

Also published in Jour., Chem. Phys., v. 43 1229-1232, Aug. 15, 1965.

Spin transitions between nonadjacent energy levels of Cr^{3+} in tetragonal symmetry in MgO become allowed by the mixing of states which occurs when the applied magnetic field is not along the symmetry axis. The tetragonal electric field arises from association with a next-nearest-neighbor (nnn) cation vacancy. When the defect axis is perpendicular to the applied field, energy level and matrix element expressions for the -3/2 - 3/2 transition are closely related to those for the normally allowed transitions. Two other transitions between alternate levels (-3/2 - 1/2 and -1/2 - 3/2) become allowed for parallel microwave and static fields. The ESR lines corresponding to these transitions have been observed (Contractor's abstract)

2017

Minnesota U., [School of Chemistry] Minneapolis.

TRAPPED HOLE CENTER CONTAINING FLUORINE IN MAGNESIUM OXIDE, by J. E. Wertz and P. V. Auzins. [1965] [3]p. incl. diagrs. (AFOSR-66-0239) (AF AFOSR-63-200) AD 629661 Unclassified

Also published in Phys. Rev., v. 139: A1645-A1647, Aug. 30, 1965

An intrinsic defect center readily induced in MgO by ionizing radiation is the positive hole localized on an oxygen atom adjacent to a positive ion vacancy (V_1 center). This has a tetragonal symmetry axis along [001] or equivalent directions. A similar ESR spectrum but with each line a hyperfine doublet was identified earlier as arising from the center $O^- -[=]-H^+O$ (V_{OH} center). This paper describes a similar ESR spectrum of a trapped hole center (V_F) with smaller (anisotropic) hyperfine splitting than V_{OH}. It is best observed in single crystals, but it may be induced in powdered MgO by fluorine doping and heating. It thus appears that fluorine is the nucleus responsible for hyperfine splitting. The contact and dipolar splitting constants are, respectively: a = 0.08 G, b = 0.33 G. The proposed model for the V_F center is $O^- -[=]- ^+$ (only deviations from normal site symmetry are shown). (Contractor's abstract)

2018

Minnesota U. [School] of Chemistry, Minneapolis.

HYDROGEN-CONTAINING TRAPPED HOLE CENTER IN MAGNESIUM OXIDE, by P. W. Kirklin, P. Auzins, and J. E. Wertz. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-66-0240) [AF AFOSR-63-200] AD 629658 Unclassified

Also published in Jour., Phys. Chem. Solids, v. 26: 1067-1074, 1965.

Earlier ESR studies of X-irradiated MgO had shown the existence of centers having a positive hole trapped on an oxygen atom adjacent to a positive ion vacancy (V1-centers). Some MgO samples show a qualitatively similar ESR spectrum with each line a doublet. Electron-nuclear double resonance studies show unambiguously that the splitting arises from a hydrogen atom collinear with the positive hole and the vacancy. Infrared studies of unirradiated MgO had earlier shown a sharp band at 3296 cm^{-1}, which was observed to be shifted to 3323 cm^{-1} on irradiation. Decay of the 3323 cm^{-1} band occurs with corresponding growth of the 3296 cm^{-1} band and loss of the ESR signal. The 3296 cm^{-1} band is attributed to an OH^- ion with hydrogen adjacent to the vacancy. The shift occurs when a hole is trapped on an oxygen opposite the vacancy from the hydrogen atom of OH^-. The new center is referred to as the V_{OH} center. (Contractor's abstract)

2019

Minnesota U., School of Chemistry, Minneapolis.

THERMOLUMINESCENT FORMATION OF Cr^{2+} IN MAGNESIUM OXIDE, by J. E. Wertz and R. E. Coffman. [1965] [3]p. incl. diagrs. table, refs. (AFOSR-66-0241) [AF AFOSR-63-200] AD 629660 Unclassified

Also published in Jour. Appl. Phys., v. 36: 2959-2961, Sept. 1965.

In undoped crystals of MgO, x irradiation converts a large fraction of Cr^{3+} in octahedral symmetry to Cr^{2+}.

Heating such crystals until a blue thermoluminescence has been observed causes further reduction. Usually 95% or more of the Cr^{3+} is converted by the combined treatments. However, in Cr-doped MgO, one is able to reduce only a small fraction of the octahedral chromium to Cr^{2+}. The Cr^{2+} is reconverted to Cr^{3+} by heating. ESR measurements show that in the same temperature interval nearly all of the Fe^{1+} formed on x irradiation has disappeared. The source of electrons acquired by Cr^{3+} thus appears to be the Fe^{1+} ions. The thermoluminescence is ascribed to the Cr^{3+}-electron interaction, as suggested by Hansler and Segelken. (Contractor's abstract)

2020

Minnesota U., School of Chemistry, Minneapolis.

ANHARMONIC POTENTIAL FUNCTIONS OF POLYATOMIC MOLECULES, by J. Overend. Final rept., Jan. 1, 1964-Dec. 31, 1965 [19]p. incl. diagr. tables, refs. (AFOSR-68-0125) (AF AFOSR-64-570)
AD 664060 Unclassified

A summary is given of a study which involved the experimental examination of vibrational-rotational spectra at very high resolution and the calculation of anharmonic force constants from the spectroscopic data. Accomplishments included the development of computer techniques by which anharmonic force constants could be adjusted to observed spectroscopic data, and the application of these techniques to studies of the anharmonicity in HCN, acetylene, SO_2, H_2O, N_2O, and several other molecules.

2021

Minnesota U. School of Chemistry, Minneapolis.

LEAST-SQUARES ADJUSTMENT OF ANHARMONIC POTENTIAL CONSTANTS: APPLICATION TO $^{12}CO_2$ AND $^{13}CO_2$, by M. A. Pariseau, I. Suzuki, and J. Overend. [1965] [10]p. incl. diagrs. tables, refs. (AF AFOSR-64-570) Unclassified

Published in Jour. Chem. Phys., v. 42: 2335-2344, Apr. 1, 1965.

An algorithm for the calculation of anharmonic potential constants from the observed vibrational energy levels and rotational constants has been set up. Values have been obtained for the cubic and quartic force constants in the most general valence anharmonic potential for carbon dioxide. (Contractor's abstract)

2022

Minnesota U. [School] of Chemistry, Minneapolis.

ELECTROMOTIVE FORCE, RAMAN, AND NUCLEAR MAGNETIC RESONANCE STUDIES ON THE INTERACTION OF CHLORIDE AND BROMIDE IONS WITH THE DIMETHYLTIN(IV) ION. INNER- AND OUTER-SPHERE COMPLEXES, by H. N. Farrer, M. M. McGrady, and R. S. Tobias. 1965 [8]p. incl. diagrs. tables, refs. (AFOSR-66-0307) (AF AFOSR-65-691)
AD 636365 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87 5019-5026, Nov. 20, 1965.

The complexing of $(CH_3)_2Sn^{+2}$(aq) by Cl^- and Br^- in aqueous solution has been studied by e.m.f., Raman, and proton n.m.r. measurements. By the use of the cells, glass electrode $|0.2\ M\ H^+,\ 2.8\ M\ Na^+,\ 3\ M\ ([ClO_4^-] + [X^-])|\ AgX|Ag$ (X = Cl and Br), the halide ion concentrations were determined in solutions containing $(CH_3)_2Sn^{+2}$. The following values for the stability constants of the chloro complexes were obtained at 25 by least-squares refinement: $\log \beta_1 = 0.380 \pm 0.001$ and $\log \beta_2 = -0.14 \pm 0.01$. Little of the 2:1 complex could have been present, and its existence is not definitely established. The interaction with Br^- was very weak, and $\log \beta_1 < -0.5$. The values of the ^{117}Sn and ^{119}Sn methyl proton spin-spin coupling constants and the integrated Raman intensities for tin-chloride bond stretching in solutions as a function of chloride ion concentration indicated that both inner- and outer-sphere complexes are formed. Only in concentrated chloride solutions are appreciable concentrations of the inner-sphere complex present. The Raman spectra show that inner-sphere complexing also occurs in concentrated bromide solutions. The dimethyltin(IV) ion is characterized by a high affinity for water molecules, and in many respects the solutions of $(CH_3)_2SnCl_2$ and $(CH_3)_2SnBr_2$ resemble those of oxonium chloride and bromide. The hypothetical free linear $(CH_3)_2Sn^{+2}$ can be regarded as an extremely "hard" acid which forms very stable complexes with bases of low polarizability and gives large crystal-field effects in lattices. (Contractor's abstract)

2023

Minnesota U., [School of Physics] Minneapolis.

ELECTRON SPIN RESONANCE STUDIES OF SELECTED SOLIDS, by T. M. Sanders, Jr. Final rept. [196- 37p. incl. diagrs. tables, refs. (AFOSR-65-085 (AF 49(638)811); AD 616788 Unclassified

The report describes research efforts in 2 major areas. First, electron spin resonance experiments on shallow donors in germanium are reported. The experiments consist in measurement of the Zeeman effect of the donors as a function of applied [110] compression. From the data a value may be derived for the valley-orbit (singlet-triplet) splitting ($4\Delta_c$) of the donor ground state. The results for P donors agree with determinations by other workers. The result for Sb in Ge is $4\Delta_c = (4.04 \pm 0.1) \times 10^{-4}$ ev. This result is not consistent with the value obtained from piezo-resistance measurements. The data also require that the singlet state lie below the triplet in Sb-donors, just as in P and As donors. An additional 4-line spin resonance spectrum in

Sb-doped Ge is ascribed to donors located near the surface of the samples, in regions of high local strain. The second major area discussed concerns polarized proton target studies. In order to increase the absolute proton polarization to a value sufficiently large for scattering experiments, the static magnetic field was increased over preliminary experiments and the temperature decreased. Near 4.7 kgauss and 1.3°K, the absolute proton polarization increased relative to the lower field value due to increases both in proton NMR frequency and in enhancement of proton polarizat by the "solid effect". Experimental apparatus was designed and constructed to extend the experiments to 12.5 kgauss and 0.5°K.

2024

Minnesota U. School of Physics, Minneapolis.

QUANTIZED VORTICES AND THE SUPERFLUID HELIUM ANALOG OF THE AC JOSEPHSON EFFECT, by W. Zimmermann, Jr. [1965] [4]p. incl. diagr. (AFOSR-65-2084) [AF AFOSR-65-793] AD 627505 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 976-979, June 14, 1965.

In a recent paper (Phys. Rev. Ltrs., v. 14. 540, 1965) Richards and Anderson reported the observation of an effect in superfluid helium which they interpreted in close analogy to the ac Josephson effect in superconductors. Their interpretation is based on an equation which was derived using the concept of a complex order parameter for the liquid. In this note, it is shown that this equation can also be derived from the conventional equations of 2-fluid hydrodynamics combined with the assumption of quantization of vorticity in the superfluid. It is believed that this approach is closely related to the order-parameter method and that the 2 points of view complement one another.

2025

Minnesota U. School of Physics, Minneapolis.

GYROSCOPIC DETEC "ION OF PERSISTENT FLOW OF SUPERFLUID LIQUID HELIUM, by J. B. Mehl and W. Zimmermann, Jr. [1955] [4]p. incl. diagrs. (AFOSR-65-2085) [AF AFOSR-65-793] AD 627506 Unclassified

Also published in Phys. Rev. Ltrs., v. 14. 815-818, May 17, 1965.

Long-lived persistent currents were observed in a superfluid flow of liquid helium. The currents were studied by means of gyroscopic effects associated with circuital flow, which permits repeated direct measurements of the angular momentum of the flow to be made without destruction of the flow. This gyroscopic technique has provided a particularly good means of establishing the existence of persistent flow and of studying its nature.

2026

Minnesota U. School of Physics, Minneapolis.

OBSERVATION OF STABLE SUPERFLUID CIRCULATION IN LIQUID-HELIUM II AT THE LEVEL OF ONE, TWO, AND THREE QUANTUM UNITS, by S. C. Whitmore and W. Zimmermann, Jr. [1965] [4]p. incl. diagrs. (AFOSR-65-2772) (AF AFOSR-65-793) AD 629827 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 389-392, Aug. 30, 1965.

Vinen's experiment (Proc. Roy. Soc. (London), v. 260A: 218, 1961) in which the circulation around a fine wire immersed in superfluid helium was measured by means of the influence that the circulation exerts on the transverse vibrations of the wire, is extended in order to present more evidence in support of the hypothesis of quantization of circulation. It is found that motion of the superfluid can persist for long periods of time with the assembly carrying the tube and wire stationary. Circulation around the wire tends to show markedly greater stability at the anticipated quantum levels than at other values. As the wire diameter was increased, the maximum value of stable circulation observed also increased. Several subsidiary observations which help support the conclusion that the effects of quantized circulation have been observed are reported.

2027

Minnesota U. School of Physics and Astronomy, Minneapolis.

SUPERFLUID LIQUID HELIUM GYROSCOPE, by J. B. Mehl and W. Zimmermann, Jr. [1965] [4]p. (AFOSR-65-1095) (AF AFOSR-62-316) AD 618080 Unclassified

Presented at meeting of Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Also published in Bull. Amer. Phys., Series II, v. 10: 30, Jan. 27, 1965.

Persistent circulating currents of superfluid helium have been observed by means of associated gyroscopic effects. The gyroscope consists of a 3 cm-diam glass sphere filled with powder, of particle size 10^{-3} cm, which forms fine channels through which the superfluid flows. The superfluid current is generated by steadily rotating the sphere about a vertical axis while cooling through the λ-point and then stopping the sphere's rotation at a lower temperature. The sphere is mounted so that it subsequently can be tipped through 90° about a horizontal axis and the vertical component of torque needed to carry out this tipping measured. By this means repeated measurements of the persisting angular momentum can be made, assuming the angular momentum to tip with the sphere. With an initial angular velocity of rotation of 0.28 radians sec^{-1}, measurements of a persisting angular momentum have been repeated up to 40 times during a period of 100 min showing no decay of the motion during that period to an accuracy of ±10%.

2028

[Mississipp. U. Dept. of Chemistry, University]

SOLVENT EFFECTS ON CHARGE-TRANSFER COMPLEXES. II. COMPLEXES OF 1,3,5-TRINITROBENZENE WITH BENZENE, MESITYLENE, DURENE, PENTAMETHYLBENZENE, OR HEXAMETHYLBENZENE, by C. C. Thompson, Jr. and P. A. D. de Maine. 1965 [6]p. incl. tables, refs. (AFOSR-65-2372) (AF AFOSR-62-19) AD 629553 Unclassified

Also published in Jour. Phys. Chem., v. 69: 2766-2771, Aug. 1965.

Formation constants (K), heats of formation (ΔH) and absorptivities of 1:1 charge-transfer complexes of 1,3,5-trinitrobenzene with hexamethylbenzene, pentamethylbenzene, durene, mesitylene, or benzene dissolved in CCl_4, n-hexane, n-heptane, cyclohexane, or $CHCl_3$ were calculated from spectroscopic data collected at 20° and 45°C for a 12 wave lengths between 2800 and 4200A. K values for all complexes vary with solvent in the order: cyclohexane > n-heptane ≈ n-hexane > CCl_4 > $CHCl_3$ with a 10 to 20-fold variation in K in passing from cyclohexane to $CHCl_3$ at 20°C. K is independent of wave length near the band maximum, but in some systems K increases at longer wave lengths, probably because of the simultaneous formation of 1:1 and higher order complexes (Contractor's abstract)

2029

[Mississippi U. Dept. of Chemistry, University]

ULTRA-VIOLET ABSORPTION SPECTRA OF IODINE-n-HEPTANE-$(PNCl_2)_3$ SOLUTIONS, by N. B. Jurinski and P. A. D. de Maine. [1965] [4]p. incl. diagr. table, refs. (AFOSR-65-2373) (AF AFOSR-62-19) AD 629551 Unclassified

Also published in Jour. Inorg and Nuclear Chem., v. 27: 1591-1594, 1965.

The changes observed in the ultra-violet absorption spectra of $(PNCl_2)_3$ in n-heptane on addition of iodine are discussed. Unsuccessful attempts to obtain spectrophotometric evidence of interaction between $(PNCl_2)_3$ or $(PNCl_2)_4$ and donors or acceptors in solution are reported. (Contractor's abstract)

2030

[Mississippi U. Dept. of Chemistry, University]

SOLVENT EFFECTS ON THE ULTRAVIOLET AND INFRA-RED ABSORPTION SPECTRA OF PHOSPHONITRILIC CHLORIDES, by N. B. Jurinski, C. C. Thompson, Jr., and P. A. D. de Maine. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-2374) (AF AFOSR-62-19) AD 629552 Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 27: 1571-1576, 1965.

A report is given of the solvent concentration and temperature dependence of the high energy-band centres (near 2100A) for $(PNCl_2)_3$ or $(PNCl_2)_4$. Twenty different inert solvents were used. These data are not described by any published solvent shift theory. Infrared absorption spectra between 600 and 4000 cm^{-1} for both compounds in different inert solvents are reported. Solvent shift theories are discussed. (Contractor's abstract)

2031

[Mississippi U. Dept. of Chemistry, University]

THE SELF-JUDGMENT METHOD OF CURVE FITTING, by P. A. D. de Maine. [1965] [9]p. incl. diagrs. tables, refs. (AF AFOSR-62-19) Unclassified

Published in Commun. Assoc. Comput. Mach., v. 8 518-526, Aug. 1965.

A computer-oriented method for processing and communicating numerical data is described. The instrument Reliability Factors (IRF), which exactly define the limits of reliability of each measured item of information, are used to compute the Maximum Permitted Error (MPE) associated with each value of each ordinate. The Self-Judgment Principle (SJP) is used to discard wrong information and to compute mean values of the parameters and their MPE's in terms of the IRF. Data compatibility tests with any number of different equations can be made quickly. Otherwise intractable problems are easily solved, and the design of many experiments is greatly simplified. The computational and mathematical techniques used to reduce bias in the SJP are discussed. Inadequacies in the statistical and graphical methods of curve fitting are noted. (Contractor's abstract)

2032

Missouri U. Dept. of Chemistry, Columbia.

SPECTROPHOTOMETRIC DETERMINATION OF BISMUTH, by J. C. Guyon and L. J. Cline. 1965 [2]p. incl. diagrs. table. (AFOSR-67-1697) (AF AFOSR-63-205) AD 656135 Unclassified

Also published in Anal. Chem., v. 37: 1778-1779, Dec. 1965.

In a study of mixed heteropoly acid formation, the molybdobismuthophosphate method for bismuth is examined. A new heteropoly method is developed for bismuth. The technique described is based on the enhancement of the blue hue of reduced sodium molybdate by bismuth. The molar absorptivity of the new bismuth system is 2×10^6 at the 5-p.p.b. level, making this method some 10 times more sensitive than existing techniques.

2033

Missouri U. [Dept. of Mathematics] Columbia.

THE SPECTRUM OF AN OPERATOR IN BANACH SPACE, by M. D. George. [1965] [3]p. (AFOSR-66-0258) [AF AFOSR-62-97] AD 631113 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 980-982, Oct. 1965.

The author proves, for complex reflexive Banach spaces X for which the norm is Gâteaux differentiable at each nonnull vector, that a bounded linear operator T on X has its spectrum contained in the closure of W(T), where W(T) is the set of complex numbers taken on by f(x, Tx) over $x \in X$ having $\|x\| = 1$, and where f(x, Tx) is the unique complex α such that $\|x + \beta(Tx - \alpha x)\| \geq \|x\|$ for all complex β. Clearly f(x, Tx) = (Tx, x) if X is a Hilbert space, for which the result is well known; here in the Banach space case, the author is using James' definition of orthogonality. Earlier, Lumer (Trans. Amer. Math. Soc., v. 100: 29-43, 1961) proved the stated inclusion for only the approximate point spectrum, but for an arbitrary Banach space, by using semi-inner-products. More recently, in some similar not yet published joint work of Lumer and Williams, it seems that the full inclusion asserted here can be proved for a set closely related to W(T) without assuming X either reflexive or having the Gâteaux differentiability property. (Math. Rev., abstract)

2034

Missouri U. [Dept. of Mathematics] Columbia.

ON THE CONVERGENCE RATE OF THE LAW OF LARGE NUMBERS FOR LINEAR COMBINATIONS OF INDEPENDENT RANDOM VARIABLES, by D. L. Hanson and L. H. Koopmans. [1965] [6]p. (AFOSR-65-2074) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-746] and Atomic Energy Commission) AD 627665 Unclassified

Also published in Ann. Math. Stat., v. 36: 559-564, Apr. 1965.

The following theorem is proved: Let $\xi_k : k = 0, \pm 1, \ldots$, be an independent sequence of real valued random variables with $E\xi_k = 0$ and moment generating functions $f_k(t) = Ee^{t\xi_k}$ such that (1) for every $\beta > 0$ there exists $T_\beta > 0$ such that $f_k(t)$ exists and $|1 - f_k(t)| < \beta|t|$ for $|t| < T_\beta$ uniformly in k. Let $a_{n,k} : k = 0, \pm 1, \ldots; n = 1, 2, \ldots$ be real numbers such that: (2) $\sum_{k=-\infty}^{\infty} |a_{n,k}| < A < \infty$ for $n = 1, 2, \ldots$ (3) $f(n) = \sup_k |a_{n,k}| \to 0$ as $n \to \infty$. Then $S_n = \lim_{a \to -\infty, b \to \infty} \sum_{k=a}^{b} a_{n,k} \xi_k$ is defined as an almost sure limit for all n, and for every $\epsilon > 0$ there exists a positive $\rho_\epsilon < 1$ (depending on A but not on the particular $a_{n,k}$'s) such that (4) $P[|S_n| > \epsilon] < 2\rho_\epsilon^{1/f(n)}$. The theorem is applied to establish exponential convergence rates for the strong law of large numbers for subsequences of linear processes of non-identically distributed random variables. The theorem is also applied to summability theory and convergence rates are provided for Toeplitz means of independent random variables.

2035

Missouri U. [Dept. of Mathematics] Columbia.

CONVERGENCE RATES FOR THE LAW OF LARGE NUMBERS FOR LINEAR COMBINATIONS OF EXCHANGEABLE AND *-MIXING STOCHASTIC PROCESSES, by D. L. Hanson and L. H. Koopmans. [1965] [13]p. (AFOSR-66-2219) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-746] and Atomic Energy Commission) AD 643064 Unclassified

Also published in Ann. Math. Stat., v. 36: 1840-1852, Dec. 1965.

In the present paper upper bounds on $P[|S_n| \geq \epsilon]$ are investigated for 2 types of discrete parameter stochastic processes, ξ, closely related to independent sequences: exchangeable processes and *-mixing processes. Also, a basic theorem is established for exchangeable processes which enables conditions to be stated leading to upper bounds which end to zero with n at virtually any sub-exponential rate. These bounds are shown to be sharp in certain important special cases by exhibiting a mixture of normal random variables which actually attains them under the given conditions. Finally, the exponential bounds thus obtained for independent sequences is shown to carry over to *-mixing processes.

2036

Mithras, Inc., Cambridge, Mass.

RESONANT HARMONIC GENERATION AND NON-LINEAR OPTICS, by [C. S. Naiman, J. Schwartz and others]. Scientific rept. Oct. 1, 1964-Mar. 31, 1965. [Apr. 1965] 27p. incl. diagrs. table, refs. (Rept. no. MC 63-96SR) (AFOSR-65-0727) (AF 49(638)1464) Unclassified

This report sketches the basic theory of optical second harmonic generation in sufficient generality to include materials with absorption at the fundamental, the second harmonic, or both. It is shown how such absorptions can result in enlarged values of the coefficient of second harmonic generation. The effects of the basic light propagation properties of the material as they contribute to the overall production of second harmonic radiation are further developed. In particular, a discussion is given of the relations between the elements of the second harmonic generation tensor, and the relations between these coefficients appropriate to the crystals of interest in this study.

2037

Mithras, Inc., Cambridge, Mass.

RESONANT HARMONIC GENERATION AND NON-LINEAR OPTICS, by C. S. Naiman, J. Schwartz, and J. Ducuing. Final technical status rept. no. 2, Oct. 1, 1964-Sept. 30, 1965, 26p. incl. diagrs. table. (Rept. no. MC 63-96-R2) (AFOSR-66-0701) (AF 49(638)1464) AD 631676 Unclassified

Enhancement of the coefficient, x(2), of optical second harmonic generation by resonant absorption is discussed. In particular the conditions under which the resulting increase in x(2) overcomes any losses due to the linear absorptions so introduced are developed. Trivalent rare earth dopants in crystalline hosts of suitable symmetry, among other feasible materials, are examples of materials shown capable of efficient harmonic generation. Experimental techniques are developed for use of stimulated Raman effect methods for shifting the frequencies of available laser sources. The theory of harmonic generation in absorbing materials is discussed plus the variation in measurement techniques required in experimental studies of these materials. (Contractor's abstract)

2038

Nacional U. de Cordoba. [Dept. of Acoustics] (Argentina).

[FIRST LATIN AMERICAN ACOUSTICAL MEETING] Primeras jornadas Latino Americanas de acustica, Cordoba, (Argentina) May 17-23, 1965. [1965] 346p. incl. illus. diagrs. tables, refs. (AFOSR-67-1954) (AF AFOSR-65-916) AD 657324 Unclassified

The "Memoria" (Proceedings) includes 46 papers presented in the week long working sessions of the First Latin American Meeting on Acoustics covering the following fields of Acoustics: Research and Teaching, Architectural Acoustics, Physiological Acoustics, Psychoacoustics, Acoustical Instrumentation, Musical Acoustics, Noise and its control, Communications and Speech, Ultrasonics, Sonic Radiation and Propagation, Vibrations. Every paper, translated into Spanish, is headed by a Summary in English. Authors include some of the world authorities in Acoustics such as Prof. Cyril M. Harris, President of the Acoustical Society of America; Prof. Martin Grutzmacher and Prof. Gunther Lehmann from Germany; Prof. Friedrich Bruckmayer of Vienna, etc.

2039

Nacional U. de La Plata. [Council of Scientific and Technical Investigation] (Argentina).

[THE CALCULATION OF THE ABSOLUTE VELOCITY OF REACTIONS BETWEEN FLUORINE ATOMS AND OXIDES OF SULFUR MOLECULES AS RELATED TO FLUORINATED OXIDES OF SULFUR RADICALS] Die Bestimmung der Absolutgeschwindigkeit der Reaktionen zwischen F-Atomen und SO_3-Molekulen bzw. FSO_3-Radikalen, by J. E. Bolzan, J. E. Sicre, and H J Schumacher. [1965] [11]p. incl. tables. (AFOSR-66-0355) (AF AFOSR-65-800) AD 622804 Unclassified

Also published in Zeitschr. Phys. Chem., v. 46: 78-87, May 1965.

The simultaneously occurring reactions of F atoms with SO_3 and ($F_2S_2O_6 \rightarrow 2FSO_3$) were examined quantitatively at 70 - 110 C. The Fatoms do not react with $F_2S_2O_6$ molecules but only with FSO_3 radicals. The ratio of velocity constants of the reactions with SO_3 and FSO_3 is 3.0×10^{-2} and is temperature independent. Therefore, the activation energy of both reactions must be nearly identical and approximately zero. The following reaction scheme allows an explanation of all experimental results. $F_2 + h\nu_{(365\ m\mu)} \rightarrow 2F$. $F + SO_3 \rightarrow FSO_3$. $F + FSO_3 \rightarrow F_2SO_3$. $FSO_3 + FSO_3 \rightleftharpoons F_2S_2O_6$.

2040

Naples U. Inst of Theoretical Physics (Italy)

HADAMARD'S CLASS OF GREEN'S FUNCTIONS IN REGULARIZED $g\varphi^4$ THEORY, by M. Marinaro. [1965] (AFOSR-67-0595) (AF 61(052)826) AD 647550 Unclassified

Also published in Nuovo Cimento, Series X, v. 39: 401-404, Sept. 1, 1965.

It is shown that the n-particle Green's functions are non-analytic, and that for a regularized theory go in Euclidean space they belong at least to Hadamard s class 2 of nonanalytic functions.

2041

Naples U. Inst. of Theoretical Physics (Italy).

STABILITY CONDITIONS FOR A BOSON SYSTEM INTERACTING WITH A PARTLY REPULSIVE AND PARTLY ATTRACTIVE POTENTIAL, by A. Coniglio, M. Maturi and M. Marinaro. [1965] [12]p. (AFOSR-67-0597) (AF 61(052)826) AD 647629 Unclassified

Also published in Nuovo Cimento, Series X, v. 40 184-196, Nov. 11, 1965.

The properties of a dilute system of Bose particles with a short-range repulsive and a long-range attractive potential are studied. Some conditions on the scattering amplitude are found to assure the thermodynamic stability of the system. The method developed by Beliaev is used for calculating the ground-state energy and the elementary excitation spectrum of the system. The results are compared with those of Huang, Ezawa, and Iordanskii and are found to be in complete agreement.

2042

Naples U. Inst. of Theoretical Physics (Italy).

NONANALYTICAL PROPERTIES OF PROPAGATORS. THE $g\varphi^4$ THEORY, by E. R. Caianiello, A Campolattaro, and M. Marinaro. [1965] [17]p. incl. refs. (AFOSR-67-1505) (AF 61(052)826) AD 654830 Unclassified

Also published in Nuovo Cimento, Series X, v. 38: 1777-1783, Aug. 16, 1965.

When perturbative expansion diverge, the search for solutions of the equations for propagators is a problem of real variable. It is shown, on the example of a neutral scalar field with $g\varphi^4$ self-coupling, that the coefficients of the divergent perturbative expansions can still be used in principle, heuristically, to obtain the wanted solutions. The proposed procedure, which is quite general, yields easily the known correct answer if applied to a solvable numerical model of this theory, giving solutions which are holomorphic in l/g and not uniquely determined by the knowledge of the perturbative coefficients. In the general case, the difference between any 2 such solutions would satisfy a bound state equation. A suitably regularized form of the theory is studied in some detail, its solutions, if any exist, belong, like those of the model, to

if any exist, belong, like those of the model, to Hadamard's "class 2" of nonanalytical functions.

2043

National Bureau of Standards, Washington, D. C.

HEAT CAPACITY AND THERMODYNAMIC PROPERTIES OF BERYLLIUM ALUMINATE (CHRYSOBERYL), $BeO \cdot Al_2O_3$, FROM 16 TO 380°K, by G. T. Furukawa and W. G. Saba. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-1786) [ISSA-65-8] AD 625096
Unclassified

Also published in Jour. Research Nat'l. Bur. Stand., v. 69A: 13-18, Jan.-Feb 1965.

The results of heat-capacity measurements are reported for beryllium aluminate in the temperature range 16 to 380°K. The sample to be tested was prepared by arc fusion of a stoichiometric mixture of high purity BeO and Al_2O_3 powder and determined to be 100% pure in the processing of the heat-capacity data. The uncertainty in the final values for heat capacity is estimated to be ± 0.1% between 80 and 380°K and increase at lower temperatures to ± 3% at 16°K. The thermodynamic data were calculated from these measurements on an IBM 7094 computer for the range 0 to 380°K.

2044

National Bureau of Standards, Washington, D. C.

PRELIMINARY REPORT ON THE THERMODYNAMIC PROPERTIES OF SELECTED LIGHT-ELEMENT AND SOME RELATED COMPOUNDS, by T. B. Douglas and C. W. Beckett. Technical summary rept. no. 14, July 1, 1965, 438p. incl. illus. diagrs. tables, refs. (NBS rept. no. 8919) (AFOSR-66-0324) (ISSA-65-8)
AD 478141 Unclassified

This is the fourteenth report on the current experimental, theoretical, and evaluative program on the thermodynamic properties of selected light-element and some related compounds of primary interest in high-temperature research. The content of the report falls logically into the following 3 categories: past accomplishments; new experimental results and literature reviews and bibliographies.

2045

National Bureau of Standards, Washington, D. C.

PRELIMINARY REPORT ON THE THERMODYNAMIC PROPERTIES OF SELECTED LIGHT-ELEMENT AND SOME RELATED COMPOUNDS, by C. W. Beckett, and T. B. Douglas. Technical summary rept. no. 13, Jan. 1, 1965, [115]p. incl. illus. diagrs. tables, refs. (NBS rept. no. 8628) (AFOSR-66-0492) (ISSA-65-8)
AD 466510 Unclassified

New experimental work on the borohydrides of aluminum and beryllium is reported. The mean value found for the standard heat of formation of $Al(BH_4)_3$ (298°K) is +2 kcal/mol for the gas and -5 kcal/mol for the liquid, with an estimated possible error as great at 17 kcal/mol. The infrared spectra of MgF_2 (in a krypton matrix), $Al(BH_4)_3$, and $Be(BH_4)_2$ were measured, and a new band system was discovered for F_2^+. The bending fundamental of MgF_2 appears to be 242 cm^{-1}, and continuing spectroscopic work is expected to provide additional molecular constants for the other substances. High-temperature mass-spectrometric data on the $BeO-Al_2O_3$ system were treated thermodynamically, and lead to heats of atomization for O_2, Al_2O, and the new molecule AlOBe (as well as the heat of vaporization of liquid $BeO.Al_2O_3$) The values for O_2 and Al_2O agree well with previously available values. Recent precise measurements of the relative enthalpy of graphite over the range 1200-2600°K are summarized. Liquid $Al_2)_3$ was vaporized in vacuum and the condensates subjected to varying programs of annealing. The progress from amorphous to the stable alpha crystalline form was followed in detail by X-ray and electron diffraction. The report includes four appendices. The first is a formulation property index of the twelve preceding semiannual reports. The second comprises new tables of the standard thermodynamic properties of condensed phases of 17 substances, including 13 "mixed" oxides. The third appendix gives thermochemical values for additional compounds of several elements which have resulted from a current revision of NBS Circular 500. The fourth appendix includes the table of ionization potentials and electron affinities of light-element atoms and molecules presented in the last report but now considerably revised and augmented by recent information.

2046

National Bureau of Standards, Washington, D. C.

HEAT OF FORMATION OF ALUMINUM FLOURIDE BY DIRECT COMBINATION OF THE ELEMENTS, by E. S. Domalski and G. T. Armstrong. [1965] [11]p. incl. illus. diagrs. tables, refs. (AFOSR-66-0568) (ISSA-65-8) Unclassified

Also published in Jour. Research Nat'l. Bur. Stand., v. 69A: 137-147, Mar.-Apr. 1965.

The standard heat of formation of aluminum fluoride was calculated from the heats of combustion of Teflon and of aluminum-Teflon mixtures in fluorine. The heat measurements were made in a bomb calorimeter. C_2F_4(solid polymer) + $2F_2$(g) $2CF_4$(g) (1); Al(c) + $3/2F_2$(g) = AlF_3(c) (2). For reaction (1), ΔH_{298} was found equal to - 10,350.7 ± 0.4 Jg^{-1} (-247.43 ± 0.01 kcal $monomol^{-1}$), and for reaction

(2) $H^{\circ}_{298} - H^{\circ}_{f298}$ was calculated to be -1507.8 ± 1.2 kJ mol^{-1} (-360.37 ± 0.29 kcal mol^{-1}). The latter uncertainties are the computed standard deviations of the means. The calculated standard heat of formation of aluminum fluoride is estimated to be accurate to within ± 6.6 kJ mol^{-1} (1.6 kcal mol^{-1}). The measurements on Teflon were combined with existing data and the heat of formation of carbon tetrafluoride was calculated to be -221.8 kcal mol^{-1}. (Contractor's abstract)

2047

National Bureau of Standards, Washington, D. C.

HEAT CAPACITY AND ENTHALPY MEASUREMENTS ON ALUMINUM CARBIDE (Al_4C_3) FROM 15 TO 1173°K. THERMODYNAMIC PROPERTIES FROM 0 TO 2000°K, by G. T. Furukawa, T. B. Douglas and others. [1965] [16]p. incl. diagrs. tables, refs. (AFOSR-66-0626) [ISSA-65-8] AD 630980 Unclassified

Also published in Jour. Research Nat'l. Bur. Stand., v. 69A. 423-438, Sept.-Oct. 1965.

Measurements of the heat capacity and relative enthalpy were made on aluminum carbide (Al_4C_3) from 15 to 1173°K. The thermodynamic properties were calculated up to 2000°K from the data by judicious extrapolation above 1173°K. In conjunction with the heat-of-formation data on Al_4C_3 obtained by King and Armstrong and by Mah, second- and third-law analyses have been made of the thermodynamics of several high-temperature vapor-equilibrium reactions involving Al_4C_3 (Contractor's abstract)

2048

National Bureau of Standards, Washington, D. C.

HIGH-TEMPERATURE MICROWAVE SPECTROSCOPY: AlF AND AlCl, by D. R. Lide, Jr. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-66-1096) [ISSA-65-8] AD 638966 Unclassified

Also published in Jour. Chem. Phys., v. 42: 1013-1018, Feb. 1, 1965.

Microwave transitions of gaseous AlF and AlCl have been studied in a high-temperature spectrometer. The molecular constants obtained for AlF are: B_e= 16 562.56 mc/sec, α_e = 148.40 mc/sec, r_e = 1.65437 A, $(eqQ)_{Al}$= -37.6 mc/sec, μ = 1.53 D, for $Al^{35}Cl$: B_e = 7312.74 mc/sec, α_e = 48.03 mc/sec, r_e = 2.12983 A, $(eqQ)_{Al}$= -29.2 mc/sec, $(eqQ)_{Cl}$= 8.8 mc/sec, for $Al^{37}Cl$: B_e= 7140.69 mc/sec, α_e = 46.34 mc/sec. The nature of the bonding in aluminum halides is discussed, it is concluded that the bonds are highly ionic and that the Al orbitals are sp hybrids. The details of the high-temperature spectrometer are given.

2049

National Bureau of Standards, Washington, D. C.

FORCE FIELDS FOR THE BORON TRIHALIDES, by I. W. Levin and S. Abramowitz. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-66-2080) (Sponsored jointly by Advanced Research Projects Agency, [Air Force Office of Scientific Research under ISSA-65-8], and National Science Foundation) AD 643571 Unclassified

Also published in Jour. Chem. Phys. v. 43: 4213-4222, Dec. 15, 1965.

The method of Edgell and Moynihan for determining Coriolis ζ constants from the infrared band contours of degenerate vibration modes was verified for selected molecules and was then applied toward computing the ζ values of the E symmetry vibrations of the boron-trihalide molecules. Since it is not feasible to define unique potential functions for the BX3 species from only frequency data, general force fields were determined for the series by combining both the Coriolis ζ constants and the observed isotopic frequency data in a least-squares refinement scheme. The final force fields indicate that the sensitive stretch-bend interaction constant is a significantly large negative quantity that decreases as the series progresses from BF_3 to BI_3.

2050

National Bureau of Standards, Washington, D. C.

ISOTOPIC EFFECTS IN THE ν_3 FUNDAMENTAL OF MATRIX-ISOLATED BCl_3, by J. J. Comeford, S. Abramowitz, and I. W. Levin. [1965] [2]p. incl. diagr. table. (AFOSR-66-2169) [ISSA-65-8] AD 645281 Unclassified

Also published in Jour. Chem. Phys., v. 43: 4536-4537, Dec. 15, 1965.

The infrared spectrum of matrix-isolated BCl_{13} was observed at 14° and 20°K in the region of the ν^3 fundamental under conditions of moderate resolution (~ 0.6 cm^{-1}). Two separate broad bands assigned to ν^3 of $^{10}BCl_3$ and $^{11}BCl_3$ in turn broken up into several bands due to the chlorine isotope effect. It is the object of the note to explain quantitatively this chlorine isotopic effect making use of a recently derived force field.

2051

National Bureau of Standards, Washington, D. C.

SPECTROPHOTOMETRIC DETERMINATION OF THE RATE OF DISSOCIATION OF TETRAFLUOROHYDRAZINE BEHIND A SHOCK WAVE, by L. M. Brown and

B. deB. Darwent. [1965] [8]p. incl. diagrs. refs. (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under [ISSA-65-8]) Unclassified

Published in Jour. Chem. Phys., v. 42· 2158-2165, Mar. 15, 1965.

The rate of dissociation of tetrafluorohydrazine in N_2 and Ar was determined at temperatures between 344° and 410°K and total pressures between 0.6 and 6.0 atm. The reaction was carried out by shock heating the gas mixtures in a shock tube. The progress of the reaction behind the incident shock wave was followed by a time-resolved spectrophotometric technique. The absorption coefficient of NF_2 at λ 2602 A was determined experimentally between 350° and 571°K and found to be 537 ± 10 liter/mol cm. The kinetics data indicated that the dissociation in 99% N_2 was quasiunimolecular throughout the experimental pressure range, attaining its first-order limit at a total pressure not far above 6 atm and its second-order region below 0.6 atm. The observed pressure for the region of transition from first- to second-order kinetics was reasonably consistent with the transition pressure obtained from classical theory on the basis of the estimated value (2×10^{15} sec^{-1}) of the pre-exponential factor for the limiting high-pressure first-order specific rate. At approximately 2 atm the observed specific rate for the nitrogen mixture was given by $k_2(N_2) = 10^{14.98 \pm 0.42} \exp[(-19.4 \pm 0.7$ kcal/mol)/RT] sec^{-1} between 344° and 407°K. The indicated uncertainties are the standard deviations of the associated values. (Contractor's abstract)

2052

National Observatory of Athens. Seismological Inst. (Greece).

AFTERSHOCK SEQUENCE AND CRUSTAL STRUCTURE IN THE REGION OF GREECE, by A. G. Galanopoulos and B. C. Papazachos. Annual summary rept. no. 1, June 1, 1964-May 31, 1965, 5p. (AFOSR-65-2938) (AF 61(052)803) AD 627616 Unclassified

The object of this study was to determine the wave velocities of body waves, to attempt to calculate the average thickness of the crust and to have an estimation about the change of the thickness of the crust from place in the region considered. The first problem was to identify the most prominent phase and find their travel time curves. Different procedures were followed to determined the travel time curves for epicentral distance between 0 and 150 km and for epicentral distance between 200 and 1000 km. By using data from 250 earthquakes with epicenters near the station of Athens, the velocities of the direct P and S waves were found to be equal to 5.25 km/sec and 3.19 km sec, respectively. The determined mean focal depth of these earthquakes is 7 km. By using data from about 1000 earthquakes with epicenters in the region of Greece the most prominent phases for epicentral distances between 0 and 1000 km were identified. Their travel time curves were also determined.

2053

National Observatory of Athens. [Seismological Inst.] (Greece).

SPACE AND TIME VARIATIONS OF STRAIN RELEASE IN THE AREA OF GREECE, by N. Delibasis and A. G. Galanopoulos. [1965] [12]p. incl. diagrs. (AFOSR-66-1226) (AF 61(052)803) AD 638527 Unclassified

Also published in Ann. Geol. Pays Helleniques, v. 18· 135-146, 1965.

Six cross-sections show the latitude and longitude variations of the total strain released by all earthquakes of magnitude >4 3/4 occurred in the area of Greece bounded by the parallels of 34 N and 42 N and the meridians of 19°E and 29°E during the period 1841-1959, and the cumulative magnitude corresponding to the total strain released in the eastern and western section, bounded by the 24°E meridian, over the 120- year interval 1841-1960 in dependence of time. There was verified the presence of an oscillation pattern with 2 migration cycles of the maximum of strain release between the 2 sections. The oscillation period was found to be 52 yr and the oscillation amplitude almost constant, i.e. about 8 to 9 1/4 cumulative earthquake magnitude.

2054

National Observatory of Athens. Seismological Inst. (Greece).

THE SEISMIC ACTIVITY IN THE CYPRUS AREA, by A. G. Galanopoulos and N. D. Delibasis. [1965] [19]p. incl. diagrs. table, refs. (Rept. no. 4) (AFOSR-67-2762) (AF 61(052)803) Unclassified

Cyprus has 2 dominate topographic features, the Kyrenia range in the north and the Troodos Mountain in the south. There is evidence that the summit of Troodos, an igneous massif, has been elevated by more than 3,000 m since Cretaceous time while the rest of the island has risen only some 700 m, indicating isostatic adjustment to the underthrusting of the Eurasian hinterland by the African foreland. Cyprus and the adjacent sea areas are covered by one of the largest positive gravity anomalies found in the eastern Mediterranean. This large positive anomaly is superimposed on a regional negative anomaly. The earthquakes history of Cyprus shows only 15 severe earthquakes with damaging effect on the island. Two of these were accompanied by tsunamis strong enough to cause destruction on the southern coast. During the period 1911-1963 there are records of 18 earthquakes with epicenters within a distance of 100 km from the nearest coast of Cyprus. Six of these had a magnitude of 5.8 to 6.5 while the rest ranged between 4.75 and 5.75. The fact that all but one of the 18 occurred in or near the zone of underthrusting suggests that the

earthquake activity is closely related to the evolution and the deep-seated structure of this zone.

2055

[Naturalia et Biologia] Paris (France).

INHIBITION OF NONSPECIFIC SENSORY ACTIVITIES FOLLOWING STRIOPALLIDAL AND CAPSULAR STIMULATION, by G. Krauthamer and D Albe-Fessard. [1965] [25]p. incl. illus. diagrs. refs. (AFOSR-65-2852) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-13 and National Institute of Neurological Diseases and Blindness) AD 629092 Unclassified

Also published in Jour. Neurophysiol., v. 28: 100-124, Jan. 1965.

In cats under chloralose anesthesia, the nonspecific peripherally evoked responses of the anterior marginal and middle suprasylvian gyrus were inhibited following stimulation of the basal ganglia. The inhibition was bilateral and limited to the nonspecific sensory potentials evoked by peripheral stimuli. Primary somatic, visual, and auditory potentials were not inhibited. The inhibition was not associated with any cortical activity of striatal origin and the results of cortical ablation experiments indicate a subcortical locus of inhibition. The parameters of the inhibitory stimulation were studied. The effective stimulus usually consisted of a brief volley (25 msec), though single shocks were found to be effective for some electrode placements. Mapping of the basal ganglia showed the inhibitory points to be concentrated in the dorsolateral aspect of the head of the caudate nucleus, the dorsal globus pallidus, and the entopeduncular nucleus. Stimulation of the medial caudate nucleus, putamen, and claustrum was ineffective. Other inhibitory zones were located in the internal capsule; they were spatially distinct from other capsular regions which were either silent or excitatory. The possible significance of this distribution of inhibitory zones is discussed. The inhibition extended over 150-350 msec. Its onset was gradual, building up to a max 30-50 msec after striatal stimulation.

2056

[Naturalia et Biologia, Paris (France)]

RESPONSES OF MONKEY THALAMUS TO SOMATIC STIMULI UNDER CHLORALOSE ANAESTHESIA, by D. Albe-Fessard and D. Bowsher. [1965] [15]p. incl. illus. refs. (AFOSR-65-2830) (AF EOAR-63-13) AD 628368 Unclassified

Also published in Electroencephalog. and Clin. Neurophysiol. Jour., v. 19: 1-15, July 1965.

The localization and characteristics of responses to somatic stimuli have been investigated by means of anatomo-electrophysiological methods in the thalamus and adjacent structures of Macaca cynomolgus under chloralose anaesthesia. Somatotopic responses were found in the nucleus ventralis posterior, exactly like those seen under barbiturates or in the waking animal by other workers. Short latency convergent responses, from all limbs, were evoked in the nucleus supragenicularis. Long latency convergent responses were observed in nuclei geniculatus medialis (pars magnocellularis), parafascicularis, commissuri posterioris, in the ventral parts of nucleus lateralis posterior, in parts of ventralis lateralis, and occasionally in nuclei reticularis thalami, centralis lateralis and the lateralmost part of nucleus dorsalis medialis. Preferential responses, in the sense of (a) greater amplitude of response to stimulation of one limb, or (b) absence of representation of one or two limbs were seen in the centrum medianum and in the ventral part of n. ventralis lateralis, overlying VPL. In general, long latency convergent and preferential response could only be evoked by brusque (not necessarily noxious) natural stimuli, and never by phasic hair movement or light touch, of the sorts that were found to evoke somatotopic responses in VP. The natural type of stimulus giving rise to responses in VL has not been determined. (Contractor's abstract)

2057

[Naturalia et Biologia, Paris (France)]

HETEROSYNAPTIC FACILITATION IN NEURONES OF THE ABDOMINAL GANGLION OF APLYSIA DEPILANS, by E. R. Kandel and L Tauc. [1965] [27]p. incl. diagrs. table, refs. (AF EOAR-63-13) Unclassified

Published in Jour. Physiol., v. 181: 1-27, Nov. 1965.

A stimulus-pairing sequence based on classical behavioural conditioning was applied to the isolated abdominal ganglion of Aplysia depilans. Intracellular recordings from single cells were obtained, and the stimulus parameters to two different afferent nerves were controlled so that one produced a relatively small excitatory post-synaptic potential (the test stimulus) and the other, usually a brief train, produced a burst of spikes (the priming stimulus). The two stimuli were paired (once every 10 sec) for several minutes with the test preceding the priming by about 300 msec. In most of the cells examined, input pairing produced no facilitation of the test excitatory post-synaptic potential. However, in the right upper-quadrant giant cell of each ganglion and in fifteen out of ni. unidentified cells located near the medial borders of the giant cells, the test EPSP was augmented during pairing. The facilitation declined only slowly following the pairing procedure. In the unidentified cells, the test post synatic potential was augmented by about 100% during fifteen to thirty pairing trials and the facilitation declined within an average of 9 and a maximum of 20 min after the pairing procedures. The results demonstrated that in certain cells the amplitude of the post-synaptic potential produced by a weak stimulus to one pathway is capable of being facilitated for a prolonged period of time as a result of the repeated and concomitant pairing with a more effective stimulus to another pathway.

2058

[Naturaliz et Biologia, Paris (France)].

MECHANISM OF HETEROSYNAPTIC FACILITATION IN THE GIANT CELL OF THE ABDOMINAL GANGLION OF APLYSIA DEPILANS, by E. R. Kandel and L. Tauc. [1965] [20]p. incl. diagrs. refs. (AF EOAR-63-13) Unclassified

Published in Jour. Physiol., v. 181: 23-47, Nov. 1965.

An analysis of the cellular mechanisms of heterosynaptic facilitation in the right upper quadrant giant cell of the abdominal ganglion of Aplysia depilans was undertaken. Possible contributions by either the passive properties or the spike-generating activity of the post-junctional cell were excluded by the demonstration that (a) the priming stimulus did not produce a significant conductance change in the giant cell, and (b) a train of directly initiated spikes could not serve as a priming stimulus. Facilitation could be demonstrated despite a blockade, by curare, of post-synaptic inhibition, thereby eliminating the possibility of disinhibition. The response configurations to different test stimuli were compared before and during facilitation. In most cases, the test post-synatic potential retained their configuration during peak facilitation indicating an increase in the efficacy of the units initially making up the test pathway. A presynaptic facilitation hypothesis was tested by use of an elementary, presumably monosynaptic, PSP. Such an elementary PSP was facilitated by 100% and for periods up to 15 min after pairing with a priming stimulus. The data are therefore consistent with this hypothesis. The presynaptic facilitation hypothesis is, however, based on the additional assumption that (a) the test input is monosynaptic and (b) the test axon is afferent to the ganglion. Failure to meet either requirement would permit the priming stimulus to initiate repetitive activity in the test unit and thereby create a condition for post-tetanic facilitation. The criteria used and our experimental observations make it unlikely that repetitive firing of the test unit occurred, but this possibility cannot be fully excluded.

2059

Nevada U. Dept. of Physics, Reno.

FIELD EMISSION STUDIES OF THE SURFACE CONSTANTS OF REFRACTORY METALS, by P. C. Bettler. Final rept. Aug. 20, 1965, 22p. incl. illus. diagrs. table, refs. (AFOSR-65-1688) (AF AFOSR-62-297) AD 620697 Unclassified

The activation energy for surface migration, the surface tension, and the diffusivity constant for surface motion were measured, using field emission techniques, for tungsten (BCC) and rhenium (HCP). The values for tungsten agree well with results reported by other investigators. Similar work on rhenium was not reported previously. Investigations are continuing on other metals with face centered cubic and hexagonal close packed crystal structure.

2060

Nevada U. Mackay School of Mines, Reno.

CATALOG OF NEVADA EARTHQUAKES, 1852-1960, by D. B. Slemmons, A. E. Jones, and J. I. Gimlett. [1965] [47]p. incl. diagrs. tables, refs. (AFOSR-65-2890) (AF AFOSR-62-285) AD 618430 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 519-565, Apr. 1965.

Nevada earthquakes for the period from about 1852 to 1961 are tabulated on IBM punch cards. During this period 1,173 events with Nevada epicenters were felt, 586 others with Richter magnitudes above 4.0 were recorded and were probably felt by some residents, and approximately 220 were reported in nonspecific terms (e.g. 'several aftershocks were felt'). High seismicity of this region is indicated by the fact that on an equal-area basis, during the period 1934-1960, Nevada has had the highest incidence of earthquakes per unit area of any of the conterminous Western States. The seismic activity shows a distinct tendency, statistically inadequate, for a 20-yr cycle of activity, with peaks at about 1852, 1872, 1894, 1916, 1932-33, and 1954. The general increase in number of events reported each year correlates well with the increase in Nevada population, but is probably modified by the development of: increasingly sophisticated methods of recording, spacing of seismographic stations, more intensive earthquake investigations of the United States Coast and Geodetic Survey, and changing population density and distribution. A method is developed for correlating between Richter magnitude, earthquake intensity, and size of felt area. This permits estimation of earthquake magnitude for shocks that pre-date instrumental methods of recording.

2061

Nevada U. Mackay School of Mines, Reno.

THE P_g-P_n METHOD OF DETERMINING DEPTH OF FOCUS WITH APPLICATIONS TO NEVADA EARTHQUAKES, by R. W. Greensfelder. [1965] [13]p. incl. diagrs. tables, refs. (AFOSR-65-2903) (AF AFOSR-64-646) AD 618425 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 391-403, Apr. 1965.

The P_g-P_n method is theoretically developed, including a complete error analysis, and then applied to some Nevada earthquakes. It is found that as expected, the method is very sensitive to the crustal model used, and the appearance of large errors in depths of focus calculated for some earthquakes leads to the conclusion of a major discontinuity in crustal thickness (ca. 10 km) north and east of Walker Lake, Nevada. This discontinuity may have its surface expression in the Walker Lane, a major right-lateral shear zone which has been defined on both physiographic and geologic grounds.

2062

New Mexico State U. [Dept. of Mathematics] University Park.

OPERATOR REPRESENTATION THEOREMS, by E. O. Thorp and R. J. Whitley. [1965] [7]p. incl. refs. (AFOSR-66-1499) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-457 and National Science Foundation) AD 641704 Unclassified

Also published in Illinois Jour. Math., v. 9: 595-601, Dec. 1965.

Representation theorems for bounded, compact, and weakly compact operators between Banach space X and Y are given, where Y is B(s), BC(s), or certain other subspaces of B(S). Numerous corollaries and consequences are deduced. In particular more than 100 old and new operator representation theorems are readily deduced from a single theorem.

2063

New Mexico State U. [Dept. of Physics] University Park.

EFFECTIVE POTENTIAL FOR BOUND ELECTRONS IN A HYDROGEN PLASMA (Abstract), by P. C. Kepple, W. D. Deering, and O. Theimer. [1965] [1]p. [AF AFOSR-64-587] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 169, Feb. 25, 1965.

The effective potential V^* for bound electrons in a hydrogen plasma is calculated from two correlated quantities. (1) the radial charge distribution $\rho_f(r)$ of the charge cloud formed by the free electrons and ions in the neighborhood of a neutral hydrogen atom, (2) the radial distribution function $\rho_b(r)$ of the bound electron. $\rho_f(r)$ is found by solving a Poisson-Boltzmann equation with the hydrogen nucleus and $\rho_f(r)$ generates an average potential $V_f(r)$, which is added to the Coulomb potential of the nucleus to give $V^*(r)$, which is still a function of the unknown distribution $\rho_b(r)$. The latter is calculated by solving Schrödinger's equation with $V^*(r)$ by means of the WBK approximation. Self-consistent numerical results for $V^*(r)$ are presented that are quite different from the Debye-Huckel potential.

2064

New Mexico U., Albuquerque.

COMMUNICATION CYBERNETICS SEMINAR, by J. R. Foote. Final rept. Jan. 7, 1965, 2p. (AFOSR 65-0210) (AF AFOSR-64-32) Unclassified

A list is presented of the lectures given at the 1964 Summer Scientific Seminar in Cybernetics and Communication, held in Cloudcroft, N. M., June 15-26, 1964. These include: (1) Cybernetics Today; (2) People, Problems, and Computers, (3) Self-Organizing Systems; (4) Communication Theory and Practice (5) Communication and Large Organization, (6) Human Interaction and Communication with Computers; (7) Information Processing and Decision Making; (8) Sensory Factors in Receiving and Transmitting Information, (9) Structure and Functional Organization of the Brain; (10) Possible Molecular Bases for Information Storage and Transfer in the Brain; (11) Philosophical Aspects of Cerebral Function; (12) Effects of Drugs on Brain Function; (13) International and Cross-Cultural Communication; and (14) Communication and Organizational Effectiveness.

2065

New Mexico U., Albuquerque.

SCIENCE IN THE SIXTIES; TENTH ANNIVERSARY AFOSR SCIENTIFIC SEMINAR, Cloudcroft, N. M., June 14-25, 1965, ed. by D. L. Arm. Albuquerque, New Mexico U. Office of Publications, 1965, 206p. incl. illus. diagrs. tables, refs. (AFOSR-68-2384) [AF AFOSR-65-861] AD 678056 Unclassified

This volume is a collection of articles based upon lectures presented at the seminar. Since the seminar spanned a wide variety of sciences, these articles indicate the state-of-the-art in areas comprising the spectrum of scientific eff[illegible] being supported by AFOSR.

2066

New Mexico U. Bureau of Engineering Research, Albuquerque.

CAVITY EFFECT IN PRESSURE BAR, by F. D. Ju and K. B. Simmons. May 1965, 117p. incl. illus. diagrs. tables, refs. (Rept. no. ME-12) (AFOSR 65-1074) (AF AFOSR-64-250) AD 619820 Unclassified

The cross effects of a thin cavity in a pressure bar were investigated. The experimental research was divided into 2 stages: (1) research in materials, geometries, controlled measurements and loading methods and (2) experiments on the cavity bar to study the bar wave reflected and transmitted from the cavity section, the strain field approximate to the cavity region, the fracture mode, and the fracture strength. The model was made of epoxy and built from sections to allow for the control of certain geometrical variables. Both the nondestructive model and the fracture model designs were highly successful. The mode of fracture was invariably at the cavity section. No "scabbing" or "spalling" phenomena were detectable. The fracture tests indicated that the location of the cavity relative to the free end had little effect on the fracture strength. With increasing cavity size, the incident peak strain necessary to produce fracture decreased. However, if the strain levels were corrected for the reduced area at the cavity section, most of this variation was eliminated.

2037

New Mexico U. Bureau of Engineering Research, Albuquerque.

PRELIMINARY STUDY OF PURE SHEAR FRACTURE MODEL, by F. D. Ju and J. G. Baker. May 1965, 40p. incl. illus. diagrs. refs. (Technical rept. no. ME-13) (AFOSR-65-1195) (AF AFOSR-64-568) AD 619365 Unclassified

Under this investigation, a shear fracture model is designed to meet the following requirements. (1) an approximate pure shear state should exist in the critical section of the specimen throughout the deformation range up to fracture. (2) there should be no rotation in the specimen. (3) the shear should be limited to a narrow band along the line of shear fracture, and (4) the data should be reproducible for various specimen thicknesses. Only qualitative results are reported, but preliminary indications are that the specimen satisfactorily meets the above requirements.

2068

New Mexico U. Bureau of Engineering Research, Albuquerque.

PRODUCTION AND MEASUREMENT OF A DILATION LOADING FIELD, by F. D. Ju and R. A. Benham, Nov. 1965, 101p. incl. illus. diagrs. tables, refs. (Technical rept. no. ME-17) (AFOSR-65-2673) (AF AFOSR-65-568) AD 625790 Unclassified

A model of homogeneous, isotropic material was developed in which pure dilatation could be produced and measured. Essentially, the model is a cube of resin epoxy each face of which is pulled by equal tensile force. The equal tensile forces were produced with a hydraulic triaxial tensile testing machine developed for this project. The states of strain were then measured and recorded. An embedded 3-dimensional strain gage rosette was used. Dilatation states were produced to within instrumentation error at a hydraulic pressure of 10 psig and carried through to the maximum level of 60 psig which induced an internal strain of approximately 400 mμ in/in. The instrumentation error is estimated to have an accumulative maximum of ± 9%. There was also an evaluation of the perturbative effects due to the loading device. Included were alignment perturbation causing additional bending moment in the model and excessive friction in the load cylinder causing unequalization of the triaxial loads.

2069

New Mexico U. Dept. of Chemistry, Albuquerque.

LUMINESCENCE FROM TRANSITION-METAL COMPLEXES. TRIS(2, 2'-BIPYRIDINE)- AND TRIS(1, 10-PHENANTHROLINE) RUTHENIUM (II), by G. A. Crosby, W. G. Perkins, and D. M. Klassen. [1965] [6]p. incl. diagrs. (AFOSR-65-2386) (AF AFOSR-63-269) AD 626517 Unclassified

Also published in Jour. Chem. Phys., v. 43, 1498-1503, Sept. 1, 1965.

Absorption and emission spectra and mean lifetimes (τ_m) of the luminescence of tris(2, 2'-bipyridine)- and tris (1, 10-phenanthroline) ruthenium (II) are reported. For the 2, 2'-bipyridine complex, two weak absorption bands occurring at 15 050 cm^{-1} are assigned respectively to the $^1A_1 \rightarrow {}^3T_1$ and $^1A_1 \rightarrow {}^1T_1$ transitions of d-d type and the intense luminescence with origin at 17 250 cm^{-1} (τ_m = 5.92 μsec) is assigned to $^1T_1 \rightarrow {}^1A_1$ fluorescence. For the 1, 10-phenanthroline complex no intra-d transitions were observed in absorption but the bright luminescence with origin at 17 700 cm^{-1} (τ_m = 9.93 μsec) was assigned to $^1T_1 \rightarrow {}^1A_1$ fluorescence in analogy with the first compound. The energy levels are analyzed on the basis of an octahedral model, and empirical value for the Racah B and C parameters for Ru(II) and the crystal field parameter are evaluated. Possible uses of the compounds for lasers application are suggested. (Contractor's abstract)

2070

New South Wales U. [Dept. of Applied Mathematics] Kensington (Australia).

SYMMETRIC INTEGRATION RULES FOR HYPERCUBES. I. ERROR COEFFICIENTS, by J. N. Lyness. [1965] [17]p. incl. table. (AFOSR 65-2698) (AF AFOSR-62-400) AD 628522 Unclassified

Also published in Math. Comput., v. 19, 260-276, Apr. 1965.

A compact notation is introduced to describe and systematise symmetric integration rules and the Euler-Maclaurin expansion is used to describe their error terms. The application to cytolic rules is discussed especially in relation to the number of function evaluations required. This paper is devoted exclusively to theory, illustrated by well-known results. This theory leads to new powerful integration rules which will be published shortly.

2071

New South Wales U. [Dept. of Applied Mathematics] Kensington (Australia).

SYMMETRIC INTEGRATION RULE FOR HYPERCUBES. II. RULE PROJECTION AND RULE EXTENSION, by J. N. Lyness. [1964] [14]p. incl. table. (AFOSR 65-2950)(AF AFOSR-62-400) AD 629529 Unclassified

Also published in Math. Comput. v. 19 394-407, July 1965.

The purpose of this paper is to introduce a theory of rule extension by which an s-dimensional rule of particular degree may be used to construct an r-dimensional rule of predetermined degree. This is a generalization of the process which leads to a product rule. The particular feature of this process is that it is a linear process, once a set of nonlinear equations have been solved to obtain the s-dimensional rule, the higher-dimensional rule may be obtained by the application of linear algebraic formulae. Previously unpublished integration rules are derived.

2072

New South Wales U. Dept of Applied Mathematics, Kensington (Australia)

INTEGRATION RULES OF HYPERCUBIC SYMMETRY OVER A CERTAIN SPHERICALLY SYMMETRIC SPACE, by J. N. Lyness. [1965] [6]p. (AFOSR-65-2957) (AF AFOSR-62-400) AD 628521 Unclassified

Also published in Math. Comput., v. 19: 471-476, July 1965.

A theory of integration rules suitable for integration over a hypercube and having hypercubic symmetry has recently been published. In this paper it is found that, with minor modification, this theory may be directly applied to obtain integration rules of hypercubic symmetry suitable for integration over a complete n-dimensional space with a weight function. As in the case of integration over hypercubes, an n-dimensional rule of degree $2t + 1$ may be constructed requiring a number of function evaluations of order $2^n t^t/t$ only.

2073

New South Wales U. Dept. of Applied Mathematics, Kensington (Australia).

SHAPE RESONANCES IN SUPERCONDUCTING CYLINDERS, by C. J. Thompson. [1965] [8]p. incl. diagrs. table. (AFOSR-65-2975) (AF AFOSR-62-400) AD 627546 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1053-1060, June 1965.

The energy gap equation for a superconducting circular cylinder at zero temperature is solved numerically for diameters in the range 10-17 A.U. As for the uniform membrane, the energy gap shows pronounced resonances when considered as a function of size. The resonances occur each time an eigenvalue for motion perpendicular to the cylinder axis passes through the Fermi surface. The peaks of the resonances ($\sim 30°K$) lie well above the bulk value for the energy gap ($\sim 7°K$), the troughs below this value ($\sim 10^{-2}°K$). The peaks are very sharp and for most values of the diameter, the energy gap is small ($< 10^{-2}°K$), and shows a tendency to remain small. (Contractor's abstract)

2074

New South Wales U. Dept. of Applied Mathematics, Kensington (Australia).

MATRIX ELEMENTS FOR A THREE-NUCLEON SYSTEM (I), by B. Davies. [1965] [13]p. incl. diagr. (AFOSR-67-1360) (AF AFOSR-64-685) Unclassified

Also published in Nuclear Phys., v. 73: 193-205, Nov. 1965.

Matrix elements of the kinetic energy and some common potential energy operators are given for the 3-nucleon system, using a classification of the wave function recently given by Kalotas and Devies. The matrix elements, which are functions of the interparticle distances only, are given for arbitrary states of the system.

2075

New South Wales U. Dept. of Nuclear and Radiation Chemistry, Kensington (Australia).

A THIRD POSITRON LIFETIME IN SOLID POLYMERS, by S. J. Tao and J. H. Green. [1965] [5]p. incl. diagr. tables, refs. (AFOSR-65-2826) (AF AFOSR-62-398) AD 629086 Unclassified

Also published in Proc. Phys. Soc. (London), v. 85: 463-467, 1965.

Positron lifetimes have been measured in Teflon (PTFE), polyethylene, nylon 6, polypropylene and paraffin wax. Using equipment of good resolution, $W_{1/2} = 0.7$ nsec, wide range, 30 nsec, and highly linear response, three components of the lifetimes are found in each case. These are about 0·3 nsec, 0·6-1·1 nsec and 1·7-4·1 nsec. Two components only have been reported so far. A connection is found between the observed intensities of the longer components and the degree of crystallinity of the polymers, and an explanation is offered. The intensities of the long components vary according to the previous heat treatment of the polymer, especially in Teflon, in a way which depends on the physical structure of the solid. The identification of the three components should permit a useful re-examination of positron lifetimes in 'molecular materials'.

2076

New South Wales U. Dept. of Nuclear and Radiation Chemistry, Kensington (Australia).

POSITRONIUM AND IT'S CHEMISTRY, by J. H. Green. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-66-0278) (AF AFOSR-62-398) AD 630228 Unclassified

Also published in Proc., Roy. Australian Chem. Inst. Jan. 1965, p. 7-12.

A positron may form a stable bound state with an electron which has been given the rather inexact name "positronium" and the symbol Ps. Experimental researchers since the pioneering work of Deutsch (1951) have now made it clear that positronium has three features of obvious chemical interest. It is a very simple atom (allowing it to qualify without a nucleus) analogous to hydrogen, it can exist and react in the triplet state, and it is an elementary free radical. These features make its possible chemical interactions very interesting indeed in their own right, and also as a diagnostic for better-known fast reactions. So much so that the recent edition of the well-known text by Friedlander and Kennedy contains a chapter on nuclear processes as chemical probes and deals with positronium, muonium, Mossbauer effect and angular correlation of γ-rays as examples.

2077

New South Wales U. Dept. of Nuclear and Radiation Chemistry, Kensington (Australia).

POSITRON LIFETIMES IN NEUTRON- AND GAMMA-IRRADIATED POLYMERS, by J. H. Green and S. J. Tao. [1965] [4]p. incl. tables. (AFOSR-66-0281) (AF AFOSR-62-398) AD 630227 Unclassified

Also published in Brit. Jour. Appl. Phys., v. 16: 981-984, July 1965.

Positron lifetimes in neutron- and gamma-irradiated solid polymers of the degrading and cross-linking type, polytetrafluoroethylene (PTFE) and polyethylene, were measured. Variations in lifetimes and intensities of the short and long components of the longer positronium lifetime are qualitative indicators of the degree of crystallinity and free radical production in the polymers. In polyethylene τ_2 decreases rapidly as cross-linking increases with small doses, especially of neutrons; I_3 decreases quite slowly as the solid becomes more amorphous. In PTFE, radical production following chain scission leads to a rapid decrease in I_3 due to conversion of positronium and an increase in the ratio $I_2/(I_2 + I_3)$ indicates increasing crystallinity.

2078

New South Wales U. Dept. of Nuclear and Radiation Chemistry, Kensington (Australia).

TIME MATCH OF PULSES AND TIME RESOLUTION OF A TIME-TO-AMPLITUDE CONVERTER, by S. J. Tao, J. Bell, and J. H. Green. [1965] [7]p. incl. diagrs. refs. (AFOSR-66-0282) (AF AFOSR-62-398) AD 630229 Unclassified

Also published in Nuclear Instr. and Methods, v. 35: 222-228, Aug. 1965.

The theory of matching of the time pulses and the double coincidence pulses for a time-to-amplitude converter is discussed and extended. The time spread introduced by the phosphor, photomultiplier γ-ray spectrum and other factors is analyzed.

2079

New South Wales U. Dept. of Nuclear and Radiation Chemistry, Kensington (Australia).

CONSTRUCTION AND PERFORMANCE OF A FAST TIME-TO-AMPLITUDE CONVERTER, by J. Bell, S. J. Tao, and J. H. Green. [1965] [9]p. incl. diagrs., tables, refs. (AFOSR 66-0508) (AF AFOSR-62-398) Unclassified

Also published in Nuclear Instr. and Methods, v. 35 213-221, Aug. 1965.

A subnanosec time-to-amplitude converter based on the pulse overlap principle and including a pair of fast transistorized single channel analyzers for side channel pulse discrimination is described. The presence of machine background and natural background in addition to the random background is discussed. A high degree of stability and linearity is achieved. The machine time resolution is about 0.12 nsec and when it is coupled with a pair of RCA6810A photomultipliers the total resolution is less than 0.7 nsec.

2080

New York State U. Dept. of Chemistry, Buffalo.

DIELECTRIC CONSTANT OF HYDROGEN-BONDED LIQUIDS, by W. Dannhauser. Final scientific rept. Feb. 1, 1961- Aug. 31, 1965. Sept. 1, 1965, 8p. (AFOSR-65-1939) (AF AFOSR-63-271) AD 626156 Unclassified

The principal goal of the project was to measure the dielectric constant of representative classes of hydrogenbonded liquids and to assess the influence of molecular structure (size and shape of the 'side chain' group) on intermolecular hydrogen-bond formation. Thirty-five compounds, representative of several classes of simple hydrogenbonded liquids, were investigated. Measurements quantitatively confirmed the intuitive conclusion that the extent of intermolecular, linear chain hydrogenbond formation is governed largely by an entropy effect, and particularly the shape, of the molecule is the most important specific variable in the intermolecular association process. An added attraction of dielectric measurements is that they provide the possibility of obtaining information about the rate of dipolar reorientation from a study of dielectric relaxation.

2081

New York State U. Dept. of Chemistry, Buffalo.

DIELECTRIC CONSTANT OF HYDROGEN-BONDED LIQUIDS. IV. EQUILIBRIUM AND RELAXATION STUDIES OF HOMOLOGOUS NEOALCOHOLS, by W. Dannhauser, L. W. Bahe and others. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-2384) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-271 and National Science Foundation) AD 628410 Unclassified

Also published in Jour. Chem. Phys., v. 43: 257-266 July 1, 1965.

The dielectric constants of $H-(CH_2)_n-C(CH_3)_2-CH_2OH$ with n = 1, 2, 3, 4, 6, and 8 have been measured from about -70° to 100° C with test frequencies 0.05 to 2×10^5 kc sec. The equilibrium dielectric constant is analyzed in terms of associative, hydrogen-bond equilibria as deduced from the temperature variation of the Kirkwood correlation factor and ΔH and ΔS of hydrogen bonding are estimated. Dielectric relaxation has been defined over several decades of time. The principal dispersion locus is Debye-like irrespective of wide variations in the apparent degree of association and $\Delta H^{\ddagger}$ and $\Delta S^{\ddagger}$ for relaxation are similar for all species. The relation of dielectric relaxation to equilibrium liquid structure is discussed and evidence for rotational mobility in solid neopentanol and neohexanol is presented.

2082

New York State U. [Dept.] of Chemistry, Buffalo.

AMERICAN CHEMICAL SOCIETY DIVISION OF PHYSICAL CHEMISTRY 1965 SUMMER SYMPOSIUM ON RELAXATION TECHNIQUES IN CHEMICAL KINETICS IN SOLUTION, New York State U., Buffalo, June 28-30, 1965, 21 p. (AFOSR-65-1534) (AF AFOSR-65-790) AD 619306 Unclassified

Reports presented at the symposium are summarized. Microwave temperature-jump method. Pulse radiolytic method. Application of n.m.r. to kinetic studies. Recent technique developments. Deuterium isotope effects in aqueous solutions of intramolecularly hydrogen-bonded acids from temperature-jump studies. Estimation of very fast reaction rates from the broadening of vibrational spectral lines: Systems of the quinone-hydroquinone type; the myoglobin-azide reaction. Cyctochrome-c systems; Prostatic acid phosphate catalysis studied by relaxation spectrometry; Kinetic studies of hydrogen bond reactions; Nuclear magnetic resonance measurements of water lifetimes in the first coordination sphere of metal ions. Ultrasonic investigation of step-wise ion association in solution; Kinetics of metal-liquid interactions as studied with the pressure step method; Reactions of the hydrated electron with metal complexes; Measurement of fast ionic reactions by relaxation effects of electron spin resonance. Pulse radiolysis studies of the hydroperoxy radical and ozonide ion in aqueous solution; Relaxation techniques for fast electrode processes; Primary hydration number of cations in solution from proton n.m.r. relaxation studies.

2083

New York State U. Dept. of Physics, Buffalo.

MULTIPOLE POLARIZABILITIES AND SHIELDING FACTORS FROM HARTREE-FOCK WAVE FUNCTIONS, by P. W. Langhoff and R. P. Hurst. [1965] [11]p. incl. tables, refs. (AFOSR-65-1965) (AF AFOSR-63-191) AD 626501 Unclassified

Also published in Phys. Rev., v. 139: A1415-A1425, Aug. 30, 1965.

Electric dipole, quadrupole, and octupole polarizabilities and shielding factors are calculated for a large number of 2- to 20-electron S-state atoms and ions. The calculations are carried out within the frame-work of an uncoupled Hartree-Fock approximation, subject to the proviso that the exchange part of Fock potential is expressable as a multiplicative function. All zeroth-order functions used are of the analytical Hartree-Fock type. The resulting numerical values are found to be strongly sensitive to the quality of the Hartree-Fock function used in the calculation, in agreement with Sternheimer's previous conclusion. This point proves to be of special importance in the case of the negative ions. In addition, it is shown that the variational method pioneered by Das and Bersohn, if carried out under proper orthogonality conditions, is equivalent to the present uncoupled Hartree-Fock approximation. Finally, it is noted that the variational method used in this work is less accurate than the Sternheimer numerical method; however, use of the variational method allows some simplification in the computational procedure.

2084

New York State U. Dept. of Physics, Buffalo.

A STUDY OF THE VALENCE ELECTRON APPROXIMATION APPLICATION TO LiH, by J. D. Stuart and R. P. Hurst. [1965] [6]p. incl. tables, refs. (AFOSR 65-2803) (In cooperation with Johns Hopkins U., Silver Spring, Md.) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-191) and Bureau of Naval Weapons) AD 628261 Unclassified

Also published in Molec. Phys., v. 9: 265-270, July 30, 1965.

Using the valence bond approach and a 6 term wave function valence electron calculations are made of the energy and dipole moment of lithium hydride. Comparisons are then made with previous 2 and with 4 electron results. It is found that reasonable agreement with 4-electron calculations of the dipole moment is obtained when the valence orbitals are made orthogonal to the orbitals of the neglected lithium inner shell 1s electrons and that an approximate variational theorem for the energy is then valid. On the other hand, when one fails to require the valence orbitals to be orthogonal to the inner shell an energy lower than the 'experimental' energy can be obtained and the computed dipole moment is in poor agreement with the computed four-electron moment and with the experimentally determined moment. Finally, as with 4-electron calculations, hybridization with the 2p coval covalent structure is necessary to give a reasonable dipole moment.

2085

New York State U. [Dept. of Physics] Buffalo.

DIPOLE AND HYPERPOLARIZABILITIES OF SOME

Also published in Jour. Chem. Phys., v. 43: 257-266 July 1, 1965.

The dielectric constants of $H-(CH_2)_n-C(CH_3)_2-CH_2OH$ with n = 1, 2, 3, 4, 6, and 8 have been measured from about -70° to 100°C with test frequencies $0.05 < f < 2 \times 10^5$ kc/sec. The equilibrium dielectric constant is analyzed in terms of associative, hydrogen-bond equilibria as deduced from the temperature variation of the Kirkwood correlation factor and ΔH and ΔS of hydrogen bonding are estimated. Dielectric relaxation has been defined over several decades of time. The principal dispersion locus is Debye-like irrespective of wide variations in the apparent degree of association and $\Delta H^{\ddagger}$ and $\Delta S^{\ddagger}$ for relaxation are similar for all species. The relation of dielectric relaxation to equilibrium liquid structure is discussed and evidence for rotational mobility in solid neopentanol and neohexanol is presented.

2082

New York State U. [Dept.] of Chemistry, Buffalo.

AMERICAN CHEMICAL SOCIETY DIVISION OF PHYSICAL CHEMISTRY 1965 SUMMER SYMPOSIUM ON RELAXATION TECHNIQUES IN CHEMICAL KINETICS IN SOLUTION, New York State U., Buffalo, June 28-30, 1965, 21p. (AFOSR-65-1534) (AF AFOSR-65-790) AD 619306 Unclassified

Reports presented at the symposium are summarized: Microwave temperature-jump method; Pulse radiolytic method; Application of n.m.r. to kinetic studies: Recent technique developments; Deuterium isotope effects in aqueous solutions of intramolecularly hydrogen-bonded acids from temperature-jump studies; Estimation of very fast reaction rates from the broadening of vibrational spectral lines; Systems of the quinone-hydroquinone type; the myoglobin-azide reaction; Cyctochrome-c systems; Prostatic acid phosphate catalysis studied by relaxation spectrometry; Kinetic studies of hydrogen bond reactions; Nuclear magnetic resonance measurements of water lifetimes in the first coordination sphere of metal ions; Ultrasonic investigation of step-wise ion association in solution; Kinetics of metal-liquid interactions as studied with the pressure step method; Reactions of the hydrated electron with metal complexes; Measurement of fast ionic reactions by relaxation effects of electron spin resonance; Pulse radiolysis studies of the hydroperoxy radical and ozonide ion in aqueous solution; Relaxation techniques for fast electrode processes; Primary hydration number of cations in solution from proton n.m.r. relaxation studies.

2083

New York State U., Dept. of Physics, Buffalo.

MULTIPOLE POLARIZABILITIES AND SHIELDING FACTORS FROM HARTREE-FOCK WAVE FUNCTIONS, by P. W. Langhoff and R. P. Hurst. [1965] [11]p. incl. tables, refs. (AFOSR-65-1965) (AF AFOSR-63-191) AD 626501 Unclassified

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Electric dipole, quadrupole, and octupole polarizabilities and shielding factors are calculated for a large number of 2- to 20-electron S-state atoms and ions. The calculations are carried out within the frame-work of an uncoupled Hartree-Fock approximation, subject to the proviso that the exchange part of Fock potential is expressable as a multiplicative function. All zeroth-order functions used are of the analytical Hartree-Fock type. The resulting numerical values are found to be strongly sensitive to the quality of the Hartree-Fock function used in the calculation, in agreement with Sternheimer's previous conclusion. This point proves to be of special importance in the case of the negative ions. In addition, it is shown that the variational method pioneered by Das and Bersohn, if carried out under proper orthogonality conditions, is equivalent to the present uncoupled Hartree-Fock approximation. Finally, it is noted that the variational method used in this work is less accurate than the Sternheimer numerical method; however, use of the variational method allows some simplification in the computational procedure.

2084

New York State U. Dept. of Physics, Buffalo.

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2085

New York State U. [Dept. of Physics] Buffalo.

DIPOLE AND HYPERPOLARIZABILITIES OF SOME

DIATOMIC MOLECULES POSSESSING PERMANENT ELECTRIC MOMENTS (Abstract), by R. P. Hurst and J. M. O'Hare. [1965] [1]p. [AF AFOSR-63-191] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 381, Mar. 24, 1965.

The energy u, in an external electric field, of a diatomic molecule having a permanent electric moment is expressible by $\mu = \mu_0 - \mu_i F_i - 1/2\, \alpha_{ij} F_i F_j - 1/6\, \beta_{ijk} F_i F_j F_k \ldots$. Here, μ_0 is the energy of the molecule out of the field, μ_i is the permanent dipole moment, α_{ij} is the dipole polarizability tensor, and β_{ijK} is the hyperpolarizability tensor. In this work, results are presented for μ_i, α_{ij} and β_{ijK} for some diatomic molecules that have permanent electric moments. The zero-order wavefunctions used in these calculations are the extended basis Hartree-Fock functions recently obtained by Chicago U. Laboratory of Molecular Structure and Spectra.

2086

New York State U. Coll. of Engineering, Stony Brook.

KINETICS OF PROTEIN SYNTHESIS BY POLYRIBOSOMES, by I. Gerst and S. N. Levine. [1965] [21]p. incl. diagrs. (AFOSR-65-2153) (Sponsored jointly by Air Force Office of Scientific Research under AF-AFOSR-64-667 and Office of Naval Research) AD 629848 Unclassified

Also published in Jour. Theoret. Biol., v. 9: 16-36, 1965.

A detailed deterministic model for the kinetics of polyribosome mediated protein synthesis is developed on the assumption that the kinetics of the system depends linearly on the messenger RNA concentration While the concentration of such components as adaptor RNA and ribosomes are regarded as constant, the messenger RNA input is taken to be time dependent and the analysis is given for both step and ramp inputs. It is shown that the theory predicts a nonlinear build-up in protein concentration followed by a linear phase in agreement with some experimental results. The slope of the linear portion corresponds to the rate of messenger RNA production.

2087

New York State U. Coll of Engineering, Stony Brook.

INVERSE PIEZOELECTRIC EFFECT IN POLYMERS, by S. N. Levine. [1965] [7]p. incl. diagrs. (AFOSR-66-0026) (AF AFOSR-64-667) AD 633400 Unclassified

Also published in Jour. Appl. Polymer Sci., v. 9: 3351-3357, Oct. 1965.

The condition for the inverse piezoelectric effect in polymers is discussed and a thermodynamic criteria is derived. The resulting expression is related to the electrical configuration of the polymer and several promising structures are proposed. A dynamical model of the piezoelectric effect is given, and expressions are derived for the compliance and electromechanical losses.

2088

New York State U. Dept. of Chemistry, Stony Brook.

STABLE AND UNSTABLE SILYL AND GERMYL COMPOUNDS, by S. Sujishi and T. D. Goldfarb. Final rept. Oct. 1, 1960-Sept. 30, 1965 [6]p. incl. table, refs. (AFOSR-67-0754) (AF AFOSR-63-277) Unclassified

The infrared spectra of several silyl and germyl compounds have been studied. It has been established that in GeH_3CN the germanium is attached to the carbon atom. The boron trifluoride adducts of hydrogen cyanide, methyl cyanide, silyl cyanide and germyl cyanide are iso-structural. No evidence has been found for p-d π- bonding between the cyanide and silyl or germyl groups in these compounds. The infrared and ultraviolet spectra of $(CH_3)_{3-n}(SiH_3)_nN$ (n = 0, 1, 2, 3) indicate that p-d π-bonding between the nitrogen and silyl groups is important. The crystal structure of $(CH_3)_2(SiH_3)N$ has been determined by x-ray diffraction and a novel pentameric unit involving pentavalent silicon has been found. The skeletal bond angles in $(GeH_3)_2O$ and $(GeH_3)_2S$ indicate that the extent of p-dπ-bonding in these molecules is smaller than in $(SiH_3)_2O$. However, the reactions of digermylsulfide with selected Lewis acids suggests a small degree of π-bonding. These reactions are different from those of either dimethyl sulfide or disily sulfide, and several new germyl compounds have been detected. Evidence has been obtained for the formation of silyl-aluminum bonds by the reaction of disilane with lithium aluminum hydride. The rate of reaction depends greatly on the nature of the ether used as the solvent. Independent I. R., Raman and N.M.R. studies indicate that lithium aluminum hydride forms ion pairs in the solvents with low reactivity.

2089

New York State U. Dept. of Electrical Engineering, Stony Brook.

ON THE RELATIVE TIME OF ADAPTIVE PROCESSES, by S. S. L. Chang. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-65 2145) (AF AFOSR-64-542) AD 629057 Unclassified

Also published in IEEE Trans. on Automatic Control, v. AC-10: 11-17, Jan. 1965.

Adaptive control systems can be classified according

to the response time of the adaptive loop T_a relative to that of the main servo loop T_m. The response time T_a cannot be smaller than the time needed for making the required measurement on which the adjustments are based. In a slow adaptive system, $T_a > T_m$, and the adjustments are made according to the estimated situation or performance. If $T_a \ll T_m$, usually a reference model is chosen and the system is forced to conform to the reference model. Sometimes the reference model is dimensionless so that the fastest response can be obtained. In both cases, $T_a \gg T_m$ and $T_a \ll T_m$, the system can be analyzed by introducing suitable approximations. The condition of stability for the adaptive loop is derived in general terms. If $T_a \approx T_m$, both analysis and synthesis become difficult. The concept of "dual control" is introduced, but not developed in the paper.

2090

New York State U. [Dept. of Electrical Engineering] Stony Brook.

AN EXTENSION OF ASCOLI'S THEOREM AND ITS APPLICATIONS TO THE THEORY OF OPTIMAL CONTROL, by S. S. L. Chang. [1965] [26]p. incl. refs. (AFOSR-65-2333) (AF AFOSR-64-542) AD 627778 Unclassified

Also published in Trans. Amer. Math. Soc., v. 115: 445-470, Mar. 1965.

Ascoli's theorem deals with continuous functions and states that the space of bounded, equicontinuous functions is compact. The present paper extends it to the measurable functions. The space of bounded equimeasurable functions, is compact, and it contains the bounded equicontinuous functions as a subset. The above theorem is applied to 2 problems in the theory of optimal control: (1) To give an existence proof of optimal control among allowed control functions which are measurable and enter the system equations in a nonlinear manner; and (2) To derive a necessary condition for optimal control in bounded phase space. The condition is different and simpler than the one derived previously by Gamkrelidze. It is proved to be also sufficient for linear systems, and its applications to engineering problems are given in previous papers.

2091

New York U., N. Y.

EVIDENCE FOR NITROGEN TRIOXIDE IN THE COMBUSTION OF A DOUBLE-BASE PROPELLANT, by L. Dauerman, G. E. Salser, and Y. A. Tajima. [1965] [2]p. incl. illus. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638) 173 and Army Materials Command) Unclassified

Published in Jour. Phys. Chem., v. 69: 3668-3669, Oct. 1965.

Mass spectrometric measurements indicate the formation of NO_3 and possibly nitrates during low pressure combustion of a typical double-base propellant (nitrocellulose, nitroglycerin, ethyl centralite and triacetin) especially during the preignition stage.

2092

New York U. Dept. of Chemistry, N. Y.

SOLUTION OF THE HYDRODYNAMIC EQUATIONS FOR LAMINAR TIME-INDEPENDENT FLAMES WITH ARBITRARILY LARGE DEVIATIONS FROM THE KINETIC STEADY STATE, by E. S. Campbell. [1965] [10]p. incl. diagrs. refs. (AFOSR-65-1473) (AF 49(638)169) AD622690 Unclassified

Also published in Combustion and Flame, v. 9: 43-52, Mar. 1965.

For the study of flame processes and their variation with fuel properties, a method is proposed suitable for large deviations from the kinetic steady state. A computer program which carries out the integration of the hydrodynamic equations subject to mathematical instability is presented in the minimum detail necessary for general use. The program has been successfully tested on the ozone-oxygen system. Further tests used as evidence for the validity of the system are given. Results are used to interpret a previous study of the hydrogen-bromine system.

2093

New York U. Dept. of Chemistry, N. Y.

A THEORETICAL ANALYSIS OF CHEMICAL AND PHYSICAL PROCESSES IN AN OZONE FLAME, by E. S. Campbell. [1965] [19]p. incl. diagrs. tables, refs. (AFOSR-65-1473) (AF 49(638)169) AD 622743 Unclassified

Also published in Chem. Eng. Sci., v. 20: 311-329, Apr. 1965.

New theoretical solutions of the 1-dimensional time independent hydrodynamic equation for an ozone flame are reported. Marked differences in comparison with previous solutions are shown to be the result of removing some approximations. The solution curves are analyzed to permit discussion of the following topics: (1) the eigenvalue character of the problem; (2) the treatment and significance of deviations from the kinetic steady-state; (3) the qualitative character of free-radical curves; (4) the role of radical recombination; (5) the relative importance of different processes of energy transport; (6) the use of the approximation of constant specific enthalpy; (7) the relative importance of heat-release by radical recombination; (8) the spatial separation of flame processes; (9) the role of diffusion; (10) the significance of kinetic energy of over-all gas-flow; and (11) the use of theoretical analysis of flames as a means of studying high temperature reactions. (Contractor's abstract)

2094

New York U. Dept. of Chemistry, N. Y.

COMPUTER CALCULATIONS FOR A PERFECT CRYSTAL OF MULTIPOLES, by E. S. Campbell. [1965] [14]p. incl. table. AF AFOSR-63-14 Unclassified

Published in Jour. Phys. and Chem. Solids, v. 26: 1395-1408, Sept. 1965.

A general method is proposed, which tests have shown to be convenient, for the study of how the following quantities vary with molecular orientation at the lattice sites: (1) the potential produced by a perfect crystal of multipoles; (2) the interaction energy with a second multipole; (3) the self-energy and self-potential of a primitive lattice. To make a study of the variation with molecular orientation feasible, it has been necessary to decompose the calculation into 3 stages: stage Ia is a function solely of crystal geometry; stage Ib, which involves the most calculation, can be greatly shortened by the use of any molecular symmetry; stage II, which is very short compared with stage I, is the only one which requires a quantitative knowledge of the multipole moments, and, therefore, of the charge distribution. The form of the proposed procedure—the result of a study of the ice lattice—has been shown to reduce markedly the computation required and to permit convenient error checks. Numerical constants required for calculations of orders < 5 are given. (Contractor's abstract)

2095

[New York U. Dept. of Electrical Engineering, N. Y.]

COMPENSATION OF PLANT VARIATIONS IN OPTIMAL CONTROL SYSTEMS, by F. J. Alexandro, Jr. [1965] [6]p. incl. diagr. (AF AFOSR-62-321) Unclassified

Published in IEEE Trans. Automatic Control, v. AC-19: 275-280, July 1965.

Control of a linear plant, with bounded control input, may be implemented by constructing a control law generator which produces the optimal control as a function of the state variables. If the plant parameters differ from their nominal values, then maintaining optimal control by changing the control law generator is inconvenient since the control law is usually nonlinear. It is shown that in certain cases optimal control can be maintained without changing the control law generator. This is accomplished by using a linear transformation of state variables as the input to the control law generator. The variations of the plant are compensated for by changing the linear transformation. The conditions under which this possible are established in this paper. The advantage of this system is that a change in a linear function is easier to implement than a change in a nonlinear function. It is shown how this system can be incorporated into an adaptive system which compensates for plant variations. (Contractor's abstract)

2096

[New York U. Dept. of Electrical Engineering, N. Y.]

THE EQUIVALENCE OF DIGITAL AND ANALOG SIGNAL PROCESSING, by K. Steiglitz. [1965] [12]p. Incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-321 and National Science Foundation) Unclassified

Published in Inform. and Control, 8: 455-467, Oct. 1965.

A specific isomorphism is constructed via the transform domains between the analog signal $L^2(-\infty, \infty)$ and the digital signal space l_2. It is then shown that the class of linear time-invariant realizable filters is invariant under this isomorphism, thus demonstrating that the theories of processing signals with such filters are identical in the digital and analog cases. This means that optimization problems involving linear time-invariant realizable filters and quadratic cost functions are equivalent in the discrete-time and the continuous-time cases, for both deterministic and random signals. Finally, applications to the approximation problem for digital filters are discussed. (Contractor's abstract)

2097

New York U. Dept. of Electrical Engineering, N. Y.

A REGION CONCEPT AND ITS APPLICATION TO THRESHOLD LOGIC, by P. Kaszerman. [1965] [21]p. incl. diagr. refs. (AFOSR-65-2684) (AF AFOSR-63-24) AD 628827 Unclassified

Also published in Inform. and Control, v. 8: 531-551, Oct. 1965.

The concept of a "region of vertices" is introduced and precisely defined. Boundary, interior, and exterior vertices are defined. It is proved that a necessary and sufficient condition that a Boolean function be a threshold function is that the boundary TRUE vertices be separable from the boundary FALSE vertices. This leads to a simpler characterization of a threshold function than the original defining inequalities. The functions that are generated by a 2-threshold device network are examined for the properties in terms of regions of TRUE and FALSE vertices. By making use of these properties, synthesis procedures are developed. (Contractor's abstract)

2098

New York U. Dept. of Electrical Engineering, N. Y.

ON THE FORMULATION OF ADAPTIVE OPTIMAL CONTROL PROBLEMS, by A. E. Pearson and P. E. Sarachik. [1965] [10]p. incl. diagrs. refs. (AFOSR-65-2430) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR 63-284 and National Science Foundation) AD 629691 Unclassified

Presented at Joint Automatic Control Conf., Stanford, Calif., June 24-26, 1964.

Also published in Jour. Basic Eng., v. 87: 125-134, 1965.

For abstract see item no. 743.

2099

New York U. Dept. of Electrical Engineering, N. Y.

COMPUTER STORAGE AND ANALYSIS OF CONTOUR MAP DATA, by S. P. Morse. Feb. 1965, 62p. incl. diagrs. table. (Technical rept. no. 400-106) (AFOSR-65-0592) (AF AFOSR-65-24) AD 617955 Unclassified

This report describes a method for storing and analyzing contour map data in a digital computer. The data is stored in the so-called contour-line-storage form. This form represents the contour lines in terms of sequences of octally encoded, short, straight-line segments. Algorithms can be developed to analyze the data directly in this form. In some cases, however, it may be advantageous first to convert the data into a form more suitable for the particular analysis. In this report, algorithms are described for locating the ground profile of a given path on a map, generating the gradient at a point on the map, and finding the volume between two elevations. As an illustration, some of the algorithms are applied to the problem of locating the ground track of an aircraft from the pilot's record of heading and altitude vs. time. This problem involves selecting certain ground tracks as "likely candidates," generating the ground profile for each of these tracks, comparing these ground profiles with the pilot's record of altitude vs. time, and then selecting the "candidate" that most closely agrees with the pilot's record.

2100

New York U. Dept. of Electrical Engineering, N. Y.

SEGMENT FITTING OF CURVES IN PATTERN ANALYSIS USING CHAIN CORRELATION, by J. Feder and H. Freeman. Mar. 1965, 53p. incl. diagrs. tables. (Technical rept. no. 400-108) (AFOSR-65-1206) (AF AFOSR-65-24) AD 619525 Unclassified

This report is concerned with the problem of using a digital computer to fit a given curve to a similar-shaped section of a larger curve, provided such a section exists. This is the so-called segment-fitting problem. The approach toward its solution described here makes use of the method of chain correlation and is applicable only where the scale and orientation of the curves are fixed. Results based on actual computer tests are given and the sources of error are examined.

2101

New York U. Dept. of Electrical Engineering, N. Y.

A CRITERION FOR THE QUANTIZATION OF LINE-DRAWING DATA, by J. M. Glass. May 1965, 151p. incl. diagrs. tables, refs. (Technical rept. no. 400-112) (AFOSR-65-1495) (AF AFOSR-65-24) AD 621086 Unclassified

The digital transmission of line-drawing data requires that the data first be quantized. Since quantization tends to degrade the original data, it is desirable to employ as fine a quantization as possible. A criterion is developed for enabling one to determine the coarest possible quantization that will preserve the original data to within a specified tolerance. In the criterion developed, line drawings are thought of as thin elastic beams, which can be characterized by means of their strain-energy density functions. Quantization is seen to result in a spreading of these density functions, creating an uncertainty region in an energy space, the uncertainty decreasing with finer quantization. Of the possible continuous reconstructions that can be generated from the quantized data, there is one that is of particular interest - the minimum-energy curve. An appropriate quantization is determined by requiring that the total energies of the minimum-energy curve and the original curve be within a specified tolerance.

2102

New York U. Dept. of Electrical Engineering, N. Y.

ANALYSIS OF A CONTOUR MAP ON A CLOSED SURFACE, by S. P. Morse. Sept. 1965, 29p. incl. diagrs. tables. (Technical rept. no. 400-123) (AFOSR-66-0693) (AF AFOSR-65-24) AD 631670 Unclassified

The various components of a contour map are defined, and a point of view is introduced that aids in developing insight into the properties of contour maps. Contour lines of intersection of a surface with reference surfaces. The contour lines can be classified into four classes: positive, negative, maximum, and minimum. If the surface is closed, such as the Earth's surface, positive and negative contour lines are always closed curves. Where the surface is perpendicular to the reference surfaces, a cliff is formed. A cliff line on a contour map is characterized by a merger of different contour lines. There is a graphical technique for determining where the various contour lines enter and leave a cliff line. A method exists for truncating the contour map so that it covers only a portion of a closed surface and still maintains the closed-curve property of contour lines. By defining an outer boundary, one is able to talk about the interior and exterior of those contour lines that are closed curves. Lines of slope are lines that are everywhere perpendicular to the contour lines. Slope contour lines are contour lines for the slope of the surface. The former is concerned with the direction of the gradient, the latter with its magnitude

2103

New York U. Dept. of Electrical Engineering, N. Y.

A MATHEMATICAL MODEL FOR THE ANALYSIS OF CONTOUR-LINE DATA, by S. P. Morse. Oct. 1965 [44]p. incl. diagrs. tables refs. (Technical rept. no. 400-124) (AFOSR-66-0694) (AF AFOSR-65-24)

AD 631669 Unclassified

This paper develops a mathematical model for the study of contour line data. Formal definitions are given for the various classes of contour lines found on a contour map. The concept of cliff lines is introduced and the properties of both contour lines and cliff lines are investigated. The objective of the paper is to lay a foundation for the development of algorithms that will facilitate the digital computer solution of problems involving contour line data.

2104

New York U. Dept. of Electrical Engineering, N. Y.

ON AN EXTENDED CLASS OF ERROR-LOCATING CODES, by J. K. Wolf. [1965] [7]p. (AFOSR 65-2064) (AF AFOSR-65-499) AD 627687 Unclassified

Also published in Inform. and Control, v. 8: 163-169, Apr. 1965.

An explicit method of constructing error-location (EL) codes is presented for the case where errors occur in multiple sub-blocks. The procedure is applicable both when the erroneous sub-blocks occur randomly throughout the message and when they occur in bursts. The method allows for a wide range in redundancy and error-location capability. The method of construction is outlined for an EL code which locates errors occurring within 2 or fewer random sub-blocks. A general decoding procedure for the codes is presented.

2105

New York U. Dept. of Electrical Engineering, N. Y.

MEAN SQUARE RECONSTRUCTION ERROR, by A. I. Liff. [1965] [2]p. incl table. (AFOSR-65-2424) (AF AFOSR-65-499) AD 627968 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10: 370-371, July 1965.

Simple time-domain expressions for the mean square error caused by sampling and reconstructing a signal for a class of reconstructors are given. The class of reconstructors considered is a subclass of linear, time-invariant filters with time-limited impulse response and transfer function. The input signal r(t) and the noise signal n(t) are assumed to be stationary, ergodic, and independent random processes.

2106

New York U. Dept. of Electrical Engineering, N.Y

UNEQUAL ERROR PROTECTION CODES, by B. J. Masnick and J. K. Wolf. [1965] [8]p. incl. tables, refs. (AFOSR-66-0109) (AF AFOSR-65-499) AD 641060 Unclassified

Also published in IEEE Mohawk Valley Commun. Symposium, Oct. 1965, p. 205-212.

The theoretical basis for the construction of a new class of linear codes which provides different levels of error protection for different digits of the code word is introduced. Examples of such codes are presented and some construction methods are devised and verified. Upper and lower bounds on the required redundancy for such codes are derived.

2107

New York U. Dept. of Electrical Engineering, N. Y.

IDENTIFICATION OF THE STEADY STATE OPERATOR FOR DISCRETE SELF-OPTIMIZING SYSTEMS, by P. E. Sarachik. [1965] [3]p. incl. diagrs. (AFOSR-65-2075) (AF AFOSR-65-747) AD 277738 Unclassified

Also published in IEEE Trans. on Automatic Control, v. AC-10: 83-85, Jan. 1965.

It is shown that the self-optimization problem for unknown and in general nonlinear discrete time plants can be solved by an iterative procedure which alternates identification with optimization stages. It is further pointed out that when a plant is dynamic, care must be taken to insure that the plant is characterized by a unique fixed operator. For type-zero and type-one plants it is shown that by properly constructing a periodic input and allowing the plant to come to the periodic steady-state, the plant is correctly characterized by a steady-state operator. Finally, methods for performing the required identification are discussed.

2108

New York U. Dept. of Electrical Engineering, N. Y.

FUNCTIONAL ANALYSIS IN AUTOMATIC CONTROL, by P. E. Sarachik. [1965] [12]p. incl refs. (AFOSR-65-2076) (AF AFOSR-65-747) AD 627683 Unclassified

Also published in IEEE Internat'l. Conv. Rec., 1965, p. 96-107.

Some recent applications of functional analysis to automatic control problems are described. A sufficient introduction to basic concepts is given to make the paper self-contained. Applications to the minimum norm and minimum time problems are discussed and it is shown that an analytical form of the optimal solution can be readily found by using certain functional analysis concepts. It is indicated how the iteration techniques for solution of operator or functional equations in a Banach space can be applied to generate a computational algorithm for obtaining the solution to an optimization problem. It is also which how the functional analysis approach can reveal what particular properties of an unknown system must be identified in order to solve an optimization problem.

2109

New York U. Dept. of Electrical Engineering, N. Y.

CONTROLLABILITY AND OBSERVABILITY OF LINEAR DISCRETE-TIME SYSTEMS, by P. E. Sarachik and E. Kreindler. [1965] [14]p. incl. diagr. (AFOSR-65-2077) (Sponsored jointly by Aeronautical Systems Division; and Air Force Office of Scientific Research under AF AFOSR-65-747) AD 627717 Unclassified

Also published in Internat'l. Jour. Control, v. 1: 419-432, May 1965.

A system is considered to be completely controllable if any initial state can be transferred to any other state in finite time; it is completely observable if the state at any time can be determined from knowledge of the inputs and outputs over a finite time. In this paper a self-contained development is presented of the subject of controllability and observability of discrete-time systems. It is noted that the discrete-time case is directly analogous to the continuous-time case. In fact, most of the results for the discrete-time case can be obtained from the continuous-time case by replacing the continuous-time variable t with discrete points t_k on the t-axis and by replacing integrals with summations. However, some differences exist, and a direct and independent approach to controllability and observability is used here to avoid such differences and to consider the more general discrete-time systems.

2110

New York U. Dept. of Electrical Engineering, N. Y.

CONCERNING ADJOINTS OF DISCRETE-TIME SYSTEMS, by P. E. Sarachik and E. Kreindler. [1965] [2]p. (AFOSR 65-2354) (In cooperation with Grumman Aircraft Engineering Corp., Bethpage N. Y. AF 49(638) 1207) (AF AFOSR-65-747) AD629814 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10 350-352, July 1965.

For abstract see item no. 1024.

2111

New York U. Dept. of Physics, N. Y.

CONVECTIVE INSTABILITY IN A COMPRESSIBLE ATMOSPHERE, by E. A. Spiegel. [1965] [23]p. incl. diagrs. tables, refs. (AFOSR 65-2827) AF AFOSR-62-386) AD 628525 Unclassified

Also published in Astrophys. Jour., v. 141: 1068-1090, Apr. 1, 1965.

The linear equations for time-independent convection in a plane-parallel layer of perfect gas are studied for the case of constant viscosity and conductivity. These equations determine the condition for the onset of steady convection. The equations are treated from 3 points of view. First a perturbation expansion in terms of layer thickness is carried out to first order. The zeroth-order terms give the Boussinesq equations studied by Lord Rayleigh. The first-order terms show that if the Rayleigh number is evaluated at the mid-height of the layer, its eigenvalues are stationary with respect to variations in layer thickness. The first-order eigenfunctions are numerically calculated for a particular polytropic index. Next, 2 variational statements are written and some sample numerical results are presented. It is found that variational techniques are not effective in the present problem. The WKB approach is then explored and extended to the determination of uniformly valid asymptotic solutions. These provide not only stability criteria (from which explicit numerical results are derived), but also produce analytic approximations for all the eigenmodes. This method appears to be generally useful for problems of this kind. (Contractor's abstract)

2112

New York U. Dept. of Physics, N. Y.

THE PULSATIONS OF MODELS OF DELTA CEPHEI STARS. II, by N. Baker and R. Kippenhahn. [1965] [22]p. incl. diagrs. table, refs. (AFOSR-66-1687) (AF AFOSR-62-386) AD 640197 Unclassified

Also published in Astrophys. Jour., v. 142: 868-889, Oct. 1, 1965.

The vibrational stability of detailed models of δ Cephei stars is studied by numerical integration of the linearized non-adiabatic pulsation equations. In contrast to a previous investigation, improvements in the method of integration allow the non-adiabatic calculations to be carried from the surface layers deep into the star. The periods are also determined from the models. It is found that both the period and the stability coefficient can be evaluated to high accuracy on the basis of the outer half (in mass) of the star. The effect of convection on the structure of the equilibrium models is included; the interaction of convection with the pulsations is neglected. Boundary conditions are discussed in detail in an appendix. A series of 15 models of 7 Mo lying along a portion of the evolutionary track calculated by Hofmeister, Kippenhahn, and Weigert has been investigated. The results confirm the existence of a region of linear instability, due largely to the destabilizing effect of second helium ionization, in a range of mean effective temperatures centered at about 5400°K. The instability is present for both the fundamental mode and the first overtone. In contrast to previous work, the hydrogen and first helium ionizations are found to contribute significantly to the destabilizing effect, especially for the overtones. The instability zone is wider in terms of effective temperature than is indicated by observations, and the temperatures of the most unstable models appear to be several hundred degrees lower than the observed temperatures of δ Cephei stars. The results are consistent with those of our previous work and of Cox. Possible consequences of the neglect of non-linear effects are discussed in a general way.

2113

New York U. Inst. of Mathematical Sciences, N. Y.

GENERALIZED EIGENVECTORS AND SEPARATION OF VARIABLES, by M. Machover. [1965] [20]p. incl. refs. (AFOSR-65-2735) (AF AFOSR-62-108) AD 629085
Unclassified

Also published in Trans. Amer. Math. Soc. v. 115: 505-524, Mar. 1965.

Consider the reduced wave equation $(\nabla^2 + k^2)u(x, y) = f(x, y)$ on a rectangle R, with suitable boundary conditions; k may be complex and the boundary conditions non-selfadjoint. The author treats this problem by separation of variables, and is thereby led to consider expansions in terms of generalized eigenvectors. { The latter term is used in the operator-theoretic sense, and not in the sense of generalized functions. } The main tool is an expansion theorem of G. Birkhoff. Some more general problems of separable type are considered briefly.

2114

[New York U. Inst. of Mathematical Sciences, N. Y.]

SOLUTION OF THE BOLTZMANN EQUATION IN AN UNBOUNDED DOMAIN, by H. Grad. [1965] [10]p. (AFOSR-65-1357) (AF AFOSR-62-266) AD 621471
Unclassified

Also published in Commun. Pure and Appl. Math., v. 18: 345-354, Feb.-May 1965.

Infinite full 3-dimensional space obviously generates no interference from boundary layers. For solutions of the linear Boltzmann equation in this domain, the technical point in obtaining a priori estimates is the vanishing of a certain boundary integral. For the rectangular box this is observed almost by inspection. In the unbounded domain it requires an additional estimate of a sufficiently rapid decay at infinity. In this report such an estimate is obtained.

2115

New York U. Inst. of Mathematical Sciences, N. Y.

ON BOLTZMANN'S H-THEOREM, by H. Grad. [1965] [19]p. (AFOSR-65-2334) (AF AFOSR-62-266) AD 629536
Unclassified

Presented at SIAM National Meeting, Washington, D. C., May 13-14, 1964.

Also published in Jour. Soc. Indus. and Appl. Math., v. 13: 259-277, Mar. 1965.

It is a classical result for solutions of the Boltzmann equation that Boltzmann's H-function, decreases monotonically with time, but ceases to decrease if the distribution function becomes locally Maxwellian. If, after a time, the system were to become precisely locally Maxwellian it would cease to be dissipative and the H-function (which then reduces to the negative thermodynamic entropy) would henceforth remain constant at a value higher than that appropriate to thermodynamic equilibrium. In order to demonstrate an approach to equilibrium, it is necessary to show not that the distribution approaches a Maxwellian, but that it does not approach a local Maxwellian too closely or too soon. In this paper we prove, for a general form of linear Boltzmann equation, that under appropriate boundary conditions all solutions approach equilibrium. The proof uses recent strong estimates of solutions of the linear Boltzmann equation.

2116

New York U. Inst. of Mathematical Sciences, N. Y.

STRUCTURE OF THE BOLTZMANN COLLISION OPERATOR, by L. Finkelstein. [1965] [6]p. incl. diagrs. (AFOSR-65-2335) (AF AFOSR-62-266) AD 629152
Unclassified

Also published in Phys. Fluids, v. 8: 431-436, Mar. 1965.

The full Boltzmann collision operator with an infinite collision cross section is investigated. It is shown that in the general case the operator is bilinear in F and $\partial F/\partial \xi$ and 3 different representations of it are given. The linearized collision operator is further explored and a new expression for the kernel in the form of a divergence is obtained. An approximation to the linearized operator is indicated, which may prove of value in numerical calculations. (Contractor's abstract)

2117

New York U. [Inst. of Mathematical Sciences] N. Y.

STEADY STATE OSCILLATIONS IN A CAS, by H. Weitzner. [1965] [20]p. incl. diagrs. refs. (AFOSR-66-1200) (AF AFOSR-62-266) AD 640241
Unclassified

Also published in Rarefied Gas Dynamics; Proc Fourth Internat'l. Symposium, Toronto U. (Canada) (July 14-17, 1964) ed. by J. H. de Leeuw. New York Academic Press, v. 1: 1-20, 1965.

The linearized 1-dimensional Krook equation is solved for the case of a half-space of gas bounded by an oscillating wall. This situation corresponds to the commonly studied problem of the propagation of sound in a gas. The question of when a sound wave is observable is considered. Unless 2 conditions hold the sound wave will be lost in a larger, irregular disturbance. First, the observation must be taken many mean free paths from the wall. Second, the wave train is observable only for a limited length, and the number of wavelengths seen is of the order of the collision frequency over the oscillations frequency. (Contractor's abstract.)

2118

New York U. [Inst. of Mathematical Sciences] N. Y.

THE TRANSISTIONAL DRAG ON A CYLINDER AT HYPERSONIC MACH NUMBERS, by M. H. Rose. [1965] [15]p. incl. diagrs. tables. (AFOSR-66-1201) (AF AFOSR-62-266) Unclassified

Also published in Rarefield Gas Dynamics; Proc. of the Fourth Internat'l. Symposium, Toronto U. (Canada) (July 14-17, 1964) ed. by J. H. de Leeuw, New York Academic Press, v. 1; 312-324, 1965.

The drag on a cylinder traversing a neutral, rarefied gas is computed in the hypersonic range. Although intermolecular collisions are assumed rare they are not entirely negligible and, therefore, will give rise to a small departure from free-flow conditions. The mathematical procedure is similar to that previously applied to the case of a sphere. Using the identical boundary conditions for both geometries, it is then possible to gain some insight into the effect of shape upon drag. Comparisons are also made with the theoretical results obtained for an infinite, two-dimensional strip. Finally, an attempt is made to relate the theoretical predictions for the cylinder with the presently available experimental results. (Contractor's abstract)

2119

New York U. [Inst. of Mathematical Sciences]. N. Y.

ATOMIC-HYDROGEN RECOMBINATION (Abstract), by A. Salop and A. Mandl. [1965] [1]p. [AF AFOSR-62-266] Unclassified

Presented at meeting of the Amer. Phys. Soc., Columbia U., New York, June 23-25, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 596-597, June 23, 1965.

Studies are being made of the recombination of atomic hydrogen in the after glow of an rf discharge by observing resonant absorption of radiation at the atomic-hydrogen hyperfine frequency (1420 mc/sec). Large-volume (1 liter), sealed bottles filled with reagent-grade hydrogen at pressures in the range of 0.8-2.5 mm Hg are placed directly within the cavity of a 1420 mc/sec magnetic-resonance spectrometer and subjected to a pulsed 7-mc/sec electrodeless discharge at a repetition rate of typically 1.5 sec. Sampling pulses of 1420-mc/sec radiation at the same repetition rate are passed into the cavity but are phased so as to occur at a time T after the appearance of the discharge pulses. The absorption line, characteristic of the afterglow at time T, is obtained and, under the assumption that hydrogen-hydrogen spin-exchange collisions are the primary cause of line broadening, the atomic concentration is determined from an analysis of the lineshape. By varying T over the effective afterglow time, the atomic recombination may be investigated. Measurements of the efficiency for the 1st-order recombination at glass and quartz surfaces are discussed.

2120

New York U. [Inst. of Mathematical Sciences] N. Y.

TRANSPORT COEFFICIENTS FOR SYSTEMS WITH STEEP INTERMOLECULAR POTENTIALS, by R. G. Storer and H. L. Frisch. [1965] [2]p. (AF AFOSR-62-266) Unclassified

Published in Jour. Chem. Phys., v. 43: 4539-4540, Dec. 15, 1965.

A formal high-temperature perturbation expansion of the thermal transport coefficients of a fluid has recently been obtained, starting with the Kubo-Green correlation-function expressions and choosing the rigid-sphere fluid as the reference system. Further consideration is given to the expansion of the self-diffusion coefficient D in powers of n^{-1} where n is a measure of the steepness of the intermolecular potential. The result expressed is in a form which is suitable for calculation via molecular-dynamics data for rigid sphere generated on a computer.

2121

New York U. Inst. of Mathematical Sciences, N. Y.

THE CONCEPT OF MATHEMATICS HISTORICALLY SURVEYED, by M. Kline. [1965] [22]p. [AF AFOSR-64-537] Unclassified

Published in Science in the Sixties; Tenth Anniversary AFOSR Scientific Seminar, Cloudcroft, N. M. (June 14-25, 1965), ed. by D. L. Arm. Albuquerque, New Mexico U. Office of Publications, 1965, 10-31.

A broad account of the nature of mathematics and its relation to science is presented. The author's aim is to show that the 2 distinguishing characteristics of mathematics which in the past have been accepted as paramount-its rigorous methodology and its claim to truth-are invalid. After the classical Greeks contributed Euclidean geometry, insisting on the rigorous establishment of mathematics from self-evident truths, the Alexandrian Greeks created trigometry, thus giving arithmetic and algebra equal importance with geometry although they had no logical foundation. In the scientific period from the 1500's onward, the position of algebra and geometry were reversed; conclusions about geometry were to be established by algebraic reasoning. The nineteenth century creation of non-Euclidean geometry showed that the logic of Euclidean geometry was deficient and initiated the destruction of truth. However, mathematics preserved its power due to its achievements in science. By 1900, mathematicians restored the rigorous logical foundations of their subject, but paradoxes and the problem of consistency still exist. The present understanding of the nature of mathematics and its direct relation to science are discussed.

2122

New York U. Inst. of Mathematical Sciences, N. Y.

SOLUTIONS IN THE LARGE FOR NONLINEAR HYPER-

BOLIC SYSTEMS OF EQUATIONS, by J. Glimm. [1965] [19]p. (AFOSR-66-0673) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-684 and National Science Foundation) AD 633551 Unclassified

Also published in Commun. Pure and Appl. Sci., v. 18: 697-715, Nov. 1965.

Systems of the form $u_t + f(u)_x = 0$ are investigated. Solutions for all $t > 0$ are found in the case where the initial data $u(x, 0)$ are approximately constant. The solutions are discontinuous in general; these discontinuities are shock waves.

2123

Newcastle U. Dept. of Inorganic Chemistry, Newcastle upon Tyne (Gt. Brit.).

HETEROCYCLIC ORGANOBORON COMPOUNDS. PART III. SYNTHESIS OF PHENYLBORACYCLOPENTANE AND THE INFRARED SPECTRA OF THIS AND OTHER PHENYLBORON COMPOUNDS, by N. N. Greenwood and J. C. Wright. [1965] [6]p. incl. diagrs. tables. refs. (AFOSR-65-0692) (AF EOAR-62-27) AD 615692 Unclassified

Also published in Jour. Chem. Soc., v. 70: 448-453, Jan. 1965.

An improved synthesis of phenylboracyclopentane by the reaction of phenylborane-triethylamine with butadiene is reported, but the preparation of this compound from phenylboron difluoride and 1, 4-dilithiobutane could not confirmed. The infrared spectrum of phenylboracyclopentane is analyzed in detail and shown to be consistent with the proposed structure. The spectra of phenylboron difluoride and phenylborane-triethylamine are also recorded and assignments made.

2124

[Newcastle U.] Dept. of Inorganic Chemistry, Newcastle upon Tyne (Gt. Brit.).

HALOGEN DERIVATIVES OF CO-ORDINATED GALLIUM HYDRIDE, by N. N. Greenwood and A. Storr. [1965] [8]p. incl. tables, refs. (AFOSR-65-1645) [AF EOAR-62-27] AD 624372 Unclassified

Also published in Jour. Chem. Soc. (London), v. 620: 3426-3433, May 1965.

The compounds, $Me_3NGaH_{3-n}X_n$ and $Me_3NGaD_{3-n}X_n$ have been prepared and their infrared spectra recorded in benzene solution in the range 200-4000 cm^{-1}. These spectra show several interesting features that are related to the substitution of hydrogen by halogen. The methyl-proton nuclear magnetic resonance spectea of these compounds in benzene solution have also been recorded. The monosubstituted halogenogallanes, Me_3NGaH_2X, are white, slightly volatile solids, which can be purified by vacuum sublimation. The disubstituted halogenogallanes, Me_3NGaHX_2, and the fully halogenated compounds, Me_3NGaX_3, are all involatile white solids. Displacement of trimethylamine from the adduct Me_3NGaH_2Cl by boron trifluoride results in the liberation of unco-ordinated GaH_2Cl which subsequently decomposes at low temperatures even in solution. An attempt to prepare the borohydride derivative, $Me_3NGaH_2(BH_4)$, leads to decomposition to gallium metal and hydrogen.

2125

Newcastle U. Dept. of Inorganic Chemistry, Newcastle upon Tyne (Gt. Brit.).

GALLIUM HYDRIDE ADDUCTS OF TRIMETHYLPHOSPHINE AND TRIPHENYLPHOSPHINE, by N. N. Greenwood, E. J. F. Ross, and A. Storr. [1965]. [6]p. incl. diagr. refs. (AFOSR-65-1276) (AF EOAR-64-79) AD 622771 Unclassified

Also published in Jour. Chem. Soc., v. 246: 1400-1406, Feb. 1965.

The new compounds Me_3PGaH_3 and Me_3PGaD_3 have been prepared and shown by their gas-phase infrared spectra to be monomeric. The P-Ga stretching frequency has been identified at 326 cm^{-1}. The absence of a 2: 1 adduct, $(Me_3P)_2GaH_3$, was shown by tensiometric titration at -21°C. Gas-phase displacement reactions indicate that trimethylamine and trimethylphosphine have similar donor strengths towards gallium hydride. The corresponding aluminum hydride adduct Me_3PAlH_3 could not be prepared directly, and tri- and trimethylphosphine does not displace trimethylamine from Me_3NAlH_3. The compound Ph_3PGaH_3 has been prepared but readily decomposes at room temperature. The equilibrium between trimethylamine, trimethylphosphine, and their adducts with gallium hydride in benzene solution has been investigated by nmr spectroscopy.

2126

Newcastle U. Dept. of Inorganic Chemistry, Newcastle, upon Tyne (Gt. Brit.).

DERIVATIVES OF CYCLOTETRAZENOBORANE (BORATETRAZOLE), N_4H_2BH, by N. N. Greenwood and J. H. Morris. [1965] [4]p. incl. diagrs. tables. (AFOSR-66-0312) (AF EOAR-64-79) AD 632448 Unclassified

Also published in Jour. Chem. Soc. (London), v. 1156: 6205-6209, Nov. 1965.

A new 5-membered ring system containing 1-boron and 4-nitrogen atoms was synthesized by the reaction of phenyl azide with either decaborane or aniline-

borane. The structure of 2, 5-diphenylcyclotetrazenoborane. Ph_2N_4BH, was established and its spectroscopic and other properties investigated. (Contractor's abstract)

2127

North American Aviation, Inc. Atomics International Div., Canoga Park, Calif.

EIGHTH AFOSR CONTRACTORS' MEETING ON ION AND PLASMA PROPULSION RESEARCH: SUMMARIES OF RESEARCH, Los Angeles Calif., Apr. 29-30, 1965. [1965] 38p. incl. refs. (Rept. no. AI-65-77) (AFOSR 65-1266) (AF 49(638)1222) AD 622527 Unclassified

Summaries are presented of 39 papers presented at the Eighth AFOSR Contractors' Meeting on Ion and Plasma Propulsion Research. Different types of plasmas and various aspects of ion and plasma theory are considered, especially as they relate to propulsion systems.

2128

North American Aviation, Inc. Atomics International Div., Canoga Park, Calif.

FLOWING GAS DISCHARGES IN POTASSIUM AND MERCURY, by C. A. Guderjahn. July 1, 1965, 31p. incl. diagrs. tables. (AFOSR-65-1914) (AF 49(638)1222) AD 628187 Unclassified

The resistivity of superheated potassium and mercury vapor was measured. Substantial heating of the gas by the discharge was avoided by flowing the gas through the discharge region. The resistivity of potassium gas at 7.8 torr pressure, 870°K and 1 amp/cm^2 current is 2.2 ohm-cm. The resistivity of mercury gas at 14 torr pressure, 870°K and 0.67 amp/cm^2 current is 10 ohm-cm. The resistance was primarily due to short range electron-neutral atom collisions. The cross section for this process as calculated from the resistivity is 1.5×10^{-14} cm^2 for potassium and 2.5×10^{-14} cm^2 for mercury. Radiation losses were neglected in this calculation. An experimental MGD device using potassium as the working fluid was constructed. Ionization was to be nonequilibrium and provided by magnetic induction. Self-sustained operation was not achieved due to internal shorting by potassium films on insulator surfaces.

2129

North American Aviation, Inc. Atomics International Div., Canoga Park, Calif.

LOW-PRESSURE HIGH-CURRENT DISCHARGES IN MOVING GASES (Abstract), by C. A. Guderjahn [1965] [1]p. (Bound with its AFOSR 65-1266; AD 622527) AF 49(638)1222 Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles Calif. Apr. 29-30, 1965.

The conductivity of discharges in superheated potassium and mercury vapor has been measured. The measurements were carried out in flowing gas at about 10 torr pressure. The electric field within the potassium vapor plasma column was measured to be 2.3 v/cm and was nearly independent of current between 0.5 and 7 amp. This sustaining field is associated with the energy required for ionization and could be exceeded by the $\vec{v} \times \vec{B}$ field in an MGD device operating at readily obtainable velocities and magnetic fields. The mercury vapor plasma column required about 3.5 v/cm at 1 amp current and was dependent upon the current to a greater extent than the potassium vapor.

2130

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

STEADY-STATE ROCKET COMBUSTION OF GASEOUS HYDROGEN AND LIQUID OXYGEN. PART II. ANALYSIS FOR COAXIAL JET INJECTION, by L. P. Combs and M. D. Schuman. Mar. 1965, 134p. incl. illus. diagrs. tables, refs. (Research rept. no. 64-29) (AFOSR-65-1319) (AF 49(638)817) AD 623401 Unclassified

Simultaneous equations describing rocket propellant injection, atomization, mixing, vaporization, and combustion are formulated for a cylindrical liquid oxygen jet surrounded by an annular gaseous hydrogen stream. The formulation is based on division of the combustion chamber into a nonburning region near the injector and a combustion region further downstream. Processes in the nonburning region are required to satisfy certain combustibility criteria before combustion is possible. The propellants then pass through a plane flame front into the combustion region. A simplified treatment of turbulent mixing between unlike reacting gas streams, one of which contains a liquid oxygen spray, characterizes the combustion region model. Solutions of the system of equations, obtained with a digital computer program, are detailed, discussed, and compared favorably with experimental information from Part I.

2131

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

CALCULATION OF VIBRATIONAL FORCE CONSTANTS, by E. C. Curtis. Final rept. Dec. 1, 1961-Aug. 31, 1965, 22p. incl. diagr. tables, refs. (Rept. no. R-6293) (AFOSR-65-1822) (AF 49(638)1135) AD 625878 Unclassified

A review is presented of a study to find better models for the calculation of vibrational force constants of simple polyatomic molecules. Two computer programs designed for the study are described. The roles

of anharmonicity and Urey-Bradley repulsions are considered. The calculation of force constants for several N-F compounds and interhalogens are discussed. The lone pair model is improved and applied to the case of NF_3 and a new model, the bent bond model, is developed for this molecule. It is included that force constant studies are promising for the understanding of chemical hybridization.

2132

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

ON THE NATURE OF UREY-BRADLEY FORCE CONSTANT. APPLICATION TO FOUR FIRST ROW IONS, by E. C. Curtis. [1965] [14]p. diagrs. tables, refs. (AFOSR 65-2264) (AF 49(638)1135) AD 624833 Unclassified

Also published in Jour. Molec. Spectros., v. 17: 108-121, July 1965.

A model for the Urey-Bradley repulsion force constants is given which consists partly of a dispersion and partly of an ionic force, resulting in $-0.5F\ 1F' < -0.1F$. It was expected that F' would be near the lower limit in the examples chosen, that is, crystals containing the ions $CO_3^{=}$, NO_3^{-}, NO_2^{-}, and NH_4^{+}. The calculations showed that part of the repulsion was indeed the results of electrostatic forces but that an appreciable part of the charge formally indicated on ions in these crystals does not actually exist.

2133

North American Aviation, Inc. Rocketdyne Div., Canoga Park, Calif.

RESPONSE OF A BURNING SOLID PROPELLANT TO PRESSURE WAVES OF FINITE AMPLITUDE, by A. L. Huebner and T. A. Coultas. June 1965, 72p. incl. diagrs. tables, refs. (Rept. no. R-6213) (AFOSR-65-1733) (AF 49(638)1208) AD 624944 Unclassified

Shock-tube techniques are utilized to determine the response of a burning solid propellant surface to pressure perturbations of small, but finite amplitudes. This method of obtaining propellant responses is described with emphasis upon the techniques developed to remove undesirable temperature gradients. Other experimental techniques utilized to obtain high-frequency response pressure measurements under reproducible pressure, flow, and temperature conditions are described. The propellants used in the study include those with a wide range of pressure exponents as well as absolute burning rate. A discussion of the treatment of the experimental data to obtain Fourier transforms and the propellant response as a function of frequency is presented, with particular emphasis upon the significance and reproducibility of the data. A comparison of these results is made with empirical instability data as well as theory.

2134

North American Aviation, Inc. Los Angeles Div., Calif.

ON THE HYPERSONIC FLOW OVER A DELTA WING WITH VERY SUPERSONIC LEADING EDGES, by N. D. Malmuth. Jan. 11,-Mar. 7, 1965. June 1, 1965, 23p. incl. diagrs, table, refs. (AFOSR-65-0757) (AF 49(638)1477) AD 618294 Unclassified

For the case of very supersonic leading edges, the inviscid hypersonic flow over the windward side of a symmetrical flat-plat delta wing at incidence is analyzed. The limit selected is that the incidence is of higher order than the aspect ratio as the incidence tends to zero at infinite Mach number. In this framework, the flow regions consist of a two-dimensional domain adjacent to the leading edges and a central conefield. The flow quantities in the central region represent small linear, rotational perturbations about the zero sweep flow. A Riemann-Poincare boundary value problem for the pressure perturbation is formulated. An additional condition involving the sidewash at the shock is found to be required to resolve the indeterminacy of the foregoing boundary value problem. Series solutions and numerical results are presented for the shock shape and the pressure. The behavior of the latter quantity is found to be similar to that given by the irrotational linear solution for the supersonic leading edge case. Finally, the relationship between the present application and others involving diffraction problems and corner flows is indicated. (Contractors' abstract)

2135

North Carolina State U. [Dept. of Mathematics] Raleigh.

A RELATION INVOLVING HANKEL TRANSFORMS WITH APPLICATIONS TO BOUNDARY VALUE PROBLEMS IN POTENTIAL THEORY, by I. N. Sneddon. [1965] [8]p. (AFOSR-66-2108) (AF 49(638)1159) AD 643563 Unclassified

Also published in Jour. Math. and Mech., v. 14: 33-40, Jan. 1965.

A classical problem of mathematical physics is that of determining the potential of the electrostatic field due to a circular disk whose potential is prescribed. One method of solving this problem is to determine the charge density on the disk and then to calculate the potential at a field point r by evaluating a surface integral over the surface of the disk. In the case in which the prescribed potential of the disk is a function only of the distance from the center of the disk, it has been shown that the charge density can be computed. This paper shows that this representation of the charge density is a special case of a general relation between Hankel transforms which are of interest in the discussion of axisymmetric boundary value problems of potential theory.

2136

North Carolina State U. [Dept. of Mathematics] Raleigh.

THE RELATION BETWEEN LOAD AND PENTRATION IN THE AXISYMMETRIC BOUSSINESQ PROBLEM FOR A PUNCH OF ARBITRARY PROFILE, by I. N. Sneddon. [1965] [11]p. incl. refs. (AFOSR-66-2112) (AF 49(638)1159) AD 643564 Unclassified

Also published in Internat'l. Jour. Eng. Sci., v. 3; 47-57, May 1965.

A solution of the axisymmetric Boussinesq problem is derived from which are deduced simple formulas for the depth of penetration of the tip of a punch of arbitrary profile and for the total load which must be applied to the punch to achieve this penetration. Simple expressions are also derived for the distribution of pressure under the punch x and for the shape of the deformed surface. The results are illustrated by the evaluation of the expressions for several simple punch shapes. (Contractor's abstract)

2137

North Carolina State U. [Dept. of Mathematics] Raleigh.

THE STRESS ON THE BOUNDARY OF AN ELASTIC HALF-PLANE IN WHICH BODY FORCES ARE ACTING, by I. N. Sneddon. [1965] [7]p. (AFOSR-66-2113) (AF 49(638)1159) AD 643566 Unclassified

Also published in Proc. Glasgow Math. Assoc., v. 7 (Pt. 1): 48-54, Jan. 1965.

In this paper the problem of determining the stress on the boundary y = 0 of the elastic half plane y 0 when there are prescribed body forces acting in the interior and the boundary is free from applied stress is considered. The Laplace transform is used to calculate the distribution of stress and the form of the displacement vector on the boundary. Also the basic formulas corresponding to an arbitrary distribution of body forces are derived. The forms of surface stress corresponding to 3 special cases are considered, namely, body forces acting in a direction normal to the boundary, point force, and body forces derivable from a potential function. Finally expressions are derived for the components of the surface displacement.

2138

North Carolina State U. [Dept. of Mathematics] Raleigh.

A NOTE ON THE PROBLEM OF THE PENNY-SHAPED CRACK, by I. N. Sneddon. [1965] [4]p. (AFOSR-66-2114) (AF 49(638)1159) AD 643565 Unclassified

Also published in Proc. Cambridge Philos. Soc., v. 61; 609-611, Apr. 1965.

This paper considers the problem of determining the distribution of stress in the neighborhood of a penny-shaped crack. Simple expressions are derived for the calculation of the stress intensity factor and the energy required to open up the crack in terms of a general (axisymmetric) pressure distribution. The solution is based on an elementary solution of a pair of dual integral equations.

2139

North Carolina State U. Dept. of Mathematics, Raleigh.

THE USE OF TRANSFORM METHODS IN ELASTICITY, II, by I. N. Sneddon. June 7, 1965, 118p. incl. diagrs. tables, refs. (AFOSR-65-0875) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-444, Army Research Office (Durham), and Office of Naval Research) AD 466098 Unclassified

The application of the theory of integral transforms is considered for the solution of certain boundary value problems in the classical theory of elasticity. The first chapter is concerned with torsion problems - specifically, the torsional deformation of a half-space, a thick slab, and a semi-infinite cylinder. The physical situation for these problems is particularly simple in that in cylindrical coordinates the displacement vector has only 1 non-vanishing component and the stress vector has only 2. The second chapter is concerned with some dynamical problems. The generation of elastic waves in a body of infinite extent by prescribed body forces is first considered and then the problem of calculating the stress distribution in a half-space or a thick plate due to dynamic loading of the free surfaces.

2140

North Carolina State U. Dept. of Mathematics, Raleigh.

A BOUSSINESQ PROBLEM FOR A FINITE CYLINDER, by D. B. Teague, May 1965, 79p. incl. diagrs. table, refs. (AFOSR-65-1328) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-444, Army Research Office (Durham), National Science Foundation and Office of Naval Research) AD 622525 Unclassified

A Boussinesq problem for a finite clamped cylinder is reduced to a Fredholm integral equation of the second kind with a symmetric kernel using the method of Sneddon-Srivastav. A simple approximate solution for the integral equation is obtained. This solution is accurate to within 3% provided the ratio of the radius of contact of the punch to the radius of the cylinder is less than one-half. Formulas are derived for the normal stress and displacement components, total force on the punch, and penetration of the tip of the punch as quadratures of the solution of the integral equation which are accurate to within 1% provided the ratio of length to radius of the cylinder is greater than unity. The accuracy of all final results is within 4% because of the accuracy of the solution of the integral equation. If the ratio of radius of contact of the punch to the radius of the cylinder is 0.1 or less, the results differ only slightly from the known solutions for the infinite half space.

2141

North Carolina State U. Dept. of Mathematics, Raleigh.

SURVEY OF ARTICLES ON THE APPLICATIONS OF

INTEGRAL TRANSFORMS IN THE THEORY OF ELASTICITY, by Y. S. Uflyand, trans. by W J. A. Whyte, ec. by I. N. Sneddon. Oct. 1, 1965, 402p. incl. diagrs. tables, refs. (AFOSR 65-1556) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR 64-444, Army Research Office [Durham] and Office of Naval Research) AD 475151 Unclassified

A systematic presentation is attempted of methods using integral transforms for solving boundary layer problems in the theory of elasticity. The report contains five parts. Part I: Methods of solution of 2-dimensional problems are developed by applying Fourier transforms to equations stated in cartesian and bipolar coordinates. Part II: The Mellin transform is applied to the basic plane problems for the wedge and to problems of the bending of wedge-shaped plates under various boundary conditions. Part III: Solutions of some classes of 3-dimensional boundary problems of elastic equilibrium are obtained by means of the Hankel transform. Part IV: The Mehler-Fock transform is used for 3-dimensional problems, including mixed problems for the half-space with a circular line dividing the boundary conditions. Part V: The Kontorovich-Lebedev transform is used for such 3-dimensional problems as the second basic problem for the wedge, the equilibrium of an infinite body weakened by a plane cut, and the basic mixed problem for a half-space with a rectilinear line dividing the boundary conditions.

2142

North Carolina State U. Dept. of Mathematics, Raleigh.

CONTACT PROBLEMS IN THE LINEAR THEORY OF VISCOELASTICITY, by G. A. C. Graham. Sept. 10, 1965, 41p. incl. diagrs. refs. (AFOSR-65-1906) (AF AFOSR-64-444) AD 626055 Unclassified

Some well known elastic half space solutions are generalized to encompass arbitrary linear viscoelastic behavior. The viscoelastic material is assumed to be homogeneous and isotropic, and thermal effects are not included. The main part of the survey is devoted to the quasi-static theory whose distinguishing feature is the neglecting of the inertia terms in the equations of motion. Expressions are found for the displacement stress field acting at any point of a viscoelastic half space whose boundary is subjected to an arbitrary time dependent distribution of normal pressure. The solution to the general axisymmetric elastic contact problem given by Sneddon is extended to viscoelasticity theory. Generalizations of the axisymmetric elastic contact problem with friction and Hertz's theory of the contact of smooth elastic bodies are also given. Problems of rolling contact are considered, and some viscoelastic half space problems are solved on the assumption that inertia terms may not be neglected.

2143

North Carolina State U. [Dept. of Mathematics] Raleigh.

THE SOLUTION OF BOUNDARY-VALUE PROBLEMS IN ORDINARY DIFFERENTIAL EQUATIONS EMPLOYING ITERATIVE DIFFERENTIAL ANALYZER EQUIPMENT, by R. E. Showalter. [1965] [7]p. incl. illus diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-444, Army Research Office (Durham), and Office of Naval Research) Unclassified

Published in Simulation, v. 5. 374-380, Dec. 1965.

The application of the iterative differential analyzer to the solution of 2-point boundary-value problems in linear differential equations which possess unique solutions is discussed. Such a boundary-value problem may be solved by varying initial conditions manually until the boundary conditions are satisfied. When it is desired to solve the problem very rapidly, the solution of the boundary-value problem may be only one step of an iteration procedure, therefore, it is logical to let the computer itself duplicate this trial-and-error process, since the frequency responses and repetitive operation speeds presently available make it possible for the analog computer to complete many iterations in the same amount of time an operator can normally complete one cycle by a trial-and-error procedure manually. The task set forth here is to (1) describe a method of iteration that is realizable on the analog computer, (2) verify that the process does yield the desired solution, and (3) determine those factors which control the speed of covergence. To carry out (2) it must be demonstrated that the iteration process does converge and that it converges to the solution of the given problem.

2144

North Carolina State U. [Dept. of Mechanical Engineering]. Raleigh.

THEORY OF NONEQUILIBRIUM THERMODYNAMICS WITH APPLICATION TO THE TRANSPORT PROCESSES IN A SOLID, by M. R. El-Saden. [1965] [5]p. incl. refs. (AFOSR-65-2086) (AF AFOSR-65-80E) AD 627735 Unclassified

Presented at ASME-AIChE Heat Transfer Conf. and Exhibit, Los Angeles, Calif., Aug. 8-11, 1965.

Also published in Jour. Heat Transfer, v. 88: 57-63, Feb. 1965.

The theory of nonequilibrium thermodynamics for inherently irreversible coupled processes is presented and the concept of heat is incorporated appropriately. The theory is applied to the problem of a solid carrying electric and heat currents in the presence of an external magnetic field. The principle of increase of entropy is employed to determine the reversibility or irreversibility of the macroscopic effects involved and to determine the limits on the material's properties. The dynamic equations show that, in the one-dimensional thermoelectric case, the heat current is not coupled to the electrical phenomenon. In 2- and 3-dimensional cases, the heat current is coupled to the electrical phenomenon only through the influence of the external magnetic field. Areas of disagreement with the literature are pointed out and discussed.

2145

North Carolina U. Dept. of Chemistry, Chapel Hill.

CHRONOPOTENTIOMETRIC STUDY OF PHENYLMERCURIC ION ADSORPTION ON A MERCURY ELECTRODE, by R. F. Broman and R. W. Murray. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2364) (AF AFOSR-64-584) AD 629808 Unclassified

Also published in Anal. Chem., v. 37: 1408-1414, Oct. 1965.

Both phenylmercuric ion and the product of its one-electron reduction are strongly adsorbed on a mercury electrode surface. The adsorbed reactant gives rise to polarographic, potential-sweep chronoamperometric, and chronopotentiometric prewaves during which the adsorbed reactant is coulometrically electrolyzed before the diffusing solution reactant is reduced. Adsorption and desorption rates of both reactant and product are slow. A spike on the chronopotentiometric prewave has been interpreted as arising from a relatively slow reorientation process within the adsorbed layer leading to a transient reaction over-potential. (Contractor's abstract)

2146

North Carolina U. Dept. of Chemistry, Chapel Hill.

POLAROGRAPHIC DROP-TIME MEASUREMENT USING AN ALTERNATING CURRENT TECHNIQUE, by J. W. Hayes, D. E. Leyden, and C. N. Reilley. [1965] [2]p. incl. illus diagrs. refs. (AFOSR-65-2764) (AF AFOSR-64-584) AD 627826 Unclassified

Also published in Anal. Chem., v. 37: 1444-1445, Oct. 1965.

The report describes a simple way to trigger an electronic counter to measure the drop time of a dropping mercury electrode using conventional operational-amplifier techniques. The signal from the current amplifier in a conventional operational-amplifier ac polarograph is filtered to remove the dc polarographic current, rectified, and applied to the counter input. The current is of sufficient magnitude over the whole potential range of the dropping mercury electrode even in the absence of depolarizer, to provide sufficient voltage for positive triggering of the counter. Because the counter receives a pulse each time the drop falls, the drop time of every other drop is registered.

2147

North Carolina U. Dept. of Chemistry, Chapel Hill.

OPERATIONAL-AMPLIFIER, ALTERNATING-CURRENT POLAROGRAPH WITH ADMITTANCE RECORDING, by J. W. Hayes and C. N. Reilley. [1965] [4]p. incl. illus. diagrs. table. refs. (AFOSR-65-2765) (AF AFOSR-64-584) AD 627838 Unclassified

Presented at 149th meeting of the Amer. Chem. Soc., Detroit, Mich., Apr. 1965.

Also published in Anal. Chem., v. 37: 1322-1325, Oct. 1965.

An alternating current polarograph, which permits automatic recording of the in-phase and quadrature components of the faradaic admittance, has been designed and constructed. Operational amplifiers are the basis of the instrumentation, but tuned amplifiers have been purposefully avoided. Phase selection is accomplished by multiplication of current and voltage signals by an electronic multiplier. Compensation for the effect of series resistance is made by subtraction of the iR drop from the voltage signal before multiplication using the predetermined value of the series resistance at drop fall. Noise levels have been reduced to a negligible level by the use of solid-state amplifiers in the low-signal level parts of the instrument. Stability is excellent, and results are within the expected limits of dummy-cell components. (Contractor's abstract)

2148

North Carolina U. Dept. of Chemistry, Chapel Hill.

THIN LAYER POTENTIAL SCAN COULOMETRY. DETERMINATION OF METAL IONS AND OF HALIDE IONS USING A MERCURY-COATED PLATINUM ELECTRODE, by D. M. Oglesby, L. B. Anderson and others. [1965] [5]p. incl. diagrs. tables. refs. (AFOSR-65-2766) (Sponsored jointly by Advanced Research Projects Agency, and Air Force Office of Scientific Research under AF AFOSR-64-584) AD 627836 Unclassified

Presented at 149th meeting of the Amer. Chem. Soc., Detroit, Mich., Apr. 1965.

Also published in Anal. Chem., v. 37: 1317-1321, Oct. 1965.

A linear ramp potential excitation was applied to a thin layer electrolysis cell containing a solution of several electroactive substances. The integral of the current response constitutes a coulometric titration of the electroactive species present. The technique, potential scan coulometry, was evaluated by electrolysis of solutions of copper, lead, cadmium, and zinc ions in a 1M KNO_3 medium and precipitation of I^-, Br^-, and Cl^- ions with mercurous ion electrogenerated from a mercury-coated platinum electrode. The technique appears to be particularly suited to rapid analysis of mixtures and of very small amounts of electroactive substance.

2149

North Carolina U. Dept. of Chemistry, Chapel Hill.

DISCRIMINATING EFFECT OF ADSORBED ASYMMETRIC FILM ELECTRODE TOWARD ELECTROACTIVE METAL COMPLEX ENANTIOMERS, by R. W. Murray

and M. Kodama. [1965] [2]p. incl. diagrs. (AFOSR 66-0301) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF AFOSR-64-584) AD 629807 Unclassified

The planned production of differences in the chemical or physical behavior of optical enantiomers requires an interaction with an optically asymmetric environment. Utilization of an optically active electrode surface could provide a route to the electrochemical differentiation of electroactive enantiomeric substances. The communication describes a convenient method for preparation of a useful asymmetric electrode surface and demonstrates, with the chronopotentiometric technique, that the electrochemistry of electroactive enantiomers at such surfaces can be different.

2150

North Carolina U., Dept. of Physics, Chapel Hill.

A PULSED NUCLEAR MAGNETIC RESONANCE APPARATUS WITH CRYOSTAT FOR LOW TEMPERATURE MEASUREMENTS, by C. E. Tarr and L. M. Stacey. 1965, 30p. incl. diagrs. (AFOSR-66-1231) (AF AFOSR-62-336) AD 637841 Unclassified

The report describes the construction and operating procedure of a pulsed nuclear resonance apparatus designed to measure the spin-lattice relaxation times in alkali halide crystals at low temperatures. A description of the cryogenics is included. The transmitter is capable of producing short, fast-rising rf pulses having a broad frequency spectrum and the receiver has a short recovery time. The apparatus as a whole is stable enough to measure the long relaxation times at low temperatures.

2151

North Carolina U. [Dept. of Physics] Chapel Hill.

CURVED SPACE AND GRAVITATION. II, by R. W. Brehme. [1965] [9]p. incl. diagrs. (AF AFOSR-64-153) Unclassified

Published in Amer. Jour. Phys., v. 33: 713-721, Sept. 1965.

The Euclidean and Einstein geodesics are defined for a 2-dimensional space-time surface. Both are shown to approach the same classical law of gravitational acceleration, and to preserve the equivalence principle. However, only the Einstein geodesic allows a local time to be defined in such a way that the local velocity of light is constant. The conical surface is discussed and the connection is made between it and the frame of the uniformly accelerated relativistic rocket. Coordinate transformations are discussed to the extent that it is established that the shape of the 2-dimensional surface embedded in a Euclidean 3-space depends on the choice of coordinate frame. (Contractor's abstract)

2152

North Carolina U. Dept. of Physics, Chapel Hill.

PHOTON BOUND STATES AND GRAVITONS, by G. Papini. [1965] [11]p. incl. refs. (AF AFOSR-64-153) Unclassified

Published in Nuovo Cimento, Series X, v. 39: 716-726, Sept. 16, 1965.

The possibility that a nonlinear photon-photon interaction gives rise to gravitons is investigated. At first photons are treated as neutral vector particles of small finite mass; then as zero-mass particles in the frame of usual gauge-invariant quantum electrodynamics. The corresponding Bethe-Salpeter equations are solved in the chain approximation. Bound states exist which have the required symmetry properties, and correspond to particles with spin two or zero. Of these, only one has zero mass and its phenomenological coupling to photons is, in the approximation considered, entirely dynamical. (Contractor's abstract)

2153

North Carolina U. [Dept. of Physics] Chapel Hill.

DISLOCATIONS AND NUCLEAR PARTICLE TRACKS IN SILVER CHLORIDE CRYSTALS, by C. B. Childs and L. M. Slifkin. [1965] [10]p. incl. illus. refs. (AFOSR-65-2112) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF AFOSR-64-450) AD 629058 Unclassified

Also published in Brit. Jour. Appl. Phys., v. 16: 771-777, 1965.

Defects such as dislocations and the tracks left by energetic charged particles may be made visible inside large crystals of silver chloride by a photoelectric technique, the net result of which is the deposition of metallic silver along the imperfections. The main advantage of this procedure in the study of dislocations is that large regions of the crystal may be observed in the cold-worked state. For the study of cosmic rays and nuclear events, a convenient and distortion-free detector is offered which may be of use in specialized applications.

2154

North Carolina U. [Dept. of Physics] Chapel Hill.

INTERNAL FRICTION OF SILVER CHLORIDE SINGLE CRYSTALS AT HIGH TEMPERATURE (Abstract), by A. Fukai and L. Slifkin. [1965] [1]p (Sponsored jointly by Advanced Research Projects Agency, and Air Force Office of Scientific Research under [AF AFOSR-64-450]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 308, Mar. 24, 1965.

Using the composite oscillator method at 35 kc/sec, the internal friction of silver chloride single crystals has been studied at temperatures up to 380°C. It has been shown that (a) the strain-independent decrement increases monotonically with increasing temperature, with an activation energy of 0.5 ev; (b) the strain-dependent decrement at constant strain amplitude exhibits a broad peak in the temperature range corresponding to the dislocation isoelectric point. This may be understood in terms of the electric charge on the dislocations. Such a charge is compensated by a space charge that produces a potential well. At the isoelectric point, the dislocation is uncharged and can oscillate with larger amplitudes, giving a larger decrement. The temperature dependence of breakaway stress gives approximately 0.23 ev as the effective binding energy of pinning points to dislocations, which agrees with that calculated from the extra concentration of impurity ions on dislocations. Preliminary measurements of the temperature dependence of Young's modulus show a significant nonlinear decrease at high temperatures.

2155

North Carolina U. [Dept. of Physics] Chapel Hill.

VACANCY-FORMATION ENERGY AND CHARGED DISLOCATIONS IN SILVER CHLORIDE (Abstract), by W. McGowan and L. Slifkin. [1965] [1]p. (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under [AF AFOSR-64-450]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 308, Mar. 24, 1965.

Using an indentation technique, the sign of the electric charge carried by dislocations in silver chloride has been determined. An isoelectric temperature is observed in the purer specimens and ranges from 18° to 85°C for a divalent impurity content of 0.3-23ppm. Dislocations are negatively charged below the isoelectric temperature and are positive above it. The voltage pulse observed upon indentation is smooth at lower temperatures but develops structure at temperatures near the isoelectric point, even changing sign several times in the vicinity of the isoelectric point. The room-temperature charge density along the dislocation line is estimated to vary from 2×10^{-5} esu cm in heavily doped material to 6×10^{-6} esu cm in pure material. From the variation of isoelectric temperature with impurity content, the energy of formation of the silver vacancy is estimated to be 0.6 ev. Using the data of Ebert and Teltows on the formation energy of the Frenkel defect, one obtains the formation energy of the silver interstitial to be 0.9 or 1.1 ev, depending on whether or not the association analysis of Ebert and Teltow is used.

2156

North Carolina U. [Dept. of Physics] Chapel Hill.

ELASTIC CONSTANTS OF LiCL, RbCL, and KF AT 4.2°K (Abstract), by A. Lehoczky and C. V. Briscoe. [1965] [1]p. (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under [AF AFOSR-64-645]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 490, Apr 26, 1965.

The elastic constants of LiCl, RbCl, and KF have been measured at 4.2° and 300°K, using an ultrasonic-pulse technique. The elastic constants C_{11} and C_{44} at 4.2°K in units of 10^{11} dyn/cm^2 are C_{11} = 6.692 and C_{44} = 1.897 for LiCl; C_{11} = 4.297 and C_{44} = 0.493 for RbCl; C_{11} = 7.570 and C_{44} = 1.336 for KF. The experimental error in C_{11} and C_{44} is approximately 1%. These elastic constants are compared with the results of several theoretical investigations. The method of de Launay has been used to calculate the Debye-characteristic temperatures at 0°K, θ_0^{el}. These Debye characteristic temperatures are compared with θ_0^c, obtainable from experimental specific heats and theoretical computations.

2157

North Carolina U. [Dept. of Physics] Chapel Hill.

ELASTIC CONSTANTS OF NaF, NaCl, AND NaBr AT 4.2°K (Abstract), by J. T. Lewis, A. Lehoczky, and C. V. Briscoe. [1965] [1]p. (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under [AF AFOSR-64-645]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 44, Jan. 27, 1965.

The elastic constants of NaF, NaCl, and NaBr have been measured at 4.2°, 80°, and 300°K, using an ultrasonic pulse technique. The elastic constants at 4.2°K in units of 10^{11} dyn/cm^2 are C_{11} = 10.85, C_{12} 2.290, and C_{44} = 2.899 for NaF; C_{11} = 5.733, C_{12} = 1.123, and C_{44} = 1.331 for NaCl; C_{11} = 4.800, C_{12} = 0.9796, and C_{44} = 1.070 for NaBr. The experimental error in C_{11} and C_{44} is approximately 1%. In C_{12}, the experimental error is approximately 4%.

These elastic constants are compared with the experimental work of other investigations, the majority of

which have been conducted at temperatures higher than 4.3°K. Comparison is also made with the theoretical calculations of several workers. The method of de Launay Launay has been used to calculate the Debye characteristic temperature at 0°K, θ_0^{el}. At 0°K, θ_0^{el} = 491°5°K for NaF, 321.2°K for NaCl, and 224.6°K for NaBr. The experimental error in θ_0^{el} is less than 1%. These values are compared with θ_0^{c}, obtainable from experimental specific heats and theoretical computations.

2158

North Carolina U. [Dept. of Statistics] Chapel Hill.

ASYMPTOTICALLY OPTIMAL TESTS FOR MULTINOMIAL DISTRIBUTORS, by W. Hoeffding. [1965] [33]p. (AFOSR-67-0681) (AF AFOSR-65-760) AD 648674 Unclassified

Also published in Ann. Math. Stat., v. 36: 369-401, Apr. 1965.

Tests of simple and composite hypotheses for multinomial distributions are considered. It is assumed that the size α_n of a test tends to 0 as the sample size N increases. The main concern of this paper is to substantiate the following proposition: If a given test of size α_n is "sufficiently different" from a likelihood ratio test then there is a likelihood ratio test of size $\leq \alpha_n$ which is considerably more powerful than the given test at "most" points in the set of alternatives when N is large enough, provided that $\alpha_n \to 0$ at a suitable rate. In particular, it is shown that chi-square tests of simple and of some composite hypotheses are inferior, in the sense described, to the corresponding likelihood ratio tests. Certain Bayes tests are shown to share the above-mentioned property of a likelihood ratio test.

2159

North Carolina U. [Dept. of Statistics] Chapel Hill.

TABLES TO FACILITATE FITTING S_u FREQUENCY CURVES, by N. L. Johnson. [1965] [12]p. incl. tables. (AFOSR-67-0683) [AF AFOSR-65-760] AD 648914 Unclassified

Also published in Biometrika, v. 52: 547-558, 1965

The article includes a description of the tables, the method of construction and accuracy of the tables, and an example of their use. Descriptors (curve fitting, Tables), Iterations, accuracy.

2160

North Dakota State U. Coll. of Chemistry and Physics, Fargo.

EXTRACTION OF Fe(III) AND In(III) FROM AQUEOUS HCl BY TRI-n-OCTYLAMINE IN NITROBENZENE, by A. D. Nelson, J. L. Fasching, and R. L. McDonald. [1965] [9]p. incl. diagrs. table, refs. (AFOSR-65-0680) (AF AFOSR-63-65) AD 615073 Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 27: 439-447, 1965.

A study has been made of the distribution of Fe(III) and In (III) between aqueous HCl and solutions of tri-n-octylamine (TOA) in nitrobenzene at trace metal concentrations and under metal loading conditions. The equilibrium between tri-n-octylamine and HCl was also investigated. The equilibrium constant for the reaction TOA + $(HCl)_2$ - TOACHl was found to be 5.6 x 10^6 over the amine salt concentration range 1.7 x 10^{-3}-9.5 x 10^{-2}M; TOACHl appears to be an essentially undissociated ion pair in nitrobenzene. The metal extraction data have been interpreted in terms of the extraction of the tetrachloro metal anions. The possibility of the addition of one or more amine hydrochlorides to the extracted metal species must also be considered; these "extra hydrochlorides' are not bound directly to the metal but, rather, are the result of electrostatic interactions. The results give not only an interesting example of the effect of organic phase ionization on the distribution ratio but also emphasize the hazards of drawing conclusions concerning the metal species extracted from equilibrium extraction data.

2161

Northwestern U. Dept. of Chemistry, Evanston, Ill.

SYMMETRY NUMBERS AND REACTION RATES. II. THE COMPUTATION OF THE REACTION-PATH DEGENERACY FOR BIMOLECULAR REACTIONS, by E. W. Schlag and G. L. Haller. [1965] [4]p. (AFOSR-65-0878) [AF AFOSR-62-83] AD 617829 Unclassified

Also published in Jour. Chem. Phys., v. 42: 584-587, Jan. 15, 1965.

The reaction path degeneracy n is a needed parameter in the computation of a rate constant based on absolute rate theory since it is only partially provided by the symmetry numbers. The previous group theoretical method for deriving n is examined for the case of bimolecular reactions. Furthermore, this method is compared to a direct count of the number of reaction possibilities, and it is seen, by comparison, that there are some difficulties in the application of the direct count method. Some direct count rules are derived which should avoid these difficulties. The computation of equilibrium constants and rate constants for reactions involving optically active species is discussed. (Contractor's abstract)

2162

Northwestern U. Dept. of Chemistry, Evanston, Ill.

ANALYSIS OF RELAXATION PROCESSES IN A MULTILEVEL SYSTEM. A MANY-SHOT EXPANSION TECHNIQUE, by R. V. Serauskas and E. W. Schlag [1965] [10]p. incl. diagrs. tables, refs.

(AFOSR-65-1671) [AF AFOSR-64-524] AD 625602
Unclassified

Presented at 148th meeting of the Amer. Chem. Soc., Chicago, Ill., Sept. 1964.

Also published in Jour. Chem. Phys., v. 42: 3009-3018, May 1, 1965.

The relaxation of a gas of polyatomic molecules, excited to a particular energy is analyzed in terms of a random walk through all relevant energy states to yield the various stable products. The quantum yield is taken as the probability of forming a given one of these products. This relation problem is solved by means of an asymptotic, natural expansion in terms of the events in the process which are physically the most significant. The first term in this many-shot expansion is the strong collision result. For nearly strong collision processes and nonequilibrium systems this many-shot expansion yields a rapidly converging series for an arbitrary ordered set of transition probabilities and hence constitutes a computationally useful solution to the Pauli master equation for such a nonequilibrium system. The relaxation problem is analyzed in terms of some assumed sets of collisional transition probabilities, including a model that assumes statistical equilibration of vibrational energy in every collision complex. It is shown in an application to an actual laboratory system that such a highly efficient model predicts many-shot behavior only slightly stronger than some recently observed experimental results.

2163

Northwestern U. Dept. of Chemistry, Evanston, Ill.

CHEMICAL KINETICS AS A RELAXATION PROCESS IN A MULTILEVEL SYSTEM. II. GENERAL FORMULATION OF THE MANY-SHOT EXPANSION, by R. V. Serauskas and E. W. Schlag. [1965] [5]p. incl. refs. (AFOSR 65-2120) [AF AFOSR-64-524] AD 630211
Unclassified

sented at 149th Nat'l. meeting of the Amer. Chem., Soc., Detroit, Mich., Apr. 1965.

Also published in Jour. Chem. Phys., v. 43: 898-902, Aug. 1, 1965.

The relaxation problem in a nonequilibrium multilevel system weakly coupled to a heat bath can be expressed in terms of a Pauli master equation. It has previously been shown that this relaxation problem can be solved in terms of a many-shot expansion, the leading term being the strong-collision result and further terms being due to weak collisions. It is shown that this many-shot expansion can be derived from a generalized matrix form of the master equation, as well as by the phenomenological approach used previously. A matrix form for a generalized nearest-neighbor model is analyzed and developed in terms of a series which considers the asymptotic contributions of upward transitions in terms of successively less-probable Markov chains. The input for these computations is a complete set of transition probabilities, for which these methods predict the appropriate laboratory observable. Under certain experimental conditions the laboratory observable is particularly sensitive to the weak-collision terms, and it is in this region that one should be able to obtain information about the effect of collisions on the distribution of internal energy. (Contractor's abstract)

2164

Northwestern U. [Dept. of Chemistry] Evanston, Ill.

[MONOENERGETIC PHOTOLYTIC REACTIONS, by E. W. Schlag. Final rept. Oct. 1, 1961 - Oct. 1, 1965 [7]p. (AFOSR-66-0153) (AF AFOSR-64-524) AD 628328
Unclassified

The photolysis of cyclobutanone was investigated. Some work on the mechanism confirmed that it was a simple photolytic decomposition. One of the directly formed products is cyclopropane. Since the light quantum excites cyclobutanone with about 112 kcal/mol, the initially formed cyclopropane will similarly be highly excited. In fact the energy of the cyclopropane can be varied continuously since the wavelength irradiating the cyclobutanone can be varied continuously. Such systems are needed as test cases in the theory of reaction rates. A new way of analyzing rate equations was proposed, for molecular systems that undergo reactions from many quantum levels. Some work in the vacuum ultraviolet region was also done. A high intensity light source in this region, operated by microwaves at high power was developed. With this source and a monochromator, thresholds for ionization of inorganic molecules were measured. Investigations relevant to the theory of absolute reaction rates were also performed.

2165

Northwestern U. [Dept. of Civil Engineering] Evanston, Ill.

VIBRATION OF THIN SHELLS, UNDER INITIAL STRESS, by G. Herrmann, M. Asce, and J. Shaw. [1965] [23]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2484) (AF AFOSR-63-100) AD 628736 Unclassified

Also published in Proc. Amer. Soc. Civil Engineers, Jour. Eng. Mech. Div., v. 91: 37-59, Oct. 1965.

Using a general bending theory of circular cylindrical shells under the influence of initial stress, simple but accurate expressions for the resonant frequency are presented. These expressions are applicable to a wide range of shell parameters. The results are compared with those of previous investigations. Experimental results are also given.

2166

Northwestern U. Dept. of Civil Engineering, Evanston, Ill.

BUCKLING OF A LONG CYLINDRICAL, SHELL

CONTAINING AN ELASTIC CORE, by G. Herrmann and M. J. Forrestal. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-2483) (AF AFOSR-64-100) AD 628702 Unclassified

Presented at AIAA Sixth Structures and Materials Conf., Palm Springs, Calif., Apr. 5-7, 1965.

Also published in AIAA Jour., v. 3: 1710-1715, Sept. 1965.

A long, thin, circular cylindrical shell containing an elastic core, bonded to the inner surface of the shell, is subjected to a uniform external hydrostatic pressure. Stability of equilibrium of the shell is investigated by considering possible neighboring equilibrium states. The loading exerted by the elastic core on the shell in the deformed state is found by solving an associated boundary value problem of the linearized theory of elasticity in the presence of initial stresses. An expression for the buckling pressure of the shell is derived, and results are presented for a wide range of shell and medium parameters. (Contractor's abstract)

2167

Northwestern U. Dept. of Civil Engineering, Evanston, Ill.

MOVING LOAD ON A FLEXIBLY SUPPORTED TIMOSHENKO BEAM, by J. D. Auchenbach and C. T. Sun. [1965] [18]p. incl. diagrs. refs. (AFOSR-66-0119) (AF AFOSR-64-100) AD 631160 Unclassified

Also published in Internat'l. Jour. Solids and Structures, v. 1: 353-370, 1965.

A uniform beam of infinite length is subjected to a force whose point of application moves with constant velocity over the beam. Solutions are obtained that are time invariant in a coordinate system moving with the load velocity. The supporting foundation includes damping effects. The influence of the damping coefficient and the load velocity on the beam response is studied. The limiting case of no damping is included and the various resonance effects are clarified. (Contractor's abstract)

2168

Northwestern U. Dept. of Electrical Engineering, Evanston, Ill.

CLOSED FORM EXPRESSION FOR THE MIE SERIES FOR LARGE, LOW DENSITY, DIELECTRIC SPHERES, by M. A. Plonus and N. Inada. [1965] [2]p. incl. diagr., (AFOSR-65-2340) (AF 49(638)1377) AD 627561 Unclassified

Also published in Proc. IEEE, v. 53: 662-663, June 1965

The Mie series for large dielectric spheres converges very slowly. However, when the relative dielectric constant ϵ of the sphere is close to unity and Δ is small, the Mie series for the backscattering cross section σ can be summed and a closed form expression for σ given. Such calculations are carried out for the backscattering cross section of a low density dielectric sphere with the restriction that $\epsilon - 1 = \Delta \ll 1$. The expression obtained is $\sigma = \pi a^2 \left(\frac{\epsilon - 1}{2}\right)^2 \left| \frac{2ka \cos 2ka - \sin 2ka}{2ka} \right|^2$.

2169

Northwestern U. Dept. of Electrical Engineering, Evanston, Ill.

EQUIVALENCE RELATIONS FOR ECHO AREAS OF DIELECTRIC SOLID CYLINDERS AND CYLINDRICAL SHELLS, by M. A. Plonus. [1965] [4]p. (AFOSR-65-2347) (AF 49(638)1377) AD 629267 Unclassified

Also published in Canad. Jour. Phys., v. 43 1682-1685, Sept. 1965.

An expression, valid at all frequencies, is derived for the echo area of a dielectric cylindrical shell of wall thickness small compared with the shell radius. This is compared with expressions, valid either in the physical optics region or Rayleigh region, for solid dielectric cylinders, and various equivalence relations are obtained.

2170

Northwestern U. [Dept. of Electrical Engineering] Evanston, Ill.

DISTANCE MATRIX OF A GRAPH AND ITS REALIZABILITY, by S. L. Hakimi and S. S. Yau. [1965] [13]p. incl. diagrs., (AFOSR-65-1007) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-98 and Army Research Office (Durham)) AD 614559 Unclassified

Also published in Quart. Appl. Math. v. 22: 305-317, Jan. 1965.

The distances in a linear graph are described by a distance matrix D. The realizability of a given D by a linear graph is discussed and conditions under which the realization of D is unique are established. The optimum realization of D, i.e., the realization of D with "minimum total length", is investigated. A procedure is given by wich a tree realization of D can be found, if such a realization exists. Finally, it is shown that a tree realization, if it exists, is unique and is the optimum realization of D.

2171

Northwestern U. Dept. of Electrical Engineering, Evanston, Ill.

REALIZATION OF THE IMMITTANCE MATRICES OF THREE-TERMINAL NETWORKS WITH TWO KINDS OF

ELEMENTS, by K. C. Wang and S. S. Yau. [1965] [2]p. incl. diagr. (AFOSR-66-0205) (AF AFOSR-63-98) AD 641250 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 438-439, Sept. 1965.

Recently, Lucal and Ozaki considered the synthesis of 3-terminal networks with 2 kinds of elements. Since they are concerned with the exact realization of the transfer function and the 2 driving-point functions, their methods can be applied only to very restricted cases. This note presents a synthesis technique which can realize a large class of 3-terminal short-circuit admittance matrices with 2 kinds of elements.

2172

Northwestern U. Dept. of Electrical Engineering, Evanston, Ill.

SYNTHESIS OF RLC TWO-PORT NETWORKS, by K. C. Wang, and S. S. Yau. [1965] [2]p. incl. diagrs. AFOSR-66-0206) (AF AFOSR-63-98) AD 641263 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12. 437-438, Sept. 1965.

Recently, Forte found that the positive-real condition is sufficient for the realizability of a symmetric matrix of order 2 as the immittance matrix of an RLC 2-port network if the transfer function is realized within a constant multiplier. However, his realization technique requires approximation method and hence is quite complicated. In this correspondence, an alternative realization method which does not require any approximation technique is discussed.

2173

Northwestern U. Dept. of Electrical Engineering, Evanston, Ill.

PROBABILISTIC FLOWS THROUGH A COMMUNICATION NETWORK, by H. Frank and S. L. Hakimi. [1965] [2]p. (AFOSR-66-0207) (AF AFOSR-63-98) AD 641248 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 413-414, Sept 1965.

If the probability of the flow rate F_{ij} between vertices v_i and v_j is given by, e.g $F_{ij} \geq \Pr[\min |A_k| \geq z]$ can be completed, where $|A_k|$ is the value of cut-set A_k obtained by adding the capacities of branches in A_k. It is shown that the above probability can be calculated from $F(z) = \int_z^{\infty} \cdots \int f(a_1, a_2, \cdots, a_q)\, da_1, da_2 \cdots da_q$.

2174

Northwestern U. Dept. of Electrical Engineering, Evanston, Ill.

CUT-SET MATRICES AND LINEAR CODES, by S. L. Hakimi and H. Frank. [1965] [2]p. incl. diagr. table. (AFOSR-66-0208) (AF AFOSR-63-98) AD 624380 Unclassified

Also published in IEEE Trans. Inform. Theory, v. IT-11: 457-458, July 1965.

A method is described for constructing a most efficient code whose generating matrix is a fundamental cut matrix of a graph.

2175

Northwestern U. [Dept. of Electrical Engineering] Evanston, Ill.

OPTIMUM DISTRIBUTION OF SWITCHING CENTERS IN A COMMUNICATION NETWORK AND SOME RELATED GRAPH THEORETIC PROBLEMS, by S. L. Hakimi. [1965] [15]p. incl. diagrs. table. (AFOSR-66-0209) (AF AFOSR-63-98) AD 641266 Unclassified

Also published in Operations Research, v. 13: 462-475, May-June 1965.

The concept of a median in a weighted graph is generalized to a multimedian. Then, it is shown that the optimum distribution of p switching centers in a communication network is at a p-medium of the corresponding weighted graph. The following related problem in highway networks is also considered: what is a minimum number of policemen that can be distributed in a highway network so that no one is farther away from a policeman than a given distance D. This problem is attacked by generating all vertex-coverings (externally stable sets) of a graph by means of a Boolean function defined over the vertices of a graph. Then this idea is extended to Boolean functions that generate all matchings, all factors, and all possible subgraphs of G with given degrees.

2176

Northwestern U. Dept. of Electrical Engineering, Evanston, Ill.

AUTONOMOUS CLOCKS IN SEQUENTIAL MACHINES, by S. S. Yau. [1965] [6]p. incl. diagrs. (AFOSR-65-2349) (AF AFOSR-65-98) AD 629851 Unclassified

Also published in IEEE Trans. Electron. Comput., v. EC-14: 467-472, June 1965.

A necessary and sufficient condition for the existence of an autonomous clock in a sequential machine M is found to be the existence of a nontrivial input-independent partition on the set of internal states of M, no matter whether M is completely specified or

incompletely specified. Two different techniques are given for generating the smallest input-independent partition π^1, from which all other input-independent partitions can be obtained. One is suitable for a sequential machine whose state behavior is specified in the form of a flow table, while the other is convenient for a sequential machine whose state behavior is specified in the form of a connection matrix. Both techniques are efficient, and give all possible assignments to the redundant conditions of an incompletely specified sequential machine to reach the same nontrival input-independent partition, and hence the same autonomous clock. (Contractor's abstract)

2177

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

A GEOMETRIC PROOF OF THE LEBESQUE DIFFERENTIATION THEOREM, by D. Austin. [1965] [2]p. [AF AFOSR-62-350] Unclassified

Published in Proc. Amer. Math. Soc., v. 16: 220-221, Apr. 1965.

An elementary proof is given of the theorem that a function of bounded variation has finite derivative a.e. The argumenis are mainly geometric.

2178

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

COMPACTIFICATION OF HOMOGENFOUS SPACES, I, by R. Hermann. [1965] [24]p. incl. refs. [AF AFOSR-64-512] Unclassified

Published in Jour. Math. and Mech., v. 14: 655-678, July 1965.

The beginning sections of this paper are devoted to proving the following fact which is, according to the author, a main theorem of the paper. A compact manifold of negative Euler characteristics can have no Lie group transitively on it. More precisely, the author proves that if G H is a compact homogeneous space with non-zero Euler characteristic, acted on effectively by a connected Lie group G, then G is a semi-simple group with trivial center and a maximal compact subgroup K of G acts transitively on G H; in particular, the Euler characteristic of G H is positive and, as a homogeneous space of the compact group K, G H is an object whose structure is well known. Moreover, it is shown that a subgroup conjugate to H contains the part AN of the Iwasawa decomposition G = KAN of G, where A is an abelian group and N is a nilpotent group. (Math. Rev. abstract)

2179

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

VANISHING THEOREMS FOR HOMOLOGY OF SUBMANIFOLDS, by R. Hermann. [1965] [5]p. [AF AFOSR-64-512] Unclassified

Published in Jour. Math. and Mech., v. 14: 479-483, May 1965.

Let M be a manifold carrying an affine connection, and f a (real valued) function defined on a neighborhood of a submanifold N. The author proves an equality, at a point which is critical for f | N but not for f itself; between the Hessian form of f | N and the difference of the second fundamental form of N and of the level hypersurface of f. Using Morse theory, 2 typical applications are given. ( ) In a Riemannian manifold M, the Betti numbers (for dimensions above 1) are zero for a hypersurface N admitting uniformly strongly convex functions f, (2) in a complex manifold M with affine connection, the Betti numbers of an n-dimensional submanifold N vanish for dimensions greater than n-), if at least 2) of the eigenvalues of the Levi form are non-negative. (Math. Rev. abstract)

2180

Northwestern U. Dept. of [Metallurgy] and Materials Science, Evanston, Ill.

THE INFLUENCE OF POINT DEFECTS UPON THE COMPRESSIVE STRENGTH OF Ni-Al, by E. P. Lautenschlager, D. A. Kiewit, and J. O. Brittain. [1965] [6]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1995) (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF 49(638)436) AD 626869 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 233: 1297-1302, July 1965.

Compression tests were run in the temperature range of 700° to 900°C on β' phase NiAl intermetallic alloys of several grain sizes. At these temperatures the minimum strengths were observed at the stoichiometric composition. While significant increases in strength occurred in both the low-nickel (vacancy) and high-nickel (substitutional) regions, the highest strengths were found in the high-nickel region. During deformation serrated flow was sometimes observed in the low-nickel alloys. After deformation transgranular cracking and deformation striations were observed in all compositions tested.

2181

Northwestern U. [Dept. of Metallurgy and Materials Science] Evanston, Ill.

GRAIN BOUNDARY SLIDING IN ZINC BICRYSTALS, by N. R. Adsit and J. O. Brittain. [1965] [5]p. incl. illus. diagrs. table, refs. (AFOSR-65-0768) (AF 49(638)780) AD 616045 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 233: 305-309, Feb. 1965.

A number of zinc bicrystal specimens with the grain

boundary loaded in simple shear were plastically deformed in creep in a vacuum at 200°C and under an argon atmosphere at 350°C. The results indicated that the amount of grain boundary sliding at a given time was controlled by the slip in the grains and was proportional to the resolved shear stress on the slip plane. Curves of grain boundary sliding vs time were found to be cyclic with no regular periodicity.

2182

Northwestern U., [Dept. of Metallurgy] and Materials Science, Evanston, Ill

LOW TEMPERATURE CREEP DEFORMATION OF CRYSTALS PARTICULARLY PHENOMENA AT LIQUID HELIUM TEMPERATURES, by J. Weertman. Final rept. Mar. 1, 1960 - Mar. 1, 1965. June 1, 1965, 9p. (AFOSR-65-1484) (AF 49(638)1041) AD 620337
Unclassified

Creep behavior of cadmium and mercury were investigated in the liquid helium temperature range with emphasis on the possible mechanisms of creep. Creep was found to be temperature dependent at all temperatures of investigation down to 1.75°K, and impurities in the metals had no noticeable effects. Activation energies were determined in the range 1.75-30°K and activation volume measurements were carried out. Creep behavior in the liquid temperature range was found to differ little from the usual low temperature creep at higher temperatures. At liquid helium temperatures, however, creep did not follow low temperature theories, but correction could be made by Alefeld's new rate equation for processes at low temperatures. Quantum tunneling effects on creep were found to be unimportant at temperatures above 0.04°K.

2183

Northwestern U., [Dept. of Metallurgy and Materials Science] Evanston, Ill.

OPTICAL-ABSORPTION COEFFICIENTS OF VANADIUM PENTOXIDE SINGLE CRYSTALS, by N. Kenny, C. R. Kannewurf, and D. H. Whitmore. [1965] [1]p. [AF AFOSR-64-635] Unclassified

Presented at meeting of the Amer. Phys. Soc., Columbia U., New York, June 23-25, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 609, June 23, 1965.

The optical-absorption coefficients of orthorhombic V_2O_5 single crystals were evaluated, using incident polarized light over the wavelength range 0.47-1.8μ, and in unpolarized light from 1.5 to 7.5 μ. The intrinsic absorption edges were found to have an exponential dependence on photon energy. Fundamental absorption was observed at incident photon energies of 2.15, 2.22, and 2.17 ev for E a, E b and E c, respectively. Some evidence for a direct forbidden transition mechanism with bandgaps of 2.36 and 2.34 ev was observed for E a and E c, respectively. A double absorption peak was observed for the polarization E a; the major peak occurs at 1.00 μ and the minor peak at 0.83 μ. Since this peak is completely missing in the absorption spectra when E b and E c, the mechanism associated with the absorption peak for E a must itself be optically anisotropic. This double peak is associated with nonstoichiometric defects that act as donors.

2184

Northwestern U. [Dept. of Physics] Evanston, Ill.

THE MEASUREMENT OF VISCOSITIES OF GASES AT PRESSURES UP TO 1000 ATM, by G. Thodos. Final rept Sept. 1, 1962 - Jan. 31, 1965. Apr. 30, 1965, 2p. (AFOSR-65-1240) (AF AFOSR-63-45)
Unclassified

Viscosity measurements were made for nitrogen and the inert gases, helium, neon, argon, krypton, and xenon in their gaseous state for pressures up to 10,000 psia and temperatures of 50, 100, 150, and 200°C. Viscosity measurements were also made at the same temperatures on the binary systems methane-tetrafluoromethane up to 6000 psia and methane-carbon dioxide up to 10,000 psia. Pure substances not possessing excessive quantum deviations show a unique relationship when the residual viscosity, normalized with the viscosity parameter, is related to the reduced density. Substances possessing significant quantum deviations do not exhibit any unique behavior but show temperature dependence.

2185

Northwestern U. Gas Dynamics Lab., Evanston, Ill.

AN EXPERIMENTAL DETERMINATION OF THE THERMAL AND ELECTRICAL CONDUCTIVITY OF ATMOSPHERIC ARGON PLASMA, by C. F. Knopp. Jan. 1965. 202p. incl. illus. diagrs. tables, refs. (Rept. no. B-1-65) (AFOSR-65-1338) (AF 49(638)879) AD 621213
Unclassified

A wall stabilized arc was used to produce an equilibrium, cylindrically symmetric, arc plasma column. It was demonstrated that axial temperature gradients are negligible over a significant length of the plasma column, thus verifying the assumption that, at low flow rates, convective heat losses are not important for this type of device. A technique was developed to determine the electrical conductivity of argon as a function of temperature from the arc currents, voltage gradients, and the measured temperature profiles in the temperature range 8, 5000°K to 12, 000°K. Using measured temperature profiles, calculated radiated power, and experimentally verified electrical conductivity, the thermal conductivity of argon was determined for the same temperature range. The data were in good agreement with predicted results.

2186

Northwestern U. Gas Dynamics Lab., Evanston, Ill.

MICROWAVE DETERMINATION OF ANISOTROPIC PLASMA ELECTRON DENSITY PROFILES, by R. C. Warder, Jr. and D. L. Hector. Aug. 1965. 143p. incl. diagrs. tables. (Rept. no. B-3-65) (AFOSR-65-2215) (AF AFOSR-63-329) AD 627267 Unclassified

A method for the determination of the spatial electron density distribution in plasmas subjected to external magnetic fields is presented. The method involves the measurement of the Faraday rotation angle as a function of the external magnetic field strength. Results of calculations of normalized Faraday rotation angle versus normalized electron cyclotron frequency for various assumed electron density distributions are given. (Contractor's abstract)

2187

Northwestern U. Gas Dynamics Lab., Evanston, Ill.

MICROWAVE DIAGNOSTICS OF ARC-HEATED NITROGEN AND AIR PLASMAS, by H. M. Waller. Aug. 1965, 43p. incl. illus. diagrs. refs. (Rept. no. B-2-65) (AFOSR-66-0363) (AF AFOSR-63-329) AD 628918 Unclassified

Electrical properties of arc-heated nitrogen and simulated air plasma flows were studied using microwave diagnostic techniques. The plasmas were produced by running nitrogen through a commercial plasma jet with a supersonic nozzle attached downstream. Oxygen is mixed with the nitrogen plasma just upstream of the throat of the supersonic nozzle in order to produce the simulated air plasma. Electron densities and collision frequencies were determined from measurements of the phase shift and attenuation of E-band microwaves transmitted through the plasma. The microwave frequencies used were 76.9 and 82.4 kMc and for both air and nitrogen plasmas the following properties were determined: electron density, attenuation constant, and collision frequency. These properties are presented as functions of h_{gas}, a measure of the electrical power input to the plasma, which ranged up to 36 kw. The experimental results are compared with available theoretical predictions and qualitative agreement is found.

2188

Northwestern U. [Gas Dynamics Lab.] Evanston, Ill.

THERMOPHYSICAL PROPERTIES OF PLASMAS (Abstract), by D. P. Aeschliman, D. A. Freiwald and others. [1965] [2]p. (Bound with AFOSR 65-1266; AD 622527) (AF AFOSR-63-329) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

A study to determine the thermophysical properties of argon; air and nitrogen plasmas is being pursued along 2 lines, namely, (1) the experimental measurement of magnetoplasmas, and (2) the analytical prediction of plasma flows, using a system to obtain simultaneous photographs in perpendicular directions of seed particles in the laminar-flow arc, from which the velocity profile and the velocity gradient may be found. Also under construction is a pressure-drop measuring system. If the velocity and pressure gradients are known, the viscosity can be determined. Preliminary investigations of plasmoid-shock wave interactions are underway comparing results obtained through head-on and transverse interactions between a shock wave generated in an EM shock tube and a plasmoid in argon, air and nitrogen. Doppler shift and microwave interferometer systems are being developed to investigate an apparent precursor effect ahead of the plasmoid. A spectrographic analysis of the plasmoids and the interactions is also being considered.

2189

Northwestern U. Information-Processing and Control Systems Lab., Evanston, Ill.

DELTA MODULATION IN FEEDBACK CONTROL SYSTEMS, by G. J. Murphy and G. Shuraym. [1965] [4]p. incl. diagrs. (AFOSR-65-2348) (AF AFOSR-63-270) AD 629664 Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill Oct. 25-27, 1965.

Also published in Proc. Nat'l. Electronics Conf., v. 21: 609-612, 1965.

The purpose of this paper is to demonstrate that techniques that have previously been used for the analysis and the design of feedback control systems can be employed successfully also in the analysis and the design of delta-modulation data-transmission systems. It was shown that a delta-modulation data-transmission system is equivalent to a single-loop sampled-data relay control system in the absence of disturbances. The model of such a system is shown. In addition, it was stated that systems of this kind can not, in general, be made stable in the sense of Liapunov merely by appropriate choice of G(s) and H (s), and that, for such a system to be asymptotically stable in the sense of Lagrange, in the absence of an input signal, it is necessary and sufficient that all of the poles of sG (s)H (s) have negative real parts.

2190

Northwestern U. Information-Processing and Control Systems Lab., Evanston, Ill.

THE USE OF LUR'E FORMS TO ESTABLISH A SUFFICIENT CONDITION FOR STABILITY OF A CLASS OF DISCRETE FEEDBACK SYSTEMS WITH PARALLEL NONLINEAR ELEMENTS, by G. J. Murphy and S. H. Wu. [1965] [9]p. incl. diagr. refs. (AFOSR-65-2429) (AF AFOSR-63-270) AD 627944 Unclassified

Also published in Proc. 1965 Joint Automatic Computor Conf., Session 25: 755-763, 1965.

A lur'e form of Liapunov function is used to establish a sufficient condition for stability of a class of discrete feedback systems with parallel nonlinear elements.

2191

Notre Dame U. Dept. of Chemistry, Indiana.

CONFORMATIONAL ANALYSIS IN MOBILE CYCLOHEXANE SYSTEMS, by E. L. Eliel. [1965] [14]p. incl. diagrs. table, refs. (AFOSR-65-2389) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-772], Army Research Office (Durham), National Science Foundation, and Petroleum Research Fund) AD 628454 Unclassified

Also published in Angew. Chem., v. 4 761-774, 1965.

By 'conformational analysis' is meant the analysis of the physical and chemical properties of a compound in terms of its preferred 'conformation', i.e. rotational arrangements about single bonds. This particular review deals with cyclohexanoid compounds capable of existing in 2 or more stable conformations.

2192

Ohio State U. Dept. of Chemistry, Columbus.

REACTIONS OF 1, 4-DICHLORO-1-BUTENES WITH MAGNESIUM, A NEW CYCLOBUTENE SYNTHESIS, by M. S. Newman and G. Kaugars. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-66-0319) (AF AFOSR-64-569) AD 629838 Unclassified

Also published in Jour. Org. Chem., v. 30: 3295-3233, Oct. 1965.

The reactions of trans-1, 4-dichloro-1-phenyl-1-butene (I) and cis-1, 4-dichloro-1, 2-diphenyl-1-butene (II) with magnesium in ether afford 1-phenylcyclobutene (III) and 1, 2-diphenylcyclobutene (VIII) in 5-46 and 90% yields, respectively. A study of the reaction products from I indicates that the reaction of I to form the vinyl Grignard reagent is more rapid than that to form primary Grignard reagent. Evidence that vinyl Grignard reagents do not maintain stereochemical identity is presented.

2193

Ohio State U. Dept. of Chemistry, Columbus.

THE SOLVENT EFFECT IN THE REACTION OF BENZALDES-OXYBENZOIN WITH PHOSPHORUS PENTACHLORIDE, by M. S. Newman and G. Kaugars. [1965] [4]p. incl. diagrs. refs. (AFOSR-66-0320) (AF AFOSR-64-569) AD 629837 Unclassified

Also published in Jour. Org. Chem. v. 30: 3105-3108, Sept. 1965.

Reaction of benzaldesoxybenzoin (I) with phosphorus pentachloride in methylene chloride led to a mixture of products from which 1-chloro-2, 3-diphenylindene (V) was obtained in 30% yield. In a similar reaction in carbon tetrachloride a different mixture of products was obtained from which 3, 3-dichloro-1, 3-triphenylpropene (VII) was isolated in 47% yield. These results are discussed in the light of the fact that phosphorus pentachloride is monomeric in methylene chloride and dimeric in carbon tetrachloride.

2194

Ohio State U. Dept. of Chemistry, Columbus.

PHOTOCHEMICAL TRANSFORMATIONS OF A β, γ-EPOXY KETONE, by A. Padwa. [1965] [3]p. incl. diagrs. refs. (AFOSR-66-0296) (AF AFOSR-65-820) AD 629833 Unclassified

Also published in Jour. Chem. Soc., v. 87: 4205-4207, Sept. 10, 1965.

The light-induced β-γ epoxy ketone rearrangement of trans-1, 4-diphenyl-3, 4-epoxy-butan-I-one to dibenzoylethane has been studied. In addition to dibenzoylethane, 1-hydroxy-1, 2-diphenyl-3, 4-epoxy cyclobutane was formed. The formation of the epoxy cyclobutanol may be considered to be analogous to the formation of cyclobutanols from the irradiation of aliphatic ketones containing γ-hydrogens. The isolation of both compounds adds strong support for Yang's stepwise mechanism.

2195

Ohio State U. Dept. of Chemistry, Columbus.

PHOTOLYTIC DESULPHURIZATION OF DIBENZOYLSTILBENE EPISULPHIDE, by A. Padwa and D. Crumrine. [1965] [2]p. incl. diagrs. refs. (AFOSR-66-0297) (AF AFOSR-65-820) AD 629834 Unclassified

Also published in Chem. Commun., No. 21: 506-507, Nov. 10, 1965.

A description is given of the photo-extrusion of sulphur from dibenzoylstilbene episulphide (I) by ultraviolet light filtered through Pyrex glass. Irradiation of (I) afforded a mixture of cis-and trans-dibenzoylstilbene (II and III) in high yield. The photodesulphurization is markedly stereospecific. Consideration of the isomeric distribution of the olefin obtained in a number of photolyses and the irradiation time demonstrated at least 90% stereo-selective removal of sulphur from (I) to give (III). The loss of sulphur from the episulphide upon photolysis is most simply explained by assuming a cleavage of the C(α)-S bond of the 3-membered ring followed by loss of atomic sulphur.

2196

Ohio State U. Dept. of Chemistry, Columbus.

THE PHOTOCHEMICAL DECOMPOSITION OF α-DIAZOACETOPHENONE IN HYDROXYLIC SOLVENTS, by A. Padwa and R. Layton. [1965] [4]p. incl. table. (AFOSR-66-0298) (AF AFOSR-65-820) AD 629835 Unclassified

Also published in Tetrahedron Ltrs., v. 26: 2167-2170, 1965.

The photolysis of α-diazoacetophenone in hydroxylic solvents gave esters of phenylacetic acid and acetophenone. It was possible to generate the triplet keto carbene by selectively activating Michler's ketone in the presence of α-diaxoacetophenone by using a uranium glass filter. The sensitized photochemical decomposition in iso-propyl alcohol produced a species showing little tendency to undergo the Wolff rearrangement. These results suggest that the singlet keto carbene is the precursor of the rearranged ketone.

2197

Ohio State U. [Research Foundation] Behavioral Sciences Lab., Columbus.

LABORATORY SIMULATION OF A POLICE COMMUNICATION SYSTEM UNDER STRESS, by T. E. Drabek.

1965, 311p. incl. diagrs. tables, refs. (AFOSR-65-1714) (AF AFOSR-65-572) AD 621192 Unclassified

A laboratory simulate of the communication system of a metropolitan police organization was constructed to (1) analyze organizational stress, (2) explore the utility of realistic simulation as a technique for the analysis of complex organizations, and (3) test selected aspects of the theoretical framework by subjecting the constructed simulate to stress. The simulate involved 4 police officers and 26 simulators. It was found that the simulate behaved exactly as its real counterpart. The central hypothesis of the framework was supported, i.e., if there is organizational stress, then there will be change in organizational performance structure.

2198

Ohio State U. Research Foundation. Dept. of Aeronautical and Astronautical Engineering, Columbus.

FORMATION OF DETONATION WAVES IN FLOWING COMBUSTIBLE GASEOUS MIXTURES, by L. E. Bollinger, G. C. Smith and others. Final rept. Dec. 1, 1962- Jan. 31, 1965. Apr. 22, 1965, 7p. (Rept. no. 1574) (AFOSR-65-1051) (AF AFOSR-63-203) AD 618200 Unclassified

Detonation induction distances were measured in hydrogen-oxygen and methane-oxygen mixtures flowing at various velocities through a 9 stainless steel tube, 9 mm inside diam. The linear flow velocities of the gas mixture ranged from 0-100 m/sec in hydrogen-oxygen mixtures. Some experiments were conducted at 5 atm initial pressure. Experiments with methane-oxygen mixtures were carried out at 1 atm only; the initial velocities of these mixtures ranged from 0-30 m/sec. It was found that the formation of detonation waves in flowing combustible gaseous mixtures is dependent upon the initial pressure and the intensity of turbulence present in the gases. As the initial pressure is raised, the effect of turbulence becomes less pronounced. Higher turbulence levels cause an effective decrease in the quenching diam as indicated in these experiments. Higher flow rates for a methane-oxygen mixture (50% fuel) insure positive ignition and positive measurement of flame propagation rates.

2199

Ohio State U. [Research Foundation] Dept. of Aeronautical and Astronautical Engineering, Columbus.

DETONABILITY OF COMBUSTABLE MIXTURES, by L. E. Bollinger. [1965] 33p. incl. refs. (AFOSR-66-0342) (AF AFOSR-65-203) AD 630641 Unclassified

Presented at the Fifth Annual National Conf. on Environmental Effects on Aircraft and Propulsion Systems, Princeton, N. J., Sept. 20-22, 1965.

A limited review is given of experimental and theoretical research on the formation of detonation waves in combustible gaseous mixtures. The initiation, propagation, and transition problems were studied in some detail.

2200

Ohio State U. [Research Foundation. Dept. of Physics and Astronomy] Columbus.

RESEARCH ON ROTATING R-F FIELD PLASMA (Abstract), by M. L. Pool [1965] [1]p. (Bound with AFOSR-65-1266; AD 622527 (AF AFOSR-65-202) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Hydrogen and deuterium gases in a magnetic bottle 30 in. long have been excited by revolving magnetic and rotating electric fields produced by a 2-phase 6-kw oscillator operated at the ion cyclotron frequency of 4.2 mc/sec. The 2-phase system put a rotation quasi-current through the center of the plasma region. When the system is operated at the cyclotron frequency, the ions walk toward the center of the plasma. A 30-joule ruby laser beam was pulsed through the central region in order to produce Thomson scattering. Interference filters were used instead of a monochrometer. At 14 μ an electron density of 10^{13} cm^{-3} was measured in the central plasma region by the laser technique. A cooled solid state silicon detector in conjunction with a 200-channel pulse height analyzer was used to estimate the energy of the electrons emerging from the ends of the magnetic bottle. The shielding of the potential by the exciting quasi-current producing coils has offered considerable difficulties. It is proposed that this problem can best be solved by using a system of ferrite type magnets.

2201

Ohio State U. [Research Foundation. Dept. of Physics and Astronomy] Columbus.

THOMSON SCATTERING OF LASER LIGHT FROM A PLASMA (Abstract), D. R. Sigman, J. F. Holt, and M. L. Pool. [1965] [1]p. [AF AFOSR-65-202] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 226, Feb. 25, 1965.

Electron densities in a 4-mc/sec ion-cyclotron resonance heated plasma contained in a magnetic-mirror system have been determined by measuring the 90° Thomson scattering from a 20-J pulsed ruby-laser beam. The measurements were localized to a 1-cm^3 volume at the geometrical center of the plasma bottle. Densities as low as 10^{13} cm^{-3} could be measured. These measurements were made possible by the use of low-noise electronics. In addition, stray scattered laser light entering the light-detection system from the walls and windows of the plasma bottle was minimized. Calibration of the system was made by measuring the Rayleigh scattering from air at several pressures. The Rayleigh scattering was linear with

pressure; and, for equal gas pressures, the ratio of the Rayleigh scattering for air to that of hydrogen satisfied the index of refraction relationship. The Thomson scattering from the hydrogen plasma was found to be linear with the power input into the 4-mic sec oscillator. The maximum power used was 6 kw.

2202

Ohio State U. [Research Foundation. Dept. of Physics and Astronomy] Columbus.

TWO-PHASE RADIOFREQUENCY HEATING OF A PLASMA CONFINED IN A MAGNETIC-MIRROR SYSTEM (Abstract), by E. E. Hagenlocker, J. F Holt and others. [1965] [1]p. [AF AFOSR-65-202] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 207, Feb. 25, 1965.

A radiofrequency coil configuration that induced a rotating electric field and revolving magnetic field was constructed for this experiment. This coil configuration was used in conjunction with a magnetic-mirror system capable of confining 30-kev deuterons. In this properly phased revolving magnetic field and rotating electric field, an ion in phase with the rotating electric field would drift, in theory, toward the axis about which the electric field was rotating. The proper phasing of the 2-phase system made a considerable difference in the properties of the plasma generated. The observed electron densities at a deuteron gas pressure of 1 and 14 μ indicated ion cyclotron resonance. For a deuterium gas pressure of 14 μ the electron density and light emitted increased as the axial magnetic field was decreased because of increased heating of the free electrons.

2203

[Ohio State U. Research Foundation. Dept. of Psychology, Columbus.]

THE AMERICAN NEGRO. A PROBLEM IN EXPECTANCIES, by H. M. Lefcourt and G. W. Ladwig. [1965] [4]p. incl. tables, refs. (AF 49(638)317) Unclassified

Published in Jour. Personality and Social Psychol., v. 1: 377-380, Apr. 1965.

This study dealt with differences between Negro and white inmates in their expectancies that events are internally or externally controlled. Sixty white and 60 Negro inmates from correctional institutions were compared on 3 scales pertinent to the internal-external control dimensions, and on 3 performance variables from Rotter's Level of Aspiration Board task. On all measures Negroes revealed greater expectancy of control being external The results have implications for interpreting the frequently observed differences between white and Negro intelligence test performance and achievement striving (Contractors' abstract)

2204

[Ohio State U. Research Foundation. Dept. of Psychology, Columbus.]

THE EFFECT OF REFERENCE GROUP UPON NEGROES TASK PERSISTENCE IN A BIRACIAL COMPETITIVE GAME, by H. M. Lefcourt and G. W. Ladwig. [1965] [4]p. incl. tables, refs. (AF 49(638) 317) Unclassified

Published in Jour. Personality and Social Psychol., v. 1: 668-671, June 1965.

This study concerns Negro Ss' avoidance tendencies in competitive achievement tasks. It was predicted that Negro Ss would not show avoidance behavior if they had higher expectancies of being able to gain reinforcements for their efforts. Three groups of Negro reformatory inmates played a competitive game with white stooges who won continuously. One group, designated the high-expectancy group, was comprised of jazz musicians who had been led to believe that the game was related to personal skills of musicians. This group persisted significantly longer than either of 2 control groups. The latter demonstrated the more typical failure-avoidance characteristic of Negroes in previous research. (Contractors' abstract)

2205

[Ohio State U. Research Foundation. Dept. of Psychology, Columbus.]

RISK TAKING IN NEGRO AND WHITE ADULTS, by H. M. Lefcourt [1965] [6]p. incl. tables, refs. (AF 49(638)317) Unclassified

Published in Jour. Personality and Social Psychol., v. 2: 765-770, Nov. 1965.

Thirty Negro and 30 white adult males performed in a risk-taking experiment. Contrary to previous findings in skill-demanding tasks, Negroes demonstrated more behavior reflecting an internal control orientation than whites in the gambling situation under study. Negroes chose less low probability bets, made less shifts of bets, and generally took less risks than whites. The perception of Negroes that success in conventional tasks is controlled by forces other than their own efforts is apparently reversed in games of chance. The inference follows that environmental changes in the opportunity structure will contribute toward more of an internal control orientation among Negroes. (Contractors' abstract)

2206

Ohio State U. [Research Foundation. Dept. of Psychology] Columbus.

INTERNAL VERSUS EXTERNAL CONTROL OF

REINFORCEMENT AND DECISION TIME, by J. B. Rotter and R. C. Mulry. [1965] [7]p. incl. table, refs. (AFOSR-66-1151) (AF 49(638)741) AD 640784 Unclassified

Also published in Jour. Personality and Social Psychol., v. 2: 598-604, Oct. 1965.

Previous research has shown generality of individual differences in an expectancy that reinforcement is contingent on one's own behavior (internal control) an expectancy that reinforcement is determined by luck, chance, fate or powerful others (external control). The hypothesis was investigated that "internals' and 'externals' differ in the value placed on the same reward, depending upon whether it is perceived as contingent upon chance or skill. To test this, decision time was measured in a difficult matching test, and described to 1/2 the Ss as skill, and to 1/2 as chance determined. Results show significant interaction between internal-external control and chance v skill instructions. As hypothesized, internals take longer with skill instructions, externals with chance instructions. The study extends the construct validity of the internal-external control variable and has implications for personality, cultural differences, and decision theory.

2207

Ohio State U. Research Foundation Dept. of Psychology, Columbus.

PRIMER FOR PRODUCTIVITY, by H. B. Pepinsky, K. E. Weick, and J. W. Riner. [Final rept.] Mar. 1965, 66p. incl. diagrs. tables, refs. (In cooperation with Purdue U., Lafayette, Ind.) (AFOSR-65-0491) (AF AFOSR-62-339) AD 617956 Unclassified

A systematic and empirical case is made for the observing and interpreting, by a spectator, of the productivity of persons who hold membership in utilitarian organizations within American society. First, a metatheory of work in organizational environments, introducing key concepts for the spectator and differentiating between spectator and participant definitions of the work situation, is offered. This is followed by a definition of productivity, which again meaningfully differentiates between the causally textured definitions of spectators and participants and between such participant definitions as those of superordinate and subordinate persons. Testable propositions concerning work and its accomplishment are advanced. Second, a formal spectator's definition of organization, utilizing key concepts and definitions from the foregoing discussion, is presented. Third, an empirical case, which illustrates how key ideas can be applied to the study of organizations, is given. And finally, the authors pose a number of issues about organizational behavior, suggested by a comparison of their ideas with those of other investigators.

2208

Ohio U. [Dept. of Physics] Athens

[ELEMENTARY PARTICLE PHYSICS] by B. A. Munir Final rept. Mar. 1965, 9p. incl. illus. refs. (AFOSR-65-0601) (AF AFOSR-63-198) Unclassified

The 4.65 bev/c π^- p experiment was completed in collaboration with BNL. Studies of proton-proton interactions at 2 bev have been completed. Work was done on π^+-p scattering at 960 mev/c. The π^--p experiment at 7 bev c using the BNL 80" hydrogen bubble chamber at the AGS was performed in December 1964. Design work was done for an automatic measuring and gap counting machine for bubble chamber photographs. To aid in design work, the High Energy Physics group has a small machine shop and an electronics shop exclusively for this group, in addition to the shop facilities available in the Physics Department.

2209

Oklahoma State U. Dept. of Chemistry, Stillwater.

A CONVENIENT SYNTHESIS OF ESTERS OF DIPHENYLPHOSPHINIC ACID. III, by K. D. Berlin, T. H. Austin, and M. Nagabhushanam. [1965] [2]p. incl. tables, refs. (AFOSR-65-1261) (AF AFOSR-65-132) AD 621263 Unclassified

Also published in Jour. Org. Chem., v. 30: 1267-1268, 1965.

A report is made of the synthesis of several new phosphinates of the type $(C_6H_5)_2P(O)OR$, which involves a reaction between diphenylphosphinic chloride and the corresponding alcohol in the presence of triethylamine in ether. The method is superior to others with respect to simplicity of isolation of relatively pure products and with respect to yields of esters. Data from IR analyses and nuclear magnetic resonance examinations are given.

2210

Oklahoma State U. Dept. of Chemistry, Stillwater

GAS CHROMATOGRAPHIC ANALYSES OF ORGANOPHOSPHORUS COMPOUNDS USING A HYDROGEN FLAME IONIZATION DETECTOR. THE USE OF CHROMOSORB GAS A SOLID SUPPORT, by K. D Berlin, T. H. Austin and others. [1965] [4]p. incl. diagrs. tables. (AFOSR-65-2047) (AF AFOSR-65-132) AD 627734 Unclassified

Also published in Jour. Gas Chromatog., v. 3: 256-259, Aug. 1965.

The analyses of several classes of organophosphorus compounds are described. Some of the problems usually associated with the chromatography of these compounds are evaluated and methods used to circumvent these difficulties are discussed. This report arose as a result of an attempt to analyze, both qualitatively and quantitatively, several different types of reaction mixtures containing phosphorus compounds. Results indicate that commercially available equipment (gas chromatograph and packed columns) is sufficient, without modification, to give good resolution and rapid

analysis of a large variety of organophosphorus substances.

2211

Oklahoma State U. Dept. of Chemistry, Stillwater.

THE PYROLYSIS OF ALKYL DIPHENYLPHOSPHINATES, by K. D. Berlin and T. H. Austin. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-2048) (AF AFOSR-65-132) AD 627953 Unclassified

Presented in part at Tetrasectional Meeting of the Amer. Chem. Soc., Bartlesville, Okla. Mar. 1965.

Also published in Jour. Org. Chem., v. 30: 2745-2748, Aug. 1965.

Examination of the thermal decomposition of a series of alkyl esters of diphenylphosphinic acid indicates the pyrolysis occurs smoothly to give olefins in essentially quantitative conversions. A mechanism for the thermal transformation is postulated to involve a cyclic transition state.

2212

Oklahoma U. [Dept. of Mathematics] Norman.

SUFFICIENT CONDITIONS FOR GLOBAL EXTREMA IN THE CALCULUS OF VARIATIONS, by G. M. Ewing. [1965] [4]p. (AFOSR-66-0038) (AF AFOSR-63-211) AD 641453 Unclassified

Also published in Jour. Astronaut. Sci., v. 12: 102-105, Fall 1965.

This paper exhibits two types of sufficiency theorems, of the following kind: Given a real-valued function J on a suitable class Y of vector-functions $y = (y^1, \ldots, y^n)$, show that a particular y_0 in Y satisfies the relation:

$$J(y_0) \leq J(y) \quad \text{for all } y \in Y.$$

2213

Oklahoma U. Dept. of Physics, Norman.

LIFETIME STUDIES OF THE RADIATIVE DISSOCIATION OF EXCITED H_2, by R. G. Fowler and T. M. Holzberlein. [1965] [2]p. incl. diagr. (AFOSR-65-2879) (AF 49(638)1404) AD 628348 Unclassified

Also published in Jour. Chem. Phys., v. 42: 3723-3724, May 15, 1965.

The lifetime, τ in nsec, of the continuum radiation accompanying the transition $a^3\Sigma_g^+ - b^3\Sigma_u^+$, in molecular H was found to be independent of wavelength, 3000-6500A, but affected by pressure, p, in the range 0.02-20 mm, approx. according to the equation $\tau = (36 + 9.3p)/(1 + 0.83p)$. This time refers to the shortest or first decay process. A binary collision process, with a cross section of 1.8×10^{-15} cm^2 is implied by this p dependence. The saturation at high p may be spurious. The molecules (presumably at 1200°K) were excited by monoenergetic electrons (100 ev). Also observed was a much longer duration decay, not pressure sensitive, with a lifetime of 450 ± 100 nsec. The relative initial intensities of the 2 processes shifted from 4(slow): 1 (fast) at low p to 1:1 at high p. Absolute intensities of both processes increased with p.

2214

Oklahoma U. [Dept. of Physics] Norman.

LIFETIME OF THE 3^1P STATE OF HELIUM, by R. G. Fowler, T. M. Holzberlein, and C. H. Jacobson. [1965] [2]p. incl. diagr. (AFOSR-66-0284) (AF 49(638) 1404) AD 630095 Unclassified

Also published in Phys. Rev., v. 140: A1050-A1051, Nov. 15, 1965.

The pressure dependence of the lifetime of the helium transition $3^1p - 2^1s$ over a wide range of pressure, ranging from free escape to complete blockading. The values of lifetimes so obtained are in good agreement with theory. At pressures beyond 1 mm Hg, quenching is observed corresponding to a probable molecular formation. (Contractors abstract)

2215

Oklahoma U. [Dept. of Physics] Norman.

DISSOCIATION OF MOLECULAR HYDROGEN BY ELECTRON IMPACT, by S. J. B. Corrigan. [1965] [6]p. incl. diagrs. refs. (AFOSR-66-1446)(AF 49(638) 1404) AD 640785 Unclassified

Also published in Jour. Chem. Phys., v. 43: 4381-4386, Dec. 15, 1965.

The dissociation of molecular hydrogen by electron impact was studied by observing the rate of pressure decrease in a closed system when the dissociation fragments were trapped on molybdenum trioxide. An onset potential of 8.8 (± 0.2) ev was obtained, indicating that a large part of the dissociation must proceed through direct excitation of the repulsive $b\,^3\Sigma_u^+$ state of the molecule. From the onset potential to 95 ev, the upper energy limit of the observations, the dissociation rate increased rapidly at first, then more slowly above 14 ev passing through a flat maximum at 40 ev and then slowly decreasing up to the highest energy investigated. Reasons are given for supposing that the observed cleanup of hydrogen at high electron energies contains an effect due to dissociative neutralization of molecular ions. With this assumption the cross section for excitation of the molecule to triplet states is derived by subtracting the molecular ionization cross section from the observed total dissociation cross section. In this way a cross section is obtained for dissociation into neutral atoms which has a maximum of 9×10^{-17} cm^2

at an energy of 16.5 ev, followed by a rapid decrease with increasing electron energy. (Contractor's abstract)

2216

Oklahoma U. [Dept. of Physics] Norman.

MEASUREMENT OF THE DISSOCIATION CROSS SECTION OF MOLECULAR HYDROGEN BY ELECTRON IMPACT (Abstract), by S. J. B. Corrigan. [1965] [1]p. [AF 49(638)1404] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 158, Feb. 25, 1965.

Dissociation of molecular hydrogen by slow electrons was studied by observing the rate of pressure decrease in a closed system when the dissociation fragments were trapped on molybdenum trioxide. An onset potential of 8.7 (± 0.2) ev was obtained, indicating that a large part of the dissociation must proceed through excitation of the molecule directly to the $b^3\Sigma_u^+$ state.

With increasing electron energy, the observed cross section increased rapidly and approximately linearly at first, then less rapidly above 14 ev, passing through a flat maximum at 40 ev followed by a slow decrease up to the limit of our observations at 100 ev. It is argued that the cleanup of gas observed with 100-ev electrons can be attributed almost entirely to the action of H_2^+ ions. With this assumption, the known ionization cross section of molecular hydrogen enables the contribution from ions to be evaluated at lower electron energies. Subtracting this from the total observed cross section, a cross section is obtained or dissociation into neutral atoms that has a sharp max of

8×10^{-17} cm^2 (± 20%) at about 17 ev, falling rapidly with increasing energy until it becomes essentially zero at 50 ev

2217

[Oklahoma U. Dept. of Physics, Norman]

OPERATING MODE OF AN INVERTED ELECTRODE SYSTEM FOR ATOMIC-LIFETIME MEASUREMENTS (Abstract), by T. M. Holzberlein. [1965] [1]p. [AF 49(638)1404] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 169-170, Feb. 25, 1965.

Specially designed excitation tubes are needed for a new method recently applied to atomic-lifetime measurements and the design and operation has been the subject of recent further study. Using an external cathode in cylindrical symmetry, one finds that space-charge exclusions of radially convergent impact electrons is almost complete until plasma conditions are developed. The plasma neutralization of the electronic space charge apparently is progressive in a radial-inward sense, having a very sharp boundary between the excited and the unexcited regions of the gas. The time required for this boundary to reach the central zone is indicated by the buildup of light radiation from this zone. Propagation time is strongly pressure- and electron-energy-dependent. A network producing nearly flat-topped pulses having a variable width from 100 nsec to 20 μsec while preserving 7-nsec rise and fall times was built; 200-v pulses are delivered at an output impedance of 10-20 Ω. This circuit and its construction are discussed, together with the behavior of the device as shown by lifetime observations on the fast-decaying 5016-A line of He.

2218

Oklahoma U. Dept. of Physics, Norman.

EXPERIMENTAL STUDY OF RESONANCE RADIATION TRANSFER, by H. Mochizuki and R. G. Fowler. [1965] [5]p. incl. illus. diagrs. (AFOSR-65-1096) (AF AFOSR-62-378) AD 612530 Unclassified

Also published in Phys. Rev., v. 137: A17-A21, Jan. 4, 1965.

Experimental investigations have been made of the transfer of mercury 2537-A radiation through a slab of natural mercury gas of various densities and dimensions, using a sinusoidally modulated ($\omega = 2\pi f$, f = 5 to 50 kc sec) radiofrequency-excited (50-mc sec) source of 2537-A radiation. Transmitted radiation has been found to gain in phase relative to the source wave, while that which is scattered at 90° loses phase. From the radiation scattered at 90°, decay time constants of the imprisoned photons have been calculated by using the relation between the time constant T and the phase shift ϕ, $\phi = \tan^{-1}\omega T$. The relation $T \propto C^2 (K^2 + C^2)$, where K is a constant, has been found for the dependence on the breadth C of the resonance tube as well as the well known dependence in $T \propto \ln n$ on the molecular density n. On the other hand, the transmitted radiation obeys a relation $T_c \propto (nA)^{1/2}$ between the time constant T_c corresponding to the advanced phase shift, the thickness A of the resonance tube, and n. The dependences on other factors have also been examined. (Contractor's abstract)

2219

Oklahoma U., Dept. of Physics, Norman.

COLLISIONAL TRANSFER OF EXCITATION ENERGY IN HELIUM, by R. M. St. John and T.-W. Nee. [1965] [7]p. incl. diagrs. table (AFOSR-65-2824) (AF AFOSR-63-252) AD 628229 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 55, 426-432, Apr. 1965.

Recent absolute measurements of many helium excitation functions at low pressure and of the singlet and triplet D functions at several pressures have allowed an extension and upgrading of the multiple-state-transfer process. Atoms excited to an n^1P level are converted to a mixed singlet-triplet F state by an atomic collision. Low-lying singlet and triplet D levels are fed by the many F states thus populated. Apparent excitation functions were computed by machine for the 3^3D, 4^3D, and 4^1D states and compared with the experimental excitation functions. The computed curves best match the experimental curves when it is assumed that (a) the transfer cross section for the nth set of ^1P-F states is proportional to n^1 or n^2, and (b) the $^1F_3$ and $^3F_3$ components of the mixed state are active in the transfer-cascade processes, while the $^3F_{2,4}$ states are inactive. The energy is primarily transferred through n^1P-nF sets of states with n < 15. (Contractor's abstract)

2220

Oklahoma U. Dept. of Physics, Norman.

ELECTRON EXCITATION CROSS SECTION OF THE $3^2S \rightarrow 3^2P$ TRANSITION OF SODIUM, by L. L. Barnes, N. F. Lane, and C. C. Lin. [1965] [4]p. incl. diagrs. tables. (AFOSR-65-2882) (AF AFOSR-63-252) AD 628406 Unclassified

Also published in Phys. Rev., v. 137: A388-A391, Jan. 18, 1965.

The cross section of the $3^2S \rightarrow 3^2P$ transition of sodium produced by electron impact has been calculated by performing a numerical integration of the set of 3-channel differential equations. By means of this numerical procedure, it is no longer necessary to replace the nondiagonal matrix elements of the interaction potential by their asymptotic forms and to neglect the diagonal part of the interaction-potential matrix, as was done in the previous calculations. The cross sections calculated by this numerical scheme are smaller than those of the previous work, and the difference can be ascribed to the use of the true interaction potentials rather than their asymptotic forms. An outline of the general formulation of the numerical method for an n-channel case is given. (Contractor's abstract)

2221

Oklahoma U. Dept. of Physics, Norman.

THEORY OF THE EXCITATION OF THE 4686-A LINE OF He^+ BY ELECTRON IMPACT, by E. T. P. Lee and C. C. Lin. [1965] [4]p. (AFOSR-65-2954) (AF AFOSR-63-252) AD 628407 Unclassified

Also published in Phys. Rev., v. 138: A301-A304, Apr. 19, 1965.

The cross sections for the production of He^+ ion in the 4S state by single-electron collisions with neutral helium atoms in the ground state have been calculated by the Born approximation at various incident-electron energies from 200 to 450 ev. These cross sections range from 8.2×10^{-21} to 6.6×10^{-21} cm^2. By using the ionization-excitation cross sections of the 4P and 4D states calculated by Dalgarno and McDowell and by extending their calculations to 4F, the cross sections of the excitation of the $n = 4 \rightarrow n = 3$ transitions of He^+(4686 A) have been computed. It was found that the transition 4S - 3P contributes about 90% of the total radiation of the various members of the $n = 4 \rightarrow n = 3$ group. The theoretical cross sections of the 4686-A radiation agree with the experimental values to within 15%. It is concluded that the observed 4686-A radiation can be ascribed mainly to direct ionization-excitation to the n = 4 states of He^+ by single-electron impact, and no evidence is found for any indirect excitation mechanism which is responsible for a significant portion of the population of the 4S state of He^+. (Contractor's abstract)

2222

Oklahoma U. [Dept. of Physics] Norman.

EXCITATION AND IONIZATION-EXCITATION OF ARGON ATOMS BY ELECTRON IMPACT (Abstract), by R. J. Anderson and C. C. Lin. [1965] [1]p. [AF AFOSR-63-252] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 382-383, Mar. 24, 1965.

Electron-excitation functions for several argon lines in the range of 4060-6000 A have been measured for electron incident energies from 0 to 100 ev. These lines correspond to the various members of the $(3P)^5(5P) \rightarrow (3P)^5(4S)$, $(3P)^5(5d) \rightarrow (3P)^5(4P)$, and $(3P)^5(6d) \rightarrow (3P)^5(4P)$ transitions. The peak values of the excitation functions of these lines occur at about 25 ev and the max excitation cross sections range from 1×10^{-18} to 2×10^{-19} cm^2. Also observed are the excitation functions of the group of transitions $(3p)^4(4p) \rightarrow (3p)^4(4s)$ of the Ar^+ ions in the region of 4580-5290 A, which resulted from ionization-excitation of the argon atoms by electron impact. These lines are generally less intense than the ones observed for neutral argon and the max cross sections of the Ar^+ transitions are in the range of 4×10^{-19} to 2×10^{-20} cm^2.

2223

Oklahoma U. [Dept. of Physics] Norman.

SIMULTANEOUS EXCITATION AND IONIZATION OF HELIUM BY ELECTRON IMPACT (Abstract),

by E. T. P. Lee and C. C. Lin. [1965] [1]p. [AF AFOSR-65-252] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 182, Feb. 25, 1965.

The cross sections for the production of He^+ ion in the 4^2S state by single-electron collisions with ground state helium atoms have been calculated by the Born approximation. For the wavefunction of the ionized electrons, the hydrogenic continuum functions given by Sommerfeld were used. At an incident electron energy of 405 ev, the calculated cross section is 7.2×10^{-21} cm^2. This process is responsible for the major part of the intensity of the 4686-A radiation ($n = 4 \rightarrow n = 3$ of He^+) observed in the helium-discharge experiment. Using the ionization-excitation cross sections of the 4^2P and 4^2D states calculated by Dalgarno and McDowell, the theoretical cross section of the 4686-A line of He^+ is obtained as 3.4×10^{-21} cm^2 at 405 ev, which agrees well with the experimental value of 3.0×10^{-21} cm^2.

2224

Oklahoma U. [Dept. of Physics] Norman.

THEORY OF EXCITATION OF THE 4686-A RADIATION OF He^+ BY ELECTRON IMPACT (Abstract), by E. T. P. Lee and C. C. Lin. [1965] [1]p. [AF AFOSR-65-252] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 170, Feb. 25, 1965.

The cross sections for the production of He^+ in the 4S state by electron collisions with He atoms have been calculated at various incident-electron energies from 200 to 450 ev. These values range from 8.1×10^{-21} to 6.6×10^{-2} cm^2 with the peak at 230 ev. Unlike the case of the 4P, 4D, and 4F states of He, the excitation cross sections for 4S do not depend very sensitively on the choice of the effective nuclear charge of the continuum wavefunction. The cross sections of the excitation of the $n = 4 \rightarrow 3$ transitions of He^+ (4686 A) were obtained from the ionization-excitation cross sections of the 4S, 4P, 4D, and 4F states of He^+. The theoretical cross sections of the 4686 A radiation agree with the experimental values to within 15%. It is concluded that the observed 4686-A radiation can be ascribed mainly to the direct ionization-excitation to the $n = 4$ states of He^+ and no evidence is found for any indirect extraction mechanism that is responsible for a significant portion of the population of the 4S state of He^+.

2225

Oklahoma U. [Dept. of Physics] Norman.

TOTAL ELECTRON-IMPACT EXCITATION CROSS SECTION OF HELIUM (Abstract), by R. M. St. John, T. W. Nee, and R. W. Kassik. [1965] [1]p. [AF AFOSR-65-252] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 170, Feb. 25, 1965.

The absolute total excitation function of helium due to electron impact has been obtained. Data on 18 levels were used in order to perform extrapolations from measured cross sections within families for obtaining the cross sections for $n = 2$ and for high values of n. The measured and extrapolated cross sections were added at specific electron energies in order to produce to total-excitation function. The function shows a broad maximum of about 1900×10^{-20} cm^2 extending from 30 to 100 ev. About 58% of the function is due to $n = 2$ levels, 32% due to the 18 measured levels, and 10% due to the high n levels. Excitation to F, G, ..., states is included in the cascade component of measured ^1D and ^3D levels.

2226

Oklahoma U. [Dept. of Physics] Norman.

TRANSFER OF EXCITATION OF ENERGY IN HELIUM BY ATOMIC COLLISIONS (Abstract), by T.-W. Nee and R. M. St. John. [1965] [1]p. [AF AFOSR-65-252] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 182, Feb. 25, 1965.

The multiple-state transfer process of helium has been clarified and extended through the comparison of its predictions with recent absolute measurements of helium-excitation functions at several pressures. Atoms excited to an n^1P level are converted to a mixed singlet-triplet F state by an atomic collision. Low-lying singlet and triplet levels are fed by the many F states thusly populated. Apparent excitation functions were computed by machine for the $3\,^3D$, $4\,^3D$, 3^1D, and 4^1D states and compared with experimental curves of the 3^3D, 4^3D, and 4^1D states at four pressures. The calculations were based on a variety of assumptions relating to the variation of the transfer cross section with the principal quantum number n and to the mixed F state model. The computed functions best match the experimental curves when it is assumed that: (a) the transfer cross section for the nth set of ^1P - F states is proportional to the first power of n, and (b) the $^1F_3$ and $^3F_3$ components of the mixed state are

active in the transfer-cascade processes, while the $^3F_{2,4}$ states are inactive. The energy is primarily transferred through n^1P - nF sets of states with n ~15.

2227

Olin Mathieson Chemical Corp., New Haven, Conn.

STUDY OF SUPEROXIDIZERS, by D. A. Csejka. Final rept. Dec. 1, 1961- Jan. 31, 1965. Mar. 12, 1965, 32p. incl. diagrs. tables, refs. (AFOSR-65-1050) (AF 49(638)1137) AD 617964 Unclassified

The reactions of hydrogen atoms with gaseous ozone and with oxygen were studied to determine if hydrogen superoxide, H_2O_4, could be obtained in higher yields. Attempts to concentrate H_2O_4 by separating it from its ice matrix were made. Hydrogen superoxide was examined by X-ray, nuclear magnetic resonance and IR methods at low temperature in order to determine its structural characteristics. The heat of decomposition and formation of H_2O_4 were determined at -196°C. The reactions of H_2O_4 with ammonia, chlorine and ethylene were studied. Di-t-butyl tetroxide was prepared so that the O_4 species could be examined by IR spectroscopic techniques. The reactions of ozone with hexafluoroethane, ammonia, bromine trifluoride and chlorine trifluoride were studied. Tetrafluorohydrazine was treated with ozone, oxygen atoms, oxygen and potassium superoxide in an effort to prepare new oxides such as NF_2ONF_2, NF_2OONF_2 and NF_2OOH. The preparation of chlorine tetroxide was investigated. Reactions of nitrogen trifluoride with ethane, ammonia and diborane at elevated temperatures were examined.

2228

Optics Tech., Inc. [Belmont] Calif.

FIBER OPTICS AND THE LASER, by N. S. Kapany [1965] [23]p. incl. illus. diagrs. refs. (AFOSR-65-1977) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1200, National Institutes of Health and Office of Naval Research) AD 627456 Unclassified

Also published in Ann. New York Acad. Sci., v. 122 615-637, May 28, 1965.

Fiber optics provides an optical element capable of conducting light and images in various parts of the spectrum along flexible axes with high photometric efficiency and large acceptance angles. Not only can fibers be used as passive carriers of light and images, but also as active guides in the form of scintillating fibers, lasing fibers, cathodoluminescent fibers, and the like. The advent of lasers has provided light sources in discrete parts of the visible and infrared spectra. These sources are highly monochromatic and directional and are capable of delivering instantaneous power per cycle far in excess of that of the sun. The present work examines the following aspects of these new techniques: (1) the various applications made possible by the combination of the fields of lasers and fiber optics, (2) the use of lasers in medicine for the coagulation of tissues accessible to direct observation and of tissues inside the human body inaccessible to direct observation, using laser-fiber optics endoscopes, and (3) the possibility of using the fiber optics hypodermic probe, capable of uv excitation as well as laser coagulation in deep regions under the skin. More recent work done on lasing fibers, made possible with the availability of neodymium - doped glasses, is described along with the output characteristics and potential applications.

2229

Oregon State U. Dept. of Chemistry, Corvallis.

THE EFFECT OF STRUCTURE ON THE RATE OF DISPROPORTIONATION OF AROMATIC SULFINIC ACIDS, by J. L. Kice, D. C. Hampton and A. Fitzgerald. [1965] [4]p. incl. diagr. tables, refs. (AFOSR-65-0861) (AF AFOSR-63-106) AD 619613 Unclassified

Also published in Jour. Org. Chem., v. 30: 852-855, Mar. 1965.

The rates of disproportionation of a series of aromatic sulfinic acids have been determined in acetic acid, containing small amounts of water and sulfuric acid. All of the disproportionations exhibit kinetics which are second order in sulfinic acid and show essentially the same dependence on water and sulfuric acid concentration previously found for p-toluenesulfinic acid. For para-substituted benzenesulfinic acids one finds that electron-withdrawing para substituents retard the disproportionation while electron-releasing ones accelerate it. This is exactly the opposite of the effect of the same substituents on the rate of decomposition of the corresponding sulfinyl sulfones I, the reaction believed to be the rate-determining step in the disproportionation. This means that the observed effect of para substituents on disproportionation is entirely the result of their influence on the prior equilibrium between sulfinic acid and sulfinyl sulfone. Evidence is also presented which indicates that the equilibrium between sulfinic acid and sulfinyl sulfone is not really too unfavorable thermodynamically to the sulfinyl sulfone, and that in favorable cases the equilibrium concentration of the sulfinyl sulfone may be as much as a few per cent of the stoichiometric concentration of the sulfinic acid. (Contractor's abstract)

2230

Oregon State U. Dept. of Chemistry, Corvallis.

STRUCTURES AND DYNAMICS OF MOLECULES BY ELECTRON DIFFRACTION, by K. Hedberg and L. Hedberg. Final rept. Jan. 1, 1960 - Dec. 31, 1964. Nov. 10, 1965, 39p. incl. illus. diagrs. tables, refs. (AFOSR-65-2231) (AF AFOSR-63-281) AD 628060 Unclassified

A program of study was undertaken for the purpose of (1) determining the structure of chemically interesting molecules, by means of gaseous electron diffraction analysis, in order to better understand their chemical properties; and (2) determining the potential functions of certain molecules by combining the electron-diffraction measured amplitudes of vibration with the known vibrational frequencies. Computer programs for structural analysis were devised, and a diffraction apparatus was constructed. Molecular structure studies were carried out on disiloxane, disilyl sulfide, cyclopropane, diboron tetrachloride, cyclo-octadiene- 1, 5, 2, 3-dimethylbutadiene, dinitrogen pentoxide, fluorine fluorosulfonate. Molecular dynamics studies were performed on phosphorus trichloride, arsenic tribromide, and nitrogen dioxide.

2231

Oregon State U. Dept. of Chemistry, Corvallis.

SYNTHESIS OF OPTICALLY ACTIVE PHENYL BENZENETHIOLSULFINATE BY ASYMMETRIC OXIDATION OF PHENYL DISULFIDE, by J. L. Kice and G. B. Large. [1965] [5]p. incl. refs. (AFOSR-65-2045) (AF AFOSR-65-106) AD 627774 Unclassified

Also published in Tetrahedron Ltrs., No. 40: 3537-3541, 1965.

A simple, convenient method is presented for the preparation of an optically active aromatic thiolsulfinate having a sufficient degree of optical activity for subsequent polarimetric rate measurements. The disulfide used was phenyl disulfide, oxidized by a solution of d-percamphoric acid. The resulting product was pure phenyl benzenethiolsulfinate, mp 67-68 C with infrared and ultra violet absorption spectra identical with a known sample. The yield was approximately 60%. Measurement of the specific rotation showed that the sample of the thiolsulfinate was definitely optically active. This represents the first example of an optically active thiolsulfinate in which the sulfinyl group is the sole source of asymmetry in the molecule.

2232

Oregon State U. Dept. of Physics, Corvallis.

IMPROVED NMR PROBE FOR MAGNETIC FIELD MEASUREMENTS, by W. L. Pierce and J. C. Hicks. [1965] [2]p. incl. illus. diagr. (AFOSR-65-0786) (AF AFOSR-64-510) AD 615695 Unclassified

Also published in Rev. Scient. Instr., v. 36: 202-203, Feb 1965.

A small, simple, transistorized, marginal-oscillator type nuclear magnetic resonance (NMR) spectrometer has been developed for high resolution mapping of magnetic fields in relatively inaccessible locations, such as the interior of superconducting solenoids. With a probe volume of 8×10^{-6} l, the device is able to give magnetic flux-density measurements to an accuracy of 2 parts in 10^6 with a spatial resolution of about 1 mm. Remote operation of all controls adds considerably to its versatility.

2233

Oslo U. Inst. for Theoretical Physics (Norway).

PERTURBATION THEORY EXPANSIONS THROUGH 21ST ORDER OF THE NON-RELATIVISTIC ENERGIES OF THE TWO-ELECTRON SYSTEMS $(2p)\ ^{23}P$ AND $(1s)^{21}S$, by J Midtal. [1965] 13p. incl. tables. (Institute rept. no. 26) (AFOSR-65-1662) (AF EOAR-64-32) AD 624378 Unclassified

A 10th-order perturbation wave function is presented for the $(2p)^{23}P$ state and the $(1s)^{21}S$ state of a 2-electron system. Estimates of the correct perturbation energy coefficients through 21st order are evaluated giving the total non-relativistic energies with ten significant figures. Two important convergence properties concerning the perturbation energy coefficients furnished by the Hylleraas-Scherr-Knight variational perturbation method are considered. The numerical values of the energy coefficients obtained by using trial wave functions up to order 203 are presented, and it is found that perturbational convergence is somewhat better for the $(1s)^{21}S$ state than for the $(2p)^{23}P$ state, whereas the variational convergence is best for the $(2p)^{23}P$ state. The total non-relativistic energies computed from the sets of coefficients are given for the first 10 members of the isoelectronic sequences.

2234

Oslo U. Inst. for Theoretical Physics (Norway)

EXACT QUANTUM DYNAMICAL SOLUTIONS FOR OSCILLATOR-LIKE SYSTEMS, by M. Kolsrud. [1965] [23]p. (Institute rept. no. 28) (AFOSR-65-2754) (AF EOAR-64-32) AD 628414 Unclassified

There are very few cases in which the exact solutions of the quantum-mechanical equations of motion are known. For a certain class, however, it is possible to obtain explicit solutions, or rather to express the quantummechanical solutions in terms of the classical ones. This class consists of systems whose Hamiltonians are polynomials of the second degree in canonically conjugate dynamical variables (i.e. 'oscillator-like'). As these systems play a rather important role in quantum theory, it seems worth while to present an exact treatment of their dynamics. In order to study the variation with time of the state-or of the dynamical variables-of a system, it is convenient to introduce the unitary "timeevolution" operator T. An explicit expression for the operator T is found.

2235

Oslo U. Inst. for Theoretical Physics (Norway)

COVARIANT AND HERMITIAN SEMI-CLASSICAL

LIMIT OF QUANTUM DYNAMICAL EQUATIONS FOR SPIN 1/2 PARTICLES, by M. Kolsrud. Mar. 1965. [27]p. incl. refs. (Institute rept. no. 27) (AFOSR 65-2755) (Sponsored jointly by AFOSR under AF EOAR-64-32, and Fridrjof Nansen's Fund for Advancement of Science) AD 627723 Unclassified

The Dirac equation with a Pauli term is transformed to a covariant and Hermitian two-component form to first order in h. The Bargmann-Michel-Telegdi equations are deduced as equations of motion for spin-operators. Corresponding operators in the Dirac and semi-classical picture are discussed.

2236

Oslo U. Inst. for Theoretical Physics (Norway).

UPPER OR LOWER BOUNDS FOR SCATTERING PHASE SHIFTS, by M Kolsrud. [1965] 6p. incl. diagr. (Institute rept. no. 30) (AFOSR-66-1012) (AF EOAR-64-32) AD 638054 Unclassified

The scattering character of some earlier given variational expressions for the phase shifts is analyzed and compared with numerical examples.

2237

Oslo U. Inst. for Theoretical Physics (Norway).

AN EIGENVALUE PROBLEM IN QUANTUM MECHANICS, by M. Kolsrud. [1965] 10p. (Institute rept. no. 34) (AFOSR-66-1013) (AF EOAR-64-32) AD 638055 Unclassified

Stationary perturbation theory in quantum mechanics often makes the following assumption: A hermitian operator is expanded in a power series in terms of a small expansion parameter. Then each of the discrete eigenvalues will also be given by a power series, in terms of the same parameter. Consideration is now given to a special eigenvalue problem where this not the case. However, a slightly different expansion shows that to the assumed power series expansion of the eigenvalue there must be added logarithmic terms. The result therefore constitutes an example in a theory which treats the problem of the analyticity of the eigenvalues as functions of one or more parameters.

2238

Oslo U. Inst. for Theoretical Physics (Norway).

VARIATIONAL METHODS FOR SCATTERING PROBLEMS, by M. Kolsrud. [1965] 36p. incl. diagrs. table. (Institute rept. no. 29) (AFOSR-66-1014) (AF EOAR-64-32) AD 637700 Unclassified

The variational method of Schwinger is extended, and leads to several new stationary expressions for the phase shifts, and for the scattering amplitude. Numerical examples are given.

2239

Oslo U. Inst. of Physics, Blindern (Norway).

SEARCH FOR AN EXCITED STATE OF THE $_{\Lambda}Be^{9}$ HYPERNUCLEUS, by A. G. Frodesen, F. Lunde, and O. Skjeggestad. [1965] [4]p. incl. diagrs. (AFOSR 65-1354) (AF EOAR-63-100) AD 621353 Unclassified

Also published in Phys. Norvegica, v. 1: 277-280, 1965.

Among 43 uniquely identified $_{\Lambda}He^{5}$ and 29 $_{\Lambda}He^{4,5}$ hypernuclei produced in association with stable prongs of range 500 μ in K^{-} capture stars in nuclear emulsions, a search has been made to detect possible $_{\Lambda}He^{5}$ originating from an excited state of $_{\Lambda}Be^{9*} \rightarrow {}_{\Lambda}He^{5} + He^{4}$. For each of the capture stars the effective mass of the $_{\Lambda}He$ and each of the stable prongs have been calculated on the assumption that the stable prongs are α-particles. The experimental effective mass distribution has been compared with background estimates from Monte Carlo calculations. The data are consistent with no $_{\Lambda}He^{5}$ events coming from $_{\Lambda}Be^{9*}$.

2240

Oslo U. [Inst. of Physics] Blindern (Norway).

A FORTRAN PROGRAMME FOR THE ANALYSIS OF HYPERFRAGMENTS AND FOR OTHER EMULSION STUDIES, by A. G. Frodesen, K. S. Kolbig and M. M. Nicolic. Feb. 3, 1965, 86p. incl. diagrs tables, refs. (Rept. no. CERN 65-6) (AFOSR-65-1735) (AF EOAR-63-100) AD 625014 Unclassified

A FORTRAN computer programme is described which is primarily designed as an aid for the identification of hyperfragments from a kinematic analysis of the production and decay vertices, but which may also be applied to other emulsion studies. The programme considers the kinematics for: (1) capture at rest of a negative meson or negative baryon in light emulsion nuclei, leading to the formation of a number of charged secondaries, and at the most one neutral particle; (2) decay at rest of a hyperfragment into charged particles and at the most one neutral particle, and (3) decay in flight of a hyperfragment into charged particles. The subroutines of the programme are described, and range-energy tables (tables of isotopes and particles with binding energies of hypernuclei) and a list of FORTRAN variables are given.

2241

Oslo U. Inst of Physics, Blindern (Norway)

A SYSTEMATIC STUDY OF HYPERNUCLEI FROM Σ^- CAPTURES IN NUCLEAR EMULSIONS, by A. G. Frodesen, T. Roe and O. Skjeggestad. [1965] [7]p. incl. diagr. tables, refs. (AFOSR-65-1841) (AF EOAR-63-100) Unclassified

Also published in Nuclear Phys., v. 68: 575-581, 1965.

A total of 35 hypernuclei produced by stopping Σ^- hyperons in nuclear emulsions was studied with main emphasis on the identification problem. A kinematical analysis of the hypernucleus production and decay stars was combined with mass and charge determination of individual prongs. Out of 25 non-mesic hypernuclei, 8 could be uniquely identified and 4 assigned a unique charge. All 10 mesic decay could be uniquely identified. The emission rate of measurable hypernuclei from Σ^- capture is found to be $(3.7 \pm 0.9)\%$. For hypernuclei of charge $Z \geq 2$ the overall non-mesic decay ratio is 4.2 ± 1.9.

2242

Oslo U. Inst. of Physics, Blindern (Norway).

HIGH ENERGY PHYSICS WITH EMPHASIS ON STRANGE PARTICLES, by [O. Skjeggestad and S. O. Sörensen]. Final scientific rept. Aug. 31, 1965, 31p. incl. diagrs. tables, refs. (AFOSR-65-1912) (AF EOAR-63-100) AD 626056 Unclassified

Two approaches are used in a search among nonmesic hypernuclei for evidence of multi-nucleon stimulated Λ decay: (1) an attempt is made to detect fast deuterons or tritons among the decay products of hypernuclei by mass measurements on fast prongs. It is indicated that stimulated decay processes of the types $\Lambda + d \rightarrow n + d$ and $\Lambda + t \rightarrow n + t$ may occur; (2) a search is made for special 2-body decay modes which are expected if the multi-nucleon stimulation picture is correct. Two examples of the decay mode $_{\Lambda}He^5 \rightarrow n + He^4$ and one of the mode $_{\Lambda}He^4 \rightarrow n + He^3$ are found. The non-mesic to π^- - mesic decay ratios for hypernuclei are determined. A short description is presented of the CERN program REAP-THRESH for geometrical reconstruction of events in bubble chambers.

2243

[Oxford U. Dept. of Anatomy (Gt. Brit.)]

[RECIPROCAL CONTROLS BETWEEN NERVOUS SYSTEM AND ENDOCRINE SECRETIONS] by G. W. Harris. Final rept. Apr. 1, 1965-Sept. 30, 1965, 5p. (AFOSR-66-0604) (AF EOAR-65-3) AD 479763L Unclassified

A technique has been developed to obtain practical quantities of hypophysical portal blood from the rat. The technique was used to obtain portal blood rats in prooestrus. The presence of luteinizing releasing factor (LRF) in this blood was demonstrated by the ovarian ascorbic acid depletion method. The effects of ovulation on Thyroid stimulating hormone secretion, a new method for TSH assay in blood, and thyroid development in the neonatal rat are also under investigation.

2244

Oxford U. Dept. of Pharmacology (Gt. Brit.).

BIOCHEMISTRY OF BIOGENIC AMINES, by H. K. F. Blaschko. Final rept. Mar. 1, 1965 [4]p. incl. refs. (AFOSR-65-0668) AF EOAR-64-12) AD 615503 Unclassified

The meta-hydroxy analog of tyrosine was shown to have the effect of awakening tranquilized animals. Many sources were established for an enzyme that will oxidize hydroxyindole derivatives. Distribution of amine oxidases in mammalian blood plasma was studied; the enzyme is related to spermine oxidase. Benzylamine oxidase from pig plasma was crystallized. Work was resumed on detaching the enzyme lysolecithin from the insoluble mitochondrial detritus. Chromaffin granules of the adrenal medulla. Posterior pituitary hormones and neurophysin: Hormones were dissociated from protein by using columns of sphadex G-25 and 0. in formic acid. Granules rich in hormones were obtained by differential centrifugation, the granules containing a protein resembling the Van Dyke protein. Sulfur containing amino acids: Optically pure L-homocystine was obtained from L-methionine.

2245

Oxford U. Dept. of Pharmacology (Gt. Brit.).

[HYDROXYINDOLE OXIDASE IN THE CRYSTALLINE STYLE OF PINNA NOBILIS] Attivita idrossindolossidasica nello stilleto cristallino di Pinna Nobilis, by H. Blaschko. [1965] [9]p. incl. diagr. (AFOSR-65-1549) (AF EOAR-64-12) AD 623375 Unclassified

Also published in Riv. Biol., v. 58: 27-36, Jan.-Mar. 1965.

Experiments were conducted on the hydroxyindole oxidase activity of an enzyme present in crystalline Pinna nobilis. It is shown that a homogenate of the crystalline style oxidizes psilocine with the formation of a blue pigment. This activity was also observed in the gill plates of Mytilus edulis and is described as an expression of the phenol oxidase activity in these tissues. This finding is discussed in relation to earlier observations on the presence of a phenoloxidase in mollusks.

2246

Oxford U. Dept. of Pharmacology (Gt. Brit.).

THE AMINE OXIDASE OF PIG PLASMA IN COPPER DEFICIENCY, by H. Blaschko and F. Buffoni and others. [1965] [2]p. incl. table. (AFOSR-65-2856) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR 64-12 and National Institutes of Health) AD 629259 Unclassified

Also published in Biochem. Jour. v. 96: 4C-5C, 1965.

The amine-oxidase ('benzylamine-oxidase' or histaminase) activity of the blood serum of copper-deficient pigs was studied. Observations on the biochemical basis of the cardiovascular changes in copper-deficient pigs were made and the amine oxidase of pig plasma was crystallized and shown to be a copper-containing protein. Samples from animals maintained on a diet deficient in copper were examined for their amine-oxidase activity. The freezedried material was tested manometrically, with 10mm -benzylamine as substrate. The samples included material collected not only from deficient animals but also from animals that had received copper after a first sample had been collected while they were copper-deficient. The results show that in the deficient animals enzymic activity was either absent or extremely low. Under copper therapy the enzymic activity made its appearance. These observations are of interest in relation to the role of copper in enzymic processes. Although in the experiments the mechanism of action of copper was not studied it is believed that the pig plasma enzyme belongs to a group of oxidases in which copper is an essential constituent of the catalytic system. From what is known of the chemistry of related enzymes, the bovine spermine oxidase, the pea-seedling amine oxidase and the diamine oxidase of pig kidney, it is clear that the whole group of amine oxidases sensitive to cyanide and to carbonyl reagents represents a new type of copper-containing protein with catalytic activity.

2247

Oxford U. Dept. of Pharmacology (Gt. Brit.).

THE ADENOSINE-TRIPHOSPHATASE ACTIVITY OF ADRENAL CHROMAFFIN GRANULES, by P. Banks. [1965] [8]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2857) (AF EOAR-64-12) AD 629258 Unclassified

Also published in Biochem. Jour., v. 95: 490-496, 1965.

The preparation of a fraction containing highly purified chromaffin granules from the bovine adrenal medulla is described. The fraction contains an adenosine-triphosphatase activity that is stimulated by Mg^{2+} and that cannot be explained by contamination with mitochondria or microsomes. It is suggested that the adenosine-triphosphatase activity is related to the uptake of catecholamines by the chromaffin granules. (Contractor's abstract)

2248

Oxford U. Dept. of Pharmacology (Gt. Brit.)

ACID NUCLEASES OF THE BOVINE ADRENAL MEDULLA, by A. D. Smith and H. Winkler. [1965] [1]p. (AFOSR-66-0849) (AF EOAR-64-12) AD 639529 Unclassified

Also published in Nature, v. 207: 634, Aug. 7, 1965.

The observations show that the RNase described by Philippu and Schumann is present in the soluble protein fraction and also that an acid DNase is present in the same lysate. The material used in this study was obtained from the bovine adrenal medullary "large granule" fraction by ultracentrifugation over a sucrose density gradient. Although a possible contamination of the chromaffin granules by either mitochondria or microsomes can be excluded as a source of the enzymatic activities studied, the possibility remains that the two enzymes are lysosomal in origin. Two alternative interpretations offer themselves: either the presence of the two acid hydrolases is an expression of a close relationship between chromaffin granules and lysosomes, or the two enzymes are located not in the chromaffin granules but in lysosomes which might be present in the particulate fraction isolated from the chromaffin tissue.

2249

Oxford U. Dept. of Pharmacology (Gt. Brit.).

PYRIDOXAL PHOSPHATE AS A CONSTITUENT OF THE HISTAMINASE (BENZYLAMINE OXIDASE) OF PIG PLASMA, by H. Blaschko, and F. Buffoni. [1965] 16p. incl. diagrs. tables, refs. (AFOSR-66-1143) (AF EOAR-64-12) AD 639530 Unclassified

Also published in Proc. Roy. Soc. (London), v. 163B: 45-60, Aug. 1965.

The histaminase ('benzylamine oxidase') of pig plasma has recently been crystallized and a description is given of some of the physical and chemical properties of the pure preparation of the oxidase. The fluorescence of the enzyme is typical of a protein containing tryptophan. The phosphorus content is about four atoms per molecule. On enzymic hydrolysis a product has been obtained that has the fluorescence properties of a pyridoxal protein. This product gave rise on acid hydrolysis to material capable of activating the L-typrosine apodescarboxylase of Streptococcus faecalis R in the presence of adenosine triphosphate, indicating that pyridoxal was set free in the hydrolysis. Acid hydrolysis of a solution of the crystalline enzyme and subsequent treatment with urea yielded diffusible material with the spectroscopic and fluorescence properties of pyridoxal. Using the bacterial apodecarboxylase, traces of pyridoxal phosphate and larger amounts of free pyridoxal were shown to be present. It was calculated that about 3 or 4 moles of pridoxal were present per mole of enzyme. Together with the phosphate estimations, these phosphate per mole. Observations on rate maintained on a diet deficient in vitamin B_6 are in agreement with these conclusions. (Contractors' abstract)

2250

Oxford U. Engineering Lab. (Gt. Brit.).

WAVES IN ANISOTROPIC MEDIA, by H. Motz. Final rept. Mar. 10, 1965 [20]p. incl. diagrs. (AFOSR-66-0907) (AF EOAR-63-33) Unclassified

Theoretical studies have been directed towards

understanding how factors sometimes discounted in simple models, such as temperature and collision effects, affect the propagation of waves in an anisotropic medium. The theoretical and computational work on dielectric loaded structures has yielded a method of calculating field and frequency of the lowest TM mode, from which the dispersion curve is easily obtained. Theoretical work on waves on electron beams has been confirmed by an experiment on a two beam vacuum tube. Microwave emission from a solid state plasma device has been observed. The effect of a standing microwave field pattern on the electron temperature in a plasma has been investigated and found to accord with the theory. Laser induced electron and ion emission has been observed from metal points and plane surfaces. The time delay between the laser pulse and onset of emission has been measured as less than 3.10^{-8} sec. Stimulated emission has been observed in the ruby optical pumping experiment at 3 cm and 8 mm wavelengths.

2251

Oxford U. Engineering [Lab.] (Gt. Brit.).

TIME RESOLUTION OF LASER INDUCED ELECTRON AND ION EMISSION, by S. H. Klan, F. A. Richards, and D. Walsh. [1965] [2]p. incl. illus. diagr. (AFOSR-66-1573) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-37, and Science Research Council) AD 639852 Unclassified

Also published in IEEE Jour. Quantum Electron., v. QE-1: 359-360, Nov. 1965.

A Q-switched ruby laser illuminated tantalum and niobium-tin targets with 75 nsec, 50 millijoule pulses. Electron and ion time histories over the 50 to 500 range are reported.

2252

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

THE REACTION OF ATOMS AND RADICALS WITH VARIOUS MOLECULES, by J. W. Linnett. Final rept. Mar. 1965 [68]p. incl. diagrs. tables, refs. (AFOSR-65-1491) (AF EOAR-63-32) AD 623185 Unclassified

This report is divided into 4 parts: (1) Experiments on the absorption of hydrogen atoms by palladium, and palladium-gold alloys in connection with some earlier work on the catalytic effect of these metals and alloys on the recombination of hydrogen atoms; (2) Experiments on the attack of a number of metals by molecular and atomic oxygen to discover in which cases there were considerable differences in rate; (3) Experiments on the recombination of oxygen atoms on the surface of the alkali metal tungsten bronzes; and (4) Description of a pressure gauge which has been devised for the rapid and convenient measurement of pressures in mixtures containing chlorine at pressures of the order of 1 mm the accuracy being about $\pm$ 0.01 mm.

2253

Oxford U. Inst. of Experimental Psychology (Gt. Brit.).

BRAIN STEM STIMULATION AND ETHOLOGICAL STUDIES ON BIRDS, by N. Tinbergen, D. M. Vowles, and J. D. Delius. Final rept. Jan. 1, 1964-Jan. 31, 1965, 8p. (AFOSR-65-0666) (AF EOAR-64-2) AD 615476 Unclassified

The work was specifically intended to elucidate further the physiological mechanisms of some particular types of behavior in birds using in combination brain stimulation and observation techniques. Studies were made of the interactions between internal and external stimulation and of the interactions occurring during simultaneous stimulation of two different areas of the brain, which yield either similar or differing types of behavior. The experimental animals chosen for this work were hering gulls, whose behavior is simpler, i.e., stereotyped, than that of the classically studied mammals.

2254

Oxford U. Inst. of Experimental Psychology (Gt. Brit.).

THE EFFECT OF HUNGER ON THIRST-MOTIVATED BEHAVIOR IN THE BARBARY DOVE, by D. J. McFarland. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-66-0841) (AF EOAR-64-2) AD 639523 Unclassified

Also published in Animal Behav., v. 13: 286-292, Apr.-Jun. 1965.

A number of workers have reported that dogs and other animals, including man, eat less than normal when thirsty and drink less when hungary. It has been suggested that inhibition of eating by thirst produces a food deficit which is capable of motivating behavior learned for food reward. McFarland found that the extent to which Barbary doves would work for food when thirsty was commensurate with their secondary hunger, as measured by recovery in food intake after water deprivation. The experiments reported in this paper were designed to investigate the corresponding effect of hunger on thirst motivated behavior.

2255

Oxford U. Inst. of Experimental Psychology (Gt. Brit.).

HUNGER, THIRST AND DISPLACEMENT PECKING IN THE BARBARY DOVE, by D. J. McFarland. [1965] [8]p. incl. diagr. tables, refs. (AFOSR-66-0842) [AF EOAR-64-2] AD 637631 Unclassified

Also published in Animal Behav., v. 13: 293-300, Apr.-July 1965.

The demonstration that displacement activities can be influenced by direct relevant stimulation has led to a rejection of the view that they must necessarily be "allochthonous". Although the latter view is implicit

in the original definitions of displacement activity many recent authors have suggested that the term should continue to be used in a purely descriptive sense. Accordingly, in this paper, the term "displacement activity" is applied to activities which belong to motivational and functional systems other than that predominantly activated at the time of observation. The first step in explaining the occurrence of a displacement activity must be to determine to which system the activity belongs. This is the main object of this paper, in which a typical displacement activity is examined in relation to the motivational complex characteristic of the situation in which it occurs.

2256

Oxford U. Inst. of Experimental Psychology (Gt. Brit.)

CONTROL THEORY APPLIED TO THE CONTROL OF DRINKING IN THE BARBARY DOVE, by D J. McFarland. [1965] [15]p. incl. diagrs. refs. (AFOSR-66-1108) [AF EOAR-65-14] AD 637630 Unclassified

Also published in Animal Behav., v. 13 476-492, Oct. 1965.

A preliminary hypothesis about the system controlling drinking in the Barbary dove is derived from experimental data of a behavioral rather than a physiological kind. This hypothesis is put on a quantitative basis by using a method that is described in detail in the appendix. The model which results from this process is capable of predicting the course of water intake during recovery from water deprivation, but is unable to account for the observed bodyweight changes. By analyzing the model according to the rules outlined in the appendix, a more complex model is arrived at, which accounts for both water intake and bodyweight changes during recovery from water deprivation. This complex model also accounts for the course of food intake during water deprivation, and the extent to which water intake falls during food deprivation. The model shows a close parallel to the known physiological facts and successfully predicts the daily evaporative water loss in the Barbary dove, and the extent to which Barbary doves can tolerate water rationing without loss of bodyweight.

2257

Padua U (Italy)

SEVENTH INTERNATIONAL SYMPOSIUM ON FREE RADICALS: SUMMARIES OF INVITED PAPERS. Padua, (Italy) (Sept. 5-10. 1965) [1965] [55]p incl diagrs. tables, refs. (AFOSR-67-1796) (AF EOAR-66-01) AD 656392 Unclassified

The document comprises summaries of papers presented in the following fields: quantum theory of open shell molecular states; recent advances in free radical detection in gas phase; mass spectrometry of free radicals; far ultraviolet photochemistry in free radical studies, the electron in solution and diradicals, triplets, and unstable singlet molecules

2258

Parma U. Inst of Physiology (Italy).

TRANSMISSION OF TONIC ACTIVITY THROUGH LATERAL GENICULATE BODY AND VISUAL CORTEX, by A Arduini and A Cavargioni [1965] [16]p. incl diagrs table. refs (AFOSR-66-0789) (AF EOAR-64-38) AD 632882 Unclassified

Also published in Arch Ital Biol., v 103: 652-667, 1965

In the barbiturate cat, the transfer functions for the lateral geniculate body and visual cortex have been determined for tonic activity in dark and light adaptation by recording simultaneously from chiasma, geniculocortical radiations and corticothalamic projections Geniculate transfer functions remain fairly constant for all values of input activity tested, while the cortical transfer functions show a definite tendency to increase with decrease of the input The behavior of the cortical transfer functions has been interpreted as determined by the non specific inputs to cortical neurones The effects of injecting Nembutal seem to support this hypothesis

2259

Parma U Inst of Physiology (Italy)

ISOLATE UNIT ACTIVITY IN CENTRAL VISUAL PATHWAYS, by A Arduini, Jan. 1, 1965 - Aug. 31, 1965 [23]p. incl. diagrs. (Scientific rept. no. 1) (AFOSR-65-2216) (AF EOAR-65-8) AD 623800 Unclassified

Isolated neuronal discharges were led through microelectrodes from the fibers of the geniculo-cortical and cortico-thalamic tracts of the cat's visual system. A comparison was made of the interval histograms of the neuronal activity during dark adaptation in 3 different preparations: (1) intact brain anesthetized (Nembutal), (2) intact brain curarized, (3) midpontine, pre-trigeminally transected. In the anesthetized preparation interval histograms of the neuronal discharges in dark adaptation were also compared in the presence and in the absence of synchronized retinal activity. (Contractor's abstract)

2260

PEC Research Associates, Inc., Boulder, Colo.

NOTES ON A PARTIAL SURVEY OF CYBERNETICS IN EUROPE AND U. S. S. R., by M. A. Arbib. Final rept. May 19, 1965. 152p. incl. diagrs. refs. (AFOSR-65-1412) (AF 49(638)1446) AD 623127 Unclassified

Brief summaries are given of research activities at a number of centers and laboratories in Western and Eastern Europe. The summaries are primarily the transcribed notes of the autnor made during a recent trip. The research reported is that primarily classified as cybernetics in the Western sense, i.e., categorized as automata theory, neural modeling, artificial intelligence, and pattern recognition. Soviet work excels in areas such as control theory and information theory where strong mathematics is paramount. Research lags where it requires large-scale computers for non-numerical work. The report includes an introductory section which traces the historical progress of the role of cybernetics (in the Soviet sense, i.e., broadly as the science of control including problems of mathematical economics and operations research) in the Soviet society. Several appendices are included: (a) a listing associating particular scientists and groups with particular subject fields; (b) an annotated listing of some of the major journals which publish papers in cybernetics; (c) a list of references to reviews of aspects of Soviet science and education germane to the topics of the report, and (d) a random selection of Russian papers supplementary to (c). The report contains city, name, and subject indices.

2261

[PEC Research Associates, Inc., Boulder, Colo.]

A COMMON FRAMEWORK FOR AUTOMATA THEORY AND CONTROL THEORY, by M. A. Arbib. [1965] [17]p. (AF 49(638)1446) Unclassified

Published in SIAM Jour. Control, Ser. A, v. 3, 206-222. 1965. (AFOSR-66-0013; AD 641628)

This is an expository paper sketching some of the ideas common to automata theory and control theory. The first section on states and semigroups, indicates how discrete automata and continuous systems can be subsumed under a common definition. The unifying concept is that of the input semigroup and the semigroup of the system — or automation. Unfortunately, this central idea is not explored in any depth here. The remainder of the paper is devoted, for the most part, to linear systems and their generalization, additive systems Linear systems arise in a natural way in control theory and have, accordingly, been studied

intensively. The paper does not indicate whether additive systems have a corresponding role in automata theory. Controllability and observability are discussed for linear systems. (Math. Rev. abstract)

2262

Pennsylvania State U. [Dept. of Chemistry] University Park.

d-ORBITAL PARTICIPATION IN SILANE CONJUGATION, by L. Goodman, A. H. Konstam, and L. H. Sommer. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-0877) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-39 and Dow Corning Corp.) AD 618356 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87, 1012-1016, Mar. 5, 1965.

A substituent interference experiment on the intensity of the L_b bands in phenylsilanes demonstrates that the SiH_3 group actually does withdraw electrons from the benzene ring into Si 3d-orbitals. Such an experiment has general applicability for ascertaining participation of d-orbitals in a conjugation scheme. (Contractor's abstract)

2263

[Pennsylvania State U. Dept. of Chemistry, University Park]

PHYSICAL PROPERTIES OF ISOTOPICALLY SUBSTITUTED MOLECULES, by W. A. Steele. Final rept. [1965] [5]p. incl. diagrs. (AFOSR-65-1693) (AF AFOSR-63-118) AD 624163 Unclassified

The research accomplishments of this study include. (1) completion of a balance for accurately measuring fluid density over wide ranges of temperature and pressure; (2) construction of a low temperature still for purifying materials whose densities were measured; and (3) measurement of the density of methane and perdeuteromethane at temperatures from the melting point to the critical region, and at pressures up to 80 atm. The balance attained an accuracy of 1-2 parts in 10^4 in density and of ± 0.1 psi pressure and ± 0.01 C temperature.

2264

Pennsylvania State U. Dept. of Chemistry, University Park

SELECTIVITY OF GROUND-STATE C_1 AND TRIPLET-STATE CYCLOPROPYLIDENE IN OLEFIN ADDITION REACTIONS, by P. S. Skell and R. R. Engel. [1965] [2]p. incl. table. (AFOSR-65-2141) [AF AFOSR-64-503] AD 629052 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87, 2493-2494, June 5, 1965.

A large excess of equilibrated olefin mixture was added to the cold evacuated sample which caused the matrix to melt due to heat of condensation and reaction occurred in the liquid phase at temperatures in the -100 to -150 range. The relative rate constants for both steps of the reaction were determined (olefin, relative rate of olefin addition to C_1 to form cyclopropylidenes, and relative rate of olefin addition to cyclopropylidenes to form spiropentanes shown): 1,3-butadiene, 1, 20, propene, 5, 8, cis-2 butene, 15, 10, trans-2-butene, 32, 1, and 2-methylpropene, 30, 6.

2265

Pennsylvania State U. Dept. of Chemistry, University Park.

THE CHEMISTRY OF C_1 GROUND STATE, ^3P, by P. S. Skell and R. R. Engel. [1965] [1]p. incl. diagrs. (AFOSR-65-2142) (Sponsored jointly by Air Force Scientific Research under [AF AFOSR-64-503] and Army Research Office (Durham)) AD 629050 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87, 1135, Mar. 5, 1965.

Additions of olefins to C_1 results in formation of spiropentanes and bisethanoallenes. The products obtained from the reactions of ground-state C_1 with the cis- and trans-2-butenes are reported. The spiropentane product mixtures were analyzed and assigned structures of isomeric 1, 2, 1', 2'-tetramethylspiropentanes. The observations for the reactions of cis and trans-2-butenes with ground-state carbon atoms are summarized. A triplet C_1 reagent is required for the postulated reaction scheme, and this assignment is in accord with the spectroscopically identified triplet P ground state. Ring formation by stereospecific mode precedes ring formation by the nonstereospecific mode. (Contractor's abstract)

2266

Pennsylvania State U. Dept. of Chemistry, University Park

THE CHEMISTRY OF C_1 METASTABLE STATES, ^1D AND ^1S, by P. S. Skell and R. R. Engel. [1965] [1]p. incl. diagrs. (AFOSR-65-2143) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-503] and Army Research Office, (Durham)) AD 629049 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87, 1135, Mar. 5, 1965.

Products of the triplet ground state of monatomic carbon C_1 as well as the excited singlet S and D states were selectively produced. The ground state addition to olefins is stereospecific in the first step and nonstereospecific in the second, producing a spiropentane, the singlet D excited state adds stereospecifically in both steps. The excited states also yield other reaction products (e.g., 1,3-dimethylallene from cis-2-butene).

2267

Pennsylvania State U. Dept. of Chemistry, University Park.

REACTIONS OF CARBON VAPOR. I. REACTIONS OF TRIATOMIC CARBON WITH OLEFINS, by P. S. Skell, L. D. Wescott, Jr. and others. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2144) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-503, Army Research Office (Durham), Esso Research and Engineering Corporation, and National Science Foundation) AD 629063 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 2829-2835, July 5, 1965.

A major component of carbon vapor is C_3. The chemical properties of this substance were studied at -196° in additions to olefins, the products being bisethanoallenes. Relative rates show C_3 to be a nonselective dicarbene for oelfin additions and yet it does not show insertion properties. In a paraffin hydrocarbon matrix at -196°, C_3 is stable. This variety of C_3 adds stereospecifically to cis- and trans-2-butenes, confirming the conclusion from spectroscopic analysis of the Swings bands that the ground state is singlet. Nonstereospecificity is observed with simultaneous deposition at -196° of C_3 and the 2-butenes, indicative of a hitherto unobserved triplet state C_3, limits of 10^{-1} to 10^{-5} sec were placed on the half-life for decay of this triplet state to a singlet state.

2268

Pennsylvania State U. Dept. of Chemistry, University Park

THE REACTIONS OF CARBON ATOMS WITH CHLORINATED HYDROCARBONS, by P. S. Skell and R. F. Harris [1965] 1p. incl. diagr. (AFOSR-66-1040) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-503], and Army Research Office (Durham)) AD 632216 Unclassified

Also published in Jour. Amer. Chem. Soc., v 87: 5807, Dec. 1965.

Reactions of carbon atoms with chlorinated hydrocarbons are described. The reaction with carbon tetrachloride yields 2 products, tetrachloroethylene and octochloropropane. Carbon atoms reacts with chloroform in a similar manner, yielding trichloroethylene and 1, 1, 2, 2, 3, 3-hexachloropropane, t-butyl chloride produces 1-chloro-2, 2-dimethylcyclopropane as the major product.

2269

Pennsylvania State U. Dept of Chemistry, University Park.

THE REACTIONS OF CARBON ATOMS WITH SATURATED HYDROCARBONS, by R. R. Engel and P. S. Skell. [1965] 1p. incl. diagrs. (AFOSR-66-1041) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-503] and Army Research Office (Durham)) AD 632217 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 4663, Oct. 1965.

The reactions of carbon atoms with saturated hydrocarbons are reported. The products formed with 2-metnylpropane were 1, 1-dimethylcyclopropane and 2-methylbutane. The reaction of carbon atoms with cyclopropane gave, as the major product, methylenecyclopropane in 65% yield. Using the time-delay technique as previously described, it was determined that all products were resulting from the ^1S state of carbon.

2270

Pennsylvania State U. [Dept. of Chemistry] University Park.

CHEMICAL PROPERTIES OF LABILE SPECIES, by P. S. Skell. Final rept. 1961-1965, 5p. incl. refs. (AFOSR-67-0044) (AF AFOSR-62-52 and AF AFOSR-64-503) AD 645534 Unclassified

The major effort was expended in the study of vaporized carbon. The chemistry of C_1 and 3 states of C_3 in 2 states have been studied extensively, and reactions with olefins, alkanes and some alkyl halides have been examined in considerable detail. The success in studying carbon vapor has indicated the feasibility of extending the studies to other high temperature atomic and molecular species. The primary objective of the program was the study, at room temperature or below, of the chemical properties of species stable at high temperatures. The most interesting class of substances which falls in this category are the atomic species, which for the main part have not been studied as reactive species.

2271

Pennsylvania State U. Dept. of Chemistry, University Park.

THE FORM OF D ORBITALS IN CARBON-SULFUR BONDS, by L. Goodman and R. W. Taft. [1965] 3p. incl. diagrs. table. (AFOSR-66-0584) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-742 and National Science Foundation) AD 632763 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 4385-4387, Oct. 5, 1965.

It has been found that the effect of twisting OCH_3 group and SCH_3 group from the ring coplanarity produces fluorine nuclear magnetic resonance shielding effects which are dramatic in their qualitative differences. This F shielding result clearly requires that there is population of the S 3d orbitals in the twisted conformation and hence establishes that the d orbitals are not severely angularly deformed.

2272

Pennsylvania State U. Dept. of Chemistry, University Park.

FAR ULTRA-VIOLET ABSORPTION BY CONJUGATED ORGANIC IODIDE MOLECULES, by R. F. Schaufele and L. Goodman. [1965] 8p. incl. diagrs. tables, refs. (AFOSR-66-0588) (AF AFOSR-65-742) AD 632760 Unclassified

Also published in Trans. Faraday Soc., v. 61: 597-604, Apr. 1965.

Bands analogous to the Herzberg-Scheibe B and C bands in HI and CH_3I have been observed in iodine derivatives of planar conjugated hydrocarbons. From energy, intensity and substituent perturbation considerations they are assigned as arising primarily from $\pi f \longrightarrow 6s$ promotion, with persistence of J. j type coupling, where 6s is a Rydberg orbital predominantly composed of 6s iodine containing some carbon 3s contributions. (Contractor's abstract)

2273

Pennsylvania State U. Dept. of Engineering Mechanics, University Park.

EXPERIMENTAL TECHNIQUES FOR THE DIRECT OBSERVATION OF FATIGUE-INDUCED DEFORMATION FAULTING IN THIN-FOIL STAINLESS STEEL, by L. E. Murr and P. J. Smith. [1965] [7]p. incl. illus. diagrs. refs. (AFOSR-65-1155) (AF AFOSR-63-165) AD 618357 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 233: 755-761, Apr. 1965.

A study is made by transmission electron microscopy of thin foils of 304 stainless steel fatigues external to the electron microscope in reversed bending, and of thin foils fatigued directly within the microscope in alternating tension. The build-up of stacking faults in the thin foil during fatigue was correlated with the dislocation structures found in thin films prepared from fatigued bulk specimens. The performance of the special devices designed for fatigue of thin foils so outlined and the importance of alternative methods of preparation of more uniform fatigue specimens by vapor deposition are emphasized. (Contractor's abstract)

2274

Pennsylvania State U. Dept. of Engineering Mechanics, University Park.

A TRIAXIAL EXPERIMENT ON YIELD CONDITION IN PLASTICITY, by L. W. Hu, J. Markowitz, and T. A. Bartusn. Jan. 1965, 21p incl diagrs. tables. (AFOSR-65-0313) (AF AFOSR-64-127) AD 614574 Unclassified

A triaxial stress experiment was developed for the determination of the intersections of the initial and subsequent yield surfaces with a hydrostatic stress-principal stress plane. Results of an experiment on Nittany Brass No. 2 of the soft grade were reported. Information so obtained makes it possible rather than a 2-dimensional curve as observed in conventional biaxial stress tests. (Contractor's abstract)

2275

Pennsylvania State U. Dept. of Engineering Mechanics, University Park.

LOAD-CARRYING CAPACITIES FOR RECTANGULAR PLATES OF ANISOTROPIC MATERIALS, by L. W. Hu. Jan. 1965, 27p. incl. diagrs. tables, refs. (AFOSR-65-0314) (AF AFOSR-64-127) AD 614575 Unclassified

A complete solution to the load-carrying capacities of rectangular plates with anisotropy is obtained. The plates are simply supported and subjected to uniformly distributed load. The anisotropy is described by the modified v. Mises yield condition suggested by Hill. Also, a complete solution to the load-carrying capacities of isotropic plates is derived from the aforementioned solution as a special case. (Contractor's abstract)

2276

Pennsylvania State U. Dept. of Engineering Mechanics, University Park.

CASCADE ARRANGEMENT IN SPHERICAL PRESSURE VESSEL DESIGN FOR NUCLEAR POWER REACTORS, by L. W. Hu and J. C. Schultzler. Jan. 1965, 27p. incl. diagrs. tables. (AFOSR-65-0315) (AF AFOSR-64-127) AD 614591 Unclassified

Pressure vessels in cascade arrangement are suggested for nuclear power reactor design. The stress analysis and a procedure for the minimum weight design of cascade spherical shells are presented. A numerical example of 2 stage spherical shells is given to demonstrate the procedures developed as well as the need of such type of pressure vessels in nuclear power reactor design. (Contractor's abstract)

2277

Pennsylvania State U. Dept. of Engineering Mechanics, University Park.

THE APPLICATION OF COLOR PHOTOGRAPHY TO TRANSMISSION ELECTRON MICROSCOPE STUDIES OF THIN METAL FOILS, by L. E. Murr and N. C Inman. [1965] [9]p. incl. illus. and table. (AFOSR-65-2126) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-569 and National Science Foundation) AD 629843
Unclassified

Also published in Phys. State Solids, v. 10: 441-445, 1965.

A study was made of the application of color photography to observations of dislocation motion and other time dependent phenomena in thin metal foils by transmission electron microscopy. In the present application, pairs of sequential electron transmission micrographs are first superposed optically to obtain color addition The superposed image is then photographed using standard color emulsions. It was found that photographic density changes in black and white which result from the movement of dislocations, bend contours, dispersed particles and like phenomena, are sensitively reproduced as a corresponding color change which is immediately apparent to the eye (Contractor's abstract)

2278

Pennsylvania State U. Dept. of Engineering Mechanics, University Park.

SOME OBSERVATIONS OF DISLOCATION MOTION IN THIN METAL FOILS RESULTING FROM HIGH INTENSITY ELECTRON IRRADIATION IN AN ELECTRON MICROSCOPE, by L. E. Murr. [1965] 12p. incl. illus, diagrs, tables, refs. (AFOSR-66-2648) (AF AFOSR-64-669) AD 643186 Unclassified

Also published in Proc. Penn. Acad. Sci., v 39: 202-213, 1965

Dislocation motion in thin foils of stainless steel and inconel (76% Ni, 16% Cr) was observed by transmission electron microscopy. Stresses required to move and nucleate dislocations were measured directly from electron micrographs with the aid of selected area electron diffraction patterns of the dislocated areas. A theoretical treatment is presented to account for the stresses induced in thin foils by the action of the electron beam, and it is concluded that thermal stresses of sufficient magnitude to move dislocations could exist. (Contractor's abstract)

2279

Pennsylvania State U. [Dept. of Physics] University Park

MECHANISM OF THE PRECIPITATION OF THE SPINEL FROM MgO-Al_2O_3 SOLID SOLUTIONS, by V. S. Stubican and R. Roy. [1965] [5]p. incl. diagrs. [AFOSR-65-2024) (AF 49(638)957) AD 627716
Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1293-1297, Aug. 1965.

The point defects present in the MgO-Al_2O_3 crystalline solutions were investigated by using precise cell dimensions and density measurements. The precipitation of the spinel from crystalline solutions was studied by quantitative x-ray diffraction. It was found that the precipitation is a diffusion controlled process, and the equation for the fraction precipitated, $y = 1-\exp[-(t/\tau)^n]$, fits the experimental results for y= 0.05 - 0.95. The exponent n was found to be very close to 3 2, suggesting that under the experimental conditions the growing particles are approximately spheroidal. Electron prove investigations showed that the preferred sites for the nucleation and the precipitation of spinel were the grain boundaries and intergranular voids. (Contractor's abstract, modified)

2280

Pennsylvania State U. Dept. of Physics, University Park.

[PHYSICAL PROPERTIES OF SUBSTANCES BY MEANS OF ACOUSTICAL MEASUREMENTS , by E. J. Skudrzyk. Final rept. Jan. 1965 [16]p. (AFOSR-65-0243) (AF AFOSR-63-43) AD 627657
Unclassified

The papers listed in this report discussed the following topics: (1) measurements at very low frequencies; (2) measurements of the elastic modulus and the loss factor of small specimen such as strips and foils; (3) measurements of the bulk modulus of a small sample; (4) measurements at 500 kcs to 5 mc by loading a quartz crystal; (5) ultrasonic attenuation and wave propagation in solids; and (6) attenuation in aluminum and bell metal at frequencies between 100 cps and 10 kc.

2281

Pennsylvania State U. Dept. of Physics, University Park.

FLUX METHODS FOR THE ANALYSIS OF TRANSPORT PROBLEMS IN SEMICONDUCTORS IN THE PRESENCE OF ELECTRIC FIELDS, by J. P. McKelvey and J. C. Balogh. [1965] [7]p. incl. diagrs. (AFOSR-65-1182) [AF AFOSR-63-73] AD 621427
Unclassified

Also published in Phys. Rev., v. 137: A1555-A1561, Mar. 1, 1965.

A calculational technique based upon the detailed study of flux interactions between various parts of a diffusion-recombination system is extended to include cases where electric fields may be acting upon the particles of the system. The analysis is worked out in detail for systems obeying Boltzmann statistics in

which the field satisfies the condition $\mu E_0 < c$, where $\bar{c}$ is the mean thermal velocity. Analytic solutions for the reflection and transmission coefficients of a sheet of material of arbitrary thickness for incident carriers are worked out for constant electric fields; approximate or numerical methods are applicable for nonconstant fields. The effect of the details of scattering and recombination processes upon the solutions is considered. A simple example is worked out to exhibit areas of agreement between this method and the more conventional calculational techniques and to demonstrate certain advantages in generally and conceptual simplicity associated with the flux method. (Contractor's abstract)

2282

Pennsylvania State U., [Dept. of Physics] University Park.

FLUX METHODS FOR TRANSPORT PROBLEMS IN SOLIDS WITH NONCONSTANT ELECTRIC FIELDS. USING A WKB APPROXIMATION (Abstract), by E. F. Pulver and J. P. McKelvey. [1965] [1]p. [AF AFOSR-63-73] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Ser. II, v. 10, 504, Apr. 26, 1965.

Recently developed methods for the solution of 1-dimensional steady-state transport problems in solids (particularly semiconductors) have been extended to cases where nonconstant electric fields act upon the charged carriers of the system by the use of a WKB method of approximation. A system of coupled flux conservation equations for the diffusion-recombination system is solved, and by the use of the WKB approximation expressions for the reflection and transmission coefficient of a layer of material of arbitrary thickness, which involve integrals of the field are derived. The expressions that are obtained for the zero-recombination case are exact. Criteria for the validity of the WKB method are discussed, and it is shown that the method is applicable when the drift velocity is much less than the mean thermal velocity and when the field gradient is smaller than a specified amount. The latter condition can be expressed in the form $d(q^{-1})/dx < 1$, where $q = (2k_0w_0 + w_0^2 + h^2E^2)^{1/2}$; here k_0, w_0 represent the scattering and recombination probabilities, respectively, per particle per unit distance and $n = kT/2e$.

2283

Pennsylvania State U. Dept. of Physics, University Park.

EXSOLUTION OF β-Ga_2O_3 CRYSTALLINE SOLUTIONS IN THE SYSTEM $MgAl_2O_4$—Ga_2O_3, by G. Katz and R. Roy. [1965] 3p. incl. diagrs. tables, refs. (AFOSR-66-0232) (AF AFOSR-63-208) AD 629699 Unclassified

Presented at the Sixty-sixth annual meeting of the Amer. Ceramic Soc., Chicago, Ill., Apr. 21, 1964.

Also published in Jour. Amer. Ceram. Soc., v. 48: 450-452, 1965

The subsolidus phase equilibrium diagram for the pseudobinary join $MgAl_2O_4$—Ga_2O_3 was determined. The shape of the exsolution boundary was obtained by heat-treating samples pre-equilibrated at 1600 C. Crystalline solubility of Ga_2O_3 in $MgAl_2O_4$ decreased from 73 mol-% at 1600° to 55 mol-% at 1200°C. The crystalline solution was formed by the replacement of Mg^{2+} ions by Ga^{3+} ions to produce a cation defect spinel. The phase precipitated was the monoclinic β-Ga_2O_3 (θ-Al_2O_3 structure). Changes in the ratios of relative X-ray diffraction intensities indicated that the crystalline solutions also disorder with temperature. (Contractor's abstract)

2284

Pennsylvania State U. [Dept. of Physics] University Park.

EXPERIMENTAL CONFIRMATION OF MAJOR CHANGE OF DEFECT TYPE WITH TEMPERATURE AND COMPOSITION IN IONIC SOLIDS, by A. M. D Diness and R. Roy. [1965] 3p. incl. diagrs. (AFOSR-66-2150) (AF AFOSR-63-208) AD 643452 Unclassified

Also published in Solid State Commun., v. 3, 123-124, 1965

The change of predominant point defect-type from interstitial cations to anion vacancies is presented as a function of temperature and concentration for the flourite-type crystalline solution field in the system ZrO_2-CaO. The characterization of the point defect content of these materials is based upon experimental determinations of densities and precision X-ray lattice parameters. (Contractor's abstract)

2285

Pennsylvania State U. Dept. of Physics, University Park.

THE USE OF A NEW POTENTIAL BARRIER MODEL IN THE FOWLER-NORDHEIM THEORY OF FIELD EMISSION, by P. H. Cutler and D. Nagy. [1965] [24]p. incl. diagrs. tables, refs. (AFOSR-65-0782) (AF AFOSR-63-213) AD 616202 Unclassified

Also published in Surface Sci., v. 3: 71-94, Jan 1965.

For fields $> 5 \times 10^7$ v/cm, the observed field emitted current density deviates from the Fowler-Nordheim theory. One possible reason for this is the inaccuracy of the classical image-force barrier at small distances from the surface. This report examined the effect of a modified surface potential barrier on the emitted current and energy distributions in the field emission region. The new potential represents

quantum modifications to the classical image-force and is based on quantum-mechanical calculations of the electronic potential in the surface region of a metal. The result for the current density is obtained in analytic form, and energy distributions of the field emitted electrons are calculated for the normal and total energy cases.

2286

Pennsylvania State U. Dept. of Physics, University Park.

FIELD IONIZATION OF AN ATOM NEAR A METAL SURFACE, by D. S. Bourdreaux and P. H. Cutler. [1965] 3p. incl. diagrs. (AFOSR-66-0229) (AF AFOSR-63-213) AD 629676 Unclassified

Also published in Solid State Commun., v. 3: 219-221, 1965.

A new method is reported for calculating the field ionization of an atom near a metal surface. Instead of calculating the tunneling probability of a one-dimensional system, a variational calculation of the interaction energy of the atom with the external field is considered. The width of the ionization zone is calculated and found in reasonable agreement with known experimental data. (Contractor's abstract)

2287

Pennsylvania State U. [Field Emission Lab.] University Park.

FIELD-EVAPORATION END FORM OF TANTALUM, by S. Nakamura and E. W. Müller. [1965] [5]p. incl. illus. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-96 and Office of Naval Research) Unclassified

Published in Jour Appl. Phys., v. 36: 2535-2539, Aug. 1965.

A field-evaporation end form depends in a complicated way upon many factors. The end form of a pure and nearly perfect metal crystal as obtained under various conditions must be established experimentally to permit proper interpretation of field-ion micrographs of general specimens of that metal. The end form of tantalum, distinctly different from other bcc metals such as tungsten, molybdenum, and iron, is shown in its dependence on temperature, hydrogen promotion, and field-stress-induced slip. Low-coordination atom sites stabilized by polarization occur in specific crystallographic regions.

2288

Pennsylvania U. [Dept. of Electrical Engineering] Philadelphia.

DESCRIPTION OF CATALOGING AND INDEXING SYSTEM FOR THE ACM REPOSITORY, by M. Rubinoff and J. F. White, Jr. Jan. 25, 1965, [63]p. incl. diagrs. tables, refs. (AFOSR-65-0424) (AF 49(638) 1421) AD 612277 Unclassified

The repository library of the Association for Computing Machinery (ACM) was first proposed in 1961, and subsequently the Moore School of Electrical Engineering was designated as the site. The Moore School established an advisory board on information retrieval, a research team to provide council in relating the repository to current developments. The Moore School research team concentrated on preparation of an organizational and procedural plan for a mechanized information center with 2 principles: (1) a library must make its information as easily accessible to a customer as any store, and (2) information service should be provided at a competitive price. The system aims to store bibliographic elements, 4 echelons of index terms for enhancing user convenience, and a number of document attributes for expediting user search. The system has a "multiport" entry plan whereby search may be based on any of the many aspects of the contents of the packaging of documents. The concept of the multiport entry is an outgrowth of the Moore School multilist system (AD 270573) and has been incorporated into the indexing system via "added info" groups. The scheme also permits stochastic search through the system, i.e., attaining the most applicable word from an initial approximation and a search through related categories, sections and classes.

2289

[Pennsylvania U. Dept. of Electrical Engineering] Philadelphia.

ESTABLISHMENT OF THE ACM REPOSITORY AND PRINCIPLES OF THE IR SYSTEM APPLIED TO ITS OPERATION, by M. Rubinoff and J. F. White, Jr. [1965] [8]p. (AFOSR-66-0011) [AF 49(638)1421] AD 632185 Unclassified

Also published in Commun. Assoc. Comput. Mach., v. 8: 595-601, Oct. 1965.

The history of the establishment of the ACM Repository at the Moore School, Pennsylvania U., is reviewed briefly. The organizational and fundamental principles: (1) that information be made easily accessible to the customer, preferably on a self-serve basis, and (2) that the value of the services exceed user costs The system is designed for remote teletype writer on-line access to an information file in a 1301 disk storage which is auxiliary to the IBM 7040/1401 system at the university computer center. Significant features of the planned system include: (a) direct access via the console, (b) system storage of a complete description of itself in addition to document catalog and indexing data to enable users to design their own search strategies, (c) use of an unrestricted search vocabulary, (d) access through one or more of a large number of entry ports to enable adaptive man-machine interfacing with the indexing structure, and (e) stochastic type searching through related categories, sections, and classes of data. Thesauri and microthesauri are embedded in the system and kept dynamic and open-ended. The index terms have been generated primarily with regard to the document file

rather than with regard to a philosophical partitioning of knowledge, and with a view to interests of potential users and the nature of future accessions The collection primarily deals with computing machinery and programming languages.

2290

Pennsylvania U. School of Medicine, Philadelphia

INDEPENDENCE OF LUTEINIZING HORMONE AND ADRENOCORTICOTROPHIN SECRETION IN THE RAT, by V. D. Ramirez, D. Moore, and S. M. McCann. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-1509) (Sponsored jointly by AFOSR under AF AFOSR-62-133, and National Institute of Health) AD 622921 Unclassified

Also published in Proc. Soc. Exper. Biol. and Med., v. 118: 169-173, 1965.

Experiments were performed on adult, virgin female rats to determine if alterations in the titers of circulating adrenal and ovarian steroids would (1) produce alterations in the secretion of both luteinizing hormone (LH) and adrenocorticotrophin (ACTH), or (2) modify only the secretion of the trophin specific for the particular target gland. Results showed that alteration of the target gland steroids produced specific effects on LH in the case of ovarian steroids, and ACTH in the case of cortical steroids. Estrogen can stimulate ACTH secretion and inhibit LH secretion simultaneously.

2291

Pennsylvania U. School of Medicine, Philadelphia.

PHYSIOLOGY AND CHEMISTRY OF HYPOTHALAMIC FACTORS WHICH INFLUENCE GONADOTROPHIN SECRETION, by S. M. McCann, J. Antunes-Rodrigues and A. P. S. Dhariwal. [1965] [8]p. incl. diagrs. refs. (AFOSR-66-0994) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-133, Ford Foundation and Public Health Service) AD 634582 Unclassified

Also published in Proc. Internat'l. Union of Physiological Sciences; Twenty-third Internat'l. Cong., Tokyo (Japan) (Sept. 1-9, 1965), Amsterdam, Excerpta Medica Foundation, v. 1: 292-299, 1965.

Crude acidic hypothalamic extracts from rat, beef, or sheep are active in releasing LH (ovarian ascorbic acid assay) and FSH (mouse uterine weight augmentation or rat ovarian weight augmentation assays). These extracts are also capable of inhibiting the nursing-induced decline in pituitary prolactin stores. The LH-RF can elevate plasma LH in a variety of situations, both the FSH-RF and LH-RF are active in ovariectomized rats in which the release of FSH and LH have been inhibited either by administration of both estrogen and progesterone, or by hypothalamic lesions which eliminate neural control of gonadotrophin secretion. This latter observation suggests that these two factors act directly on the pituitary to discharge gonadotrophins. Cerebral cortical extracts are incapable of affecting gonadotrophin secretion and the LH-RF has been shown to be localized in the SME region. The FSH-RF, LH-RF and PIF are relatively heat stable on comparison with the neat lability of LH.

2292

Pennsylvania U. Hospital [Dept. of Psychiatry] Philadelphia.

UNDESIRABLE EFFECTS OF HYPNOSIS: THE DETERMINANTS AND MANAGEMENT, by M. T. Orne. [1965] [12]p. incl. refs. (AFOSR-67-1844) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-707, National Institute of Health, and Office of Naval Research) AD 656970 Unclassified

Also published in Internat'l. Jour. Clin. and Exper. Hypnosis, v. 13: 226237, 1965.

Various kinds of complications arising from the use of hypnosis are reviewed. The distinction is drawn between the induction of hypnosis when it is perceived as an episodic event, as in a laboratory context, versus the effect when it is perceived as leading to permanent changes, as in a therapeutic context. An attempt is made to draw these and other distinctions in order to understand better the possible sources of difficulties. (Contractor's abstract)

2293

Pennsylvania U. Hospital [Dept. of Psychiatry] Philadelphia.

SPECIFIC MOTOR RESPONSE DURING SLEEP TO SLEEP-ADMINISTERED MEANINGFUL SUGGESTION: AN EXPLORATORY INVESTIGATION, by J. C. Cobb, F J. Evans, and others [1965] 8p. incl. illus. diagr. refs. (AFOSR-67-1853) (AF AFOSR-65-707) AD 656647 Unclassified

Also published in Perceptual and Motor Skills, v 20: 629-636, Apr. 1965.

Complex meaningful suggestions were given during various stages of physiological sleep as defined by EEG monitoring to 4 Ss high and 4 Ss low in hypnotizability All the high hypnotizability Ss gave accurate behavioral responses while remaining asleep, but none of the low hypnotizability Ss did do. Specific response to sleep-administered suggestion was obtained only during State 1 periods. (Contractor's abstract)

2294

Philco Corp. Aeronutronic Div., Newport Beach, Calif.

DISSOCIATION ENERGY OF BORON MONOFLUORIDE FROM MASS-SPECTROMETRIC STUDIES, by D. L. Hildenbrand and E. Murad. [1965] [4]p. incl. tables, refs. (AF 49(638)1397) Unclassified

Published in Jour. Chem. Phys., v. 43: 1400-1405, Aug. 15. 1965

Gaseous equilibria involving BF, BF_3, Ca, CaF and CaF_2 were studied by mass spectrometry in the range 1583° to 1734 K. The vapor species were produced in a graphite Knudsen cell containing a mixture of elemental boron and calcium fluoride, and they were identified from their characteristic mass spectra and ionization-efficiency curves. From ion-intensity measurements made at ionizing energies a few volts above thresnold, the equilibrium constants and heats of several reactions involving BF(g) were evaluated. These results yield the standard heat of formation -27.5±3 kcal/mol for BF(g) and the dissociation energy, $D_0°$, of 7.85 ± 0.15 ev. The thermochemical dissociation energy of BF is significantly larger than a spectroscopic value obtained from linear extrapolation of the ground-state vibrational levels, but it agrees well with a value taken from a short extrapolation of the vibrational levels in the excited $^1\pi$ state. (Contractor's abstract)

2295

Philco Corp. Aeronutronic Div., Newport Beach, Calif.

THERMODYNAMIC PROPERTIES OF PROPELLANT COMBUSTION PRODUCTS, by N. D. Potter. Quarterly letter rept. no. 1, June 1-Aug. 31, 1965, 7p. incl. tables, refs. (Publ. no. QLR-65-14) (AFOSR-65-2295) (AF 49(638)1577) AD 625044 Unclassified

The objective of this research is to provide thermodynamic data for species which are potentially important combustion products of advanced chemical rockets and for species which are related to these. Enthalpy and entropy data were obtained from equilibrium measurements made by torsion-free evaporation and torsion-effusion techniques and by high temperature mass spectrometry

2296

Philco Corp. Aeronutronic Div., Newport Beach, Calif.

THERMODYNAMIC PROPERTIES OF PROPELLANT COMBUSTION PRODUCTS, by N. D. Potter. Quarterly letter rept. no. 2, Sept. 1-Dec. 31, 1965, 5p. incl. tables. (Publ. no. QLR-66-3) (AFOSR-66-0354) (AF 49(638)1577) AD 630634 Unclassified

For abstract see item no. 2295.

2297

Pisa U (Italy).

ELECTROCORTICAL CORRELATES OF AVOIDANCE CONDITIONING IN THE MONKEY AND THEIR MODIFICATIONS WITH ATROPINE AND AMPHETAMINE, by G. F. Ricci and L. Zamparo. [1965] [17]p. incl. diagrs refs. (AFOSR-65-1545) (AF EOAR-62-102) AD 623378 Unclassified

Abstract published in Biochem. Pharmacol., v. 12, (Suppl.): 268-269, 1963.

Also published in Pharmacology of Conditioning, Learning and Retention; Proc. Second Internat'l. Pharmacol. Meeting, Prague (Czechoslovakia) (Aug. 20-23, 1963), ed. by M. Ya. Mikhil'son, V. G. Lonzo, and Z. Votava. New York, Pergamon Press, 1965, p. 269-285.

Avoidance conditioning experiments were conducted on the monkey. Results are presented which show that the facilitatory mechanisms accompanying the onset of the conditioned and differential trials in the visual cortex are unaffected in spite of the behavioral effects caused by atropine and amphetamine. In contrast, the modifications of the cortical responses which accompany the performance of the correct responses both in the visual and sensory motor areas are disrupted by atropine and reactivated by amphetamine.

2298

Pisa U. (Italy).

CARLEMAN ESTIMATES FOR THE LAPLACE-BELTRAMI EQUATION ON COMPLEX MANIFOLDS, by A. Andreotti and E. Vesentini. [1965] [50]p. incl. refs. (AFOSR-65-2646) (AF EOAR-63-29) AD 627990 Unclassified

Also published in Publ. Math., No. 25: 81-130, 1965.

The finiteness theorems of Andreotti and Grauert (Bull. Soc. Math. France, v. 90: 193-259, 1962) for cohomology with coefficients on a locally free sheaf on a complex manifold are given a differential-geometric treatment. This treatment sacrifices the generality of analytic spaces, but bypasses the difficult approximation theorem of Andreotti and Grauert, using instead L2-estimates with weights on compactly supported cohomology represented by forms. The techniques used are an expansion of those of an earlier paper by the authors (Ann. Scuola Norm. Sup. Pisa, v. 15: 283-309, 1961), together with clever use of the Carleman-type inequality. The authors first obtain the vanishing of the appropriate cohomology on a q-complete manifold and proceed via the abstract finiteness theorem of L. Schwartz (C. R. Acad. Sci. Paris, v. 236: 2472-2473, 1953) to the q-pseudoconvex manifolds. The authors give a lucid exposition of all the techniques used; in particular, there is a full discussion of the relevant topological spaces, called Fréchet-Schwartz spaces. Besides the finiteness theorems, there is also a general extension theorem for forms with coefficients in a vector bundle defined near the boundary of a complex manifold. (Math. Rev. abstract)

2299

Pisa U. (Italy).

[ANALYTICAL METHODS FOR ABELIAN VARIETIES IN POSITIVE CHARACTERISTIC. CHAPTERS 3, 4] Metodi analitici per varieta abeliane in caratteristica

positiva. Capitoli 3, 4, by I. Barsotti. [1965] [52]p. incl. diagrs. refs. (AFOSR-65-2739) (AF EOAR-63-29) AD 628350 Unclassified

Also published in Ann. Scuola Norm. Super. Pisa, Ser. III, v. 19: 277-330, 1965.

Chapter 3 is devoted to the classification of certain hyperalgebras called "hyperdomains"; they form a category isomorphic to the category of canonical K-modules. Chapter 4 contains the classification of "bidomains", namely the inverse limits of hyperdomains; their category is isomorphic to the category of canonical K'-modules (K' = quotient field of K).

2300

Pisa U. (Italy).

[A GENERALIZATION OF THE THEOREM OF RIESZ-THORIN] Una generalizzazione del teorema di Riesz-Thorin, by S. Campanato and M. K. V. Murthy. [1965] [14]p. incl. refs. (AFOSR-68-0061) (AF EOAR-63-29) AD 663660 Unclassified

Also published in Ann. Scoula Norm. Super. Pisa, v. 19: 87-100, 1965.

The authors prove a large number of interpolation theorems generalizing the following theorem (of Riesz-Thorin): If T is a linear operator which simultaneously maps $L^{p_j}(\Omega)$ into $L^{q_j}(\Omega)$ with respective bounds K_j, $j = 1, 2$, then for each t on [0, 1], T maps $L^{p}(\Omega)$ into $L^{q}(\Omega)$ with bound $K_1^{1-t}K_2^{t}$ if p and q are given by $p^{-1} = (1-t)p_1^{-1} + tp_2^{-1}$, $q^{-1} = (1-t)q_1^{-1} + tq_2^{-1}$. Their first theorem is a very similar theorem concerned with maps T from $L^{p_j}(\Omega)$ to spaces $L_k^{(q_j, \lambda_j)}(\Omega)$; $u \in L_k^{(p, \lambda)}(\Omega)$ (with $p \geq 1$, $\lambda \geq 0$) if and only if $r^{-\lambda/p} \inf \| u - P \|_{p, \Omega(x,r)} \leq L < \infty$ for all $x \in \Omega$, and $0 < r \leq d$, d being the diameter of Ω and $\Omega(x, r)$ being $\{y : y \in \Omega, |x-y| < r\}$, the inf being with respect to all polynomials of degree $\leq k$. One of their most interesting results concerns an operator which simultaneously maps $L^{p1}(\Omega)$ into $L^{q1}(\Omega)$ and $L^{p2}(\Omega)$ into $C^{h2, \alpha 2}(\Omega)$, i.e., functions of class C^{h2} with α_2-Holder-continuous derivatives; the theorem is too long to state here. The theorems require that the measure of $\Omega(x, r)$ be $\geq cr^n$, $c > 0$, for each $x \in \Omega$ and $r < d$; the last theorem also requires the convexity of Ω.

2301

Pisa U. [Dept. of Mathematics] (Italy).

THE SPACES $L^{p, \lambda}$, $N^{p, \lambda}$ AND INTERPOLATION, by G. Stampacchia. [1965] [20]p. incl. refs. (ASOSR-65-2643) (AF EOAR-65-42) AD 627732 Unclassified

Also published in Ann. Scuola Norm. Super. Pisa, (Ser. III), v. 19: 443-462, 1965.

A theorem of interpolation for linear operations whose image spaces vary from L^p to E_o has been proven earlier. The purpose of this report is to supply a complete proof of this theorem. Application to the Morrey spaces and to the Holder continuous functions are given.

2302

Pisa U. [Dept. of Mathematics] (Italy).

[ON THE L^p ESTIMATES IN THE THEORY OF ELLIPTIC EQUATIONS] Sulle maggiorazioni in L^p nella teoria dell'equazioni elliittiche, by S. Campanato and G. Stampacchia. [1965] 7p. incl. refs. (AFOSR-66-0203) (AF EOAR-65-42) AD 641149 Unclassified

Also published in Boll. U. M. I., v. 20: 393-399, 1965.

L^p estimates for derivatives of solutions of second order elliptic partial differential equations are proven making use of $L^{2, \lambda}$ estimates given by Campanato and of an interpolation theorem given by Stampacchia.

2303

Pisa U. [Dept. of Mathematics] (Italy)

[ANALYTICAL METHODS FOR ABELIAN VARIETIES IN POSITIVE CHARACTERISTICS, CHAPTER 5] Metodi analitici per varieta abeliane in caratteristica positiva, Capitolo 5, by I. Barsotti. [1965] 32p. (AFOSR-66-0256) (AF EOAR-65-42) AD 632322 Unclassified

Also published in Ann. Scuola Norm. Super. Pisa, Ser. III, v. 19: 481-512, 1965

Studies are made on the classification of special hyper-algebras in characteristic p and bidomains by considering (Witt) covectors and bivectors. Derivations in the ring of bivectors with components in bidomains and analytical properties of functions on a such ring are also introduced. (Contractor's ab stract)

2304

Pisa U. [Dept. of Mathematics] (Italy).

[SECOND ORDER ELLIPTIC EQUATIONS AND $L^{(2, \lambda)}$ SPACES] Equazioni ellittiche del II ordine e spazi $L^{(2, \lambda)}$, by S. Campanato. [1965] 65p. incl. refs. (AFOSR-66-0267) (AF EOAR-65-42) AD 630214 Unclassified

Also published in Ann. Math. Pura Appl., v. 69: (ser.) 321-382, 1965.

Regularity results of Schauder type in the class of Holderian functions are proven for solutions of second order elliptic equations in the variational form. The method of proof makes use of the classes of functions $L^{2, \lambda}$ which generalize the classes considered by Morrey, and whose properties in relation to Holder continuity are studied in some previous works.

2305

Pisa U. [Dept. of Mathematics] (Italy).

[PERIODIC SOLUTIONS OF THE WAVE EQUATION WITH NONLINEAR DISSIPATIVE TERM] Soluzioni periodiche dell'equazione delle onde con termine dissipative non lineare, by G. Prodi. [1965] 13p. incl. refs. (AFOSR-66-1204) (AF EOAR-65-42) AD 639828 Unclassified

Also published in Rend. Sem. Matem. Univ. Padova, 1-13, 1965.

An existence and uniqueness theorem is proved for the n-dimensional wave equation with nonlinear dissipative term: $u'' - \Delta u + g(u') = f$ (f periodic). The function g is supposed to be monotone, with a rate of growth of p-power type. (Contractor's abstract)

2306

Pisa U. Inst. of Aeronautics (Italy).

AERODYNAMICS INTERACTION EFFECTS OF A SUPERSONIC AXISYMMETRIC JET EXHAUSTING BELOW A FLAT PLATE INTO A SUPERSONIC FREE STREAM, by E. Pistolesi and M. Marini. Final rept. May 1965 [59]p. incl. diagrs. (AFOSR-66-1394) (AF EOAR-63-97) AD 631556 Unclassified

The interference effect in a supersonic stream between a supersonic jet and a flat plate near it is studied by means of the linearized theory. The characteristics of a supersonic axisymmetric jet issuing from a duct in a supersonic stream are first obtained. The effects of the flow around the jet on a flat plate disposed at some finite distance from the jet discharge section are studied, showing the difficulties of an exact calculation and the possibilities to obtain some approximate results. (Contractor's abstract)

2307

Pisa U. Inst. of Physiology (Italy).

THE FUNCTIONAL SIGNIFICANCE OF SLEEP WITH PARTICULAR REGARD TO THE BRAIN MECHANISMS UNDERLYING CONSCIOUSNESS, by G. Moruzzi. [1965] 66p. incl. illus. diagrs. refs. (AFOSR-66-2590) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)830) and National Institute of Health) AD 643706 Unclassified

Also published in Semaine d'Etude sur Cerveau et Experience Consciente Rome, v. 30 515-577, 1965.

The main results obtained may be summarized as follows. (1) behavioral sleep is not necessarily associated with synchronization of the activity of brain neurons. There are episodes of desynchronized sleep, associated with rapid eye movements, twitching of the limbs and atonia of the antigravity muscles. These episodes have been observed in several mammals, including man, where they seem to be associated with dreams. They are related with the appearance of spikelike potential oscillations in the nucleus reticularis pontis caudalis and in the lateral geniculate body; (2) several lines of evidence suggest the existence, within the medulla and the lower pons, of EEG synchronizing structures, antagonistically oriented with regard to the activating reticular system and probably related with the onset of sleep.

2308

Pisa U. Inst. of Physiology (Italy).

RESEARCH ON THE STRUCTURE AND PHYSIOLOGY OF THE EYES OF A LYCOSID SPIDER. III. ELECTRORETINOGRAPHIC RESPONSES TO POLARIZED LIGHT, by F. Magni, F. Papi and others. [1965] 15p. incl. diagrs. refs. (AFOSR-65-2946) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-9, and the Rockefeller Foundation) AD 628376 Unclassified

Also published in Arch. Ital. Biol., v. 103: 146-158, 1965.

The electroretinographic responses of the anterior median and posterior median eyes of Arctosa variana C. L. Koch to flashes of polarized light of the same intensity, show maxima and minima upon rotation of the plane of polarization. The effect disappears when the eye is adapted to a strong background light. The analyzer mechanism is located at the level of the retina.

2309

Pisa U. [Inst. of Physiology] (Italy).

OCULAR PHENOMENA DURING SYNCHRONIZED AND DESYNCHRONIZED SLEEP, by G. Verlucchi and P. Strata. [1965] [23]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2947) (AF EOAR-62-9) AD 628379 Unclassified

Also published in Colloq. Internationaux de Centre Nat'l de la Recherche Scientifique. Aspects Anatomo-Fonctionnels de la Physiologie du Sommeil, Lyon (France) (Sept. 9-11, 1963) Paris, CRNS, No. 127: 285-307, 1965.

A review is given of the knowledge on the ocular manifestations of sleep and an attempt was made to analyse their relationships with the EEG. Special attention was given to pupils, visual accommodation, eye movements and eyelids.

2310

Pisa U. [Inst. of Physiology] (Italy)

INTRACELLULAR RECORDING FROM NEURONES OF THE RETICULAR FORMATION, by F. Magni and W. D. Willis. [1965] 11p. incl. diagrs. refs. (AFOSR-65-2948) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-9

and Rockefeller Foundation) AD 628378
Unclassified

Also published in Studies in Physiology. ed. by D. R. Curtis and A. K. McIntyre. Berlin, Springer-Verlag, 1965, p. 206-214.

This study attempted to relate electrical activity within the reticular formation to the behavior of particular kinds of reticular neurones. Reticulospinal neurones almost invariably received excitatory connections from the cerebral cortex. The cortical areas involved included the sensorimotor regions, the temporal cortex and the occipital cortex. It was established that at least part of the cortico-reticular pathway from the sensorimotor regions is monosynoptic. Since nearly half of reticulospinal neurons received afferent connections from peripheral an indication of the complexicity of the synoptic organization was generalized. Further work is being done on the patterns of connectivity of the reticular formulation.

2311

Pisa U. Inst. of Physiology (Italy).

ON THE ORIGIN OF THE DARK DISCHARGE OF RETINAL GANGLION CELLS, by G. W. Hughes and L. Maffei. [1965] 15p. incl. diagrs. refs. (AFOSR-65-2962) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-9, and Rockefeller Foundation) AD 628354
Unclassified

Also published in Arch. Ital. Biol., v 103: 45-59 1965.

In petrigeminal or decerebrate cats microelectrode spike recording from the retina was performed. The pulses were counted in one sec every 2 sec after having exposed the eye from 2 to 5 min to a very strong light (4000 Lux). The firing rate of the ganglion cells became stationary in 2 to 3 min after the light cutoff, while the threshold went on decreasing for a long time (up to 1 hr) The shapes of the transients of the ganglion cell firing rate as a function of time for 'on' and 'off' cells are presented. Because no relationship was observed during dark adaptation between the threshold changes and the ganglion cell firing rate, the conclusion was drawn that the dark discharge is not due to the activity of the receptors, but may rather be regarded as the expression of the autochthonous activity of the deafferented neural part of the retina. Other considerations lead to the hypothesis that the bipolar cells do not contribute to the activity of the ganglion cells in darkness

2312

Pisa U Inst. of Physiology (Italy)

RETINAL GANGLION CELL ACTIVITY IN CATS DURING DARK ADAPTATION, by G W Hughes and L Maffei [1965] [3]p incl. diagr. (AFOSR-65-2963) (Sponsored jointly by Air Force Office of Scientific Research under AF-EOAR-63-9, and Rockfeller Foundation) AD 628352 Unclassified

Also published in Nature, v. 205: 601-602, Feb. 6, 1965

The time-course of thresnold changes tested by means of short pulses of light and the time-course of the spontaneous firing rate of the same ganglion cell are completely different. From this observation it is concluded that: (1) any process of dark adaptation, either limited to the receptors or involving the neural elements of the retina, does not influence the ganglion cell dark discharge, at least after the transient period, (2) the dark discharge is likely to represent the spontaneous activity of deafferented retinal neurones; and (3) since there is good evidence that the visual thresnold during the process of dark adaptation is determined neurally rather than at the receptor level, it is likely that the dark deafferentation occurs between the bipolar and the ganglion cell. (Contractor's abstract)

2313

Pisa U. Inst. of Physiology (Italy).

[BEHAVIORAL AND ELECTROPHYSIOLOGICAL STUDY OF SLEEP IN THE PIGEON] Studio Comportamentale Electrofisiologico del Sonno nel Piccione, by V. Tradardi [1965] [2]p. (AFOSR-66-1122) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-9, and Rockefeller Foundation) AD 638062

Also published in Boll. Soc. Ital. Biol., v 40: 769-770, 1965.

The existence of 2 phases of sleep has been demonstrated behaviorally and electrophysiologically in the pigeon. A study was carried out on 15 adult pigeons of both sexes with implanted electrodes to record the EEG, ocular movements, and posterior neck muscle EMG. The study was done at night in complete darkness. Electrical activity was recorded on a Grass polygraph, and visual and photographic records were made in infra-red light. The first phase was characterized by a low-frequency (2-6cps), high-amplitude (75-300 mv) EEG, diminished nuchal muscle EMG, and practically silent EOG (electrooculogram). In this phase, the animals were immobile with closed eyelids. The second phase consisted of frequent single episodes lasting no longer than 10-12 sec and characterized by high-frequency (12-16cps), low amplitude (less than 50 mv) EEG, a further decrease in posterior neck muscle EMG (without complete atony), and a series of 3-8 positive or negative monophasic EOG oscillations lasting 0.1-0.2 sec and corresponding to the animal's ocular movements. During this phase the pigeon's head and neck drooped, and then suddenly the animal regained his initial position, apparently without waking up The 2 phases of sleep were similar to those observed in the cat, but the deep sleep episodes were shorter and not accompanied by complete nuchal atony The author concludes that it is probably the strong labyrinthine stimulus caused by the pigeon's head falling that interrupts the deep phase of sleep after so short a period of time

2314

Pisa U. Inst. of Physiology (Italy).

COMPARATIVE NEUROPHYSIOLOGY IN VISION, by G. Moruzzi. Final technical rept. Sept. 15, 1964-Sept. 14, 1965. Sept. 15, 1965, 10p. incl. refs. (AFOSR-65-2011) (AF EOAR-64-37) AD 627634 Unclassified

The work of this project has been concerned with investigations of the photic control of the flashing of fireflies, presynaptic inhibition in the lateral geniculate body of the cat, and the influence of sleep and wakefulness on the response of lateral geniculate neurons to sinewave photic stimulation and to flashes of light. Experiments on the firefly indicated that the effect of steady photic stimulation of the eyes on the spontaneous flashing varies inversely with the stimulus intensity. Direct electrical stimulation of the lantern with single pulses elicited a flash with constant latency. Photic stimulation with single pulses elicited a reflex flash. From investigations of the cat's lateral geniculate body, it was concluded that a presynaptic inhibitory control is exerted by the mesencephalic reticular formation and by several cortical areas on the transmission at the level of the lateral geniculate body (LGB). Control experiments on retinal units showed no difference in the response of sinewave photic stimulation during sleep and wakefulness. It was found that LGB unit responsiveness is always greater during wakefulness. The hypothesis of an inhibitory mechanism through interneurons at geniculate level is discussed as a possible explanation of decreased responsiveness found during synchronized sleep.

2315

Pisa U. [Inst. of Physiology] (Italy).

GENICULATE UNIT RESPONSES TO SINE-WAVE PHOTIC STIMULATION DURING WAKEFULNESS AND SLEEP, by L. Maffei, G. Moruzzi, and G. Rizzolatti. [1965] [2]p. incl. diagr. (AFOSR-65-2966) (AF EOAR-64-37) AD 627933 Unclassified

Also published in Science, v. 149: 563-564, July 30, 1965.

The oscillation in firing rate of units of the lateral geniculate body in response to stimulation with sinewave light was studied in unanesthetized cats with the brainstem sectioned immediately in front of the fifth nerve (pretrigemical preparation). During wakefulness, as indicated by behavior and by electroencephalograms, the time course of the oscillation in firing rate followed very closely the change in intensity of sine-wave light. During synchronized sleep there was no such relationship. (Contractor's abstract)

2316

Pisa U. [Inst. of Physiology] (Italy).

[PRESYNAPTIC INHIBITION IN THE LATERAL GENICULATE NUCLEUS] Inibizione presinaptica nel nucleo genicolato laterale, by A. Angel, F. Magni, and others. [1965] 2p. incl. refs. (AFOSR-65-1121) (AS EOAR-64-37) AD 638061 Unclassified

Also published in Atti. Accad. Naz. Lincei, Rend. Classe Sci. Fis. Mat. e Nat., Series 8, v. 38: 559-560, Apr. 1965.

Experimental evidence is presented for the existence of inhibitory control of the retinal afferents to the lateral geniculate nucleus by the reticular substance and the visual cortex. Work was done on the unanesthetized midpontine-pretrigeminal cat, a micropipette in the lateral geniculate nucleus was used to stimulate optic fibers ending there, and antidromic responses were recorded in the chiasm and optic nerve following enucleation. Stimulating the mesencephalic reticular formation or visual cortex increased the amplitude of the antidromic response, indicating a depolarization of the optic fiber terminals in the geniculate nucleus. It was concluded that this depolarizing effect is responsible for the lateral geniculate presynaptic inhibition and compare the effect to that demonstrated in the spinal medulla and cuneate nucleus following cortical stimulation.

2317

Pisa U. Inst. of Physiology (Italy).

UNIT RESPONSES OF THE LATERAL GENICULATE BODY TO LIGHT FLASHES DURING WAKEFULNESS AND SYNCHRONIZED SLEEP, by L. Maffei and G. Rizzolatti. [1965] 3p. incl. diagr. (AFOSR-66-2003) (AF EOAR-64-37) AD 643493 Unclassified

Also published in Experimentia, v. 21: 599-601, 1965.

The existence of a reticular control upon the responsiveness of cells in the lateral geniculate body (LGB) is well established. The enhancement during reticular or natural arousal of the geniculate responses evoked by electric shocks to the chiasm or optic nerve shows that the influence is facilitatory in nature. It is surprising, however, that the responses evoked by light flashes actually decrease during, or soon after mesencephalic reticular stimulation. The hypothesis of an occlusion at the level of the geniculate, between reticular and retinal inputs, cannot easily account for this discrepancy. This work is an attempt to reexamine the problem by a study of the evoked responses of single LBG units.

2318

Pisa U. Inst. of Physiology (Italy).

EXCITABILITY OF INTRA-GENICULATE OPTIC TRACT FIBRES AFTER RETICULAR STIMULATION IN THE MIDPONTINE PRETRIGEMINAL CAT, by A. Angel, F. Magni, and P. Strata. [1965] 24p. incl. diagrs. refs. (AFOSR-66-2064) (AF EOAR-64-37) AD 643102 Unclassified

Also published in Arch. Ital. Biol., v. 13: 668-693, 1965. 1965.

In the unanaesthetized mid-pontine pretrigeminal cat, stimulation of the mesencephalic reticular formation produced an enhancement in the excitability of the optic fibers entering the lateral geniculate body. The effect started 20 msec after the beginning of the stimulus, reached a maximum after 50-60 msec and lasted for 200 msec or more. The sites in the midbrain producing the effect were found in the area of the mesencephalic reticular formation. No effect was seen after stimulation of the superior colliculus, cerebral peduncles or medical meniscus. After stimulation of the mesencephalic reticular formation it was possible to record monophasically a slow wave from the optic nerve. Evidence is presented that the slow wave recorded from the optic nerve is not due to an envelop of centrifugally conducted spikes. Spikes can be recorded from the optic nerve or chiasm in animals with a sub-normal body temperature after stimulation of the mesencephalic reticular formation and they were interpreted as being analogous to the dorsal reflex. All these lines of evidence suggest that the depolarization of the terminals of optic fibres within the LGB was produced by an active presynaptic inhibitory process.

2319

Pisa U., Inst. of Physiology (Italy).

ELECTRORETINOGRAPHIC RESPONSES FROM THE EYES OF THE WOLF-SPIDER LYCOSA TARENTULA (ROSSI), by F. Magni and P. Strata. [1965] [11]p. incl. diagrs. refs. (AFOSR-66-2065) (AF EOAR-64-37) AD 643100 Unclassified

Also published in Arch. Ital. Biol., v. 103: 694-704, 1965.

In the Lycosid spider, Lycosa tarentula (Rossi), the ERG was studied in the principal and secondary eyes. Short flashes of light, up to 100 msec, evoked in the ERG of all eyes a monophasic negative wave. Longer stimuli evoked in the ERG of the principal eye a fast negative wave followed by a negative steady potential; at the end of the stimulus, the potential returned to zero or may show a positive overshoot. In the secondary eye there are, in addition, 2 slow components, the first positive, the second negative. These components can be experimentally eliminated and under these conditions the ERG resembled that of the principal eye. The ERG of the principal eye is interpreted as due, at least in part, to a generator potential arising from the receptor cells. The slow components of the secondary eye are likely to arise in other ocular structures, but it is not possible to explain their nature on the basis of the present researches. The hypothesis is made that they may be due to the activity of the neural network connecting the photoreceptor cells in the secondary eye.

2320

Pisa U. Inst. of Physiology (Italy).

INFLUENCE OF SLEEP AND WAKEFULNESS ON THE RESPONSE OF LATERAL GENICULATE UNITS TO SINEWAVE PHOTIC STIMULATION, by L. Maffei, G. Moruzzi and G. Rizzolatti. [1965] [13]p. incl. diagrs. refs. (AFOSR-66-2066) (AF EOAR-64-37) AD 643880 Unclassified

Also published in Arch. Ital. Biol., v. 103: 596-608, 1965.

A summary of the research performed provided these results. Units of the lateral geniculate body (LGB) were recorded in the unanaesthetized, midpontine pretrigeminal cat. A sinewave oscillation of light intensity, at different frequencies (from 0.1 to 1 cps), was used for visual stimulation. During behavioral and EEG wakefulness the firing of LGB units was modulated by the sinewave light in an almost linear fashion. The oscillation of the firing rate appeared to be perfect replica of the sinewave. The "on" cells were in phase with the stimulus, the "off" cells were 180 out of phase; and the "on-off" cells presented a stimulus response phase relationship between 0 and 180 . During synchronized sleep, every relation between sinewave stimulus and response disappeared. Control experiments, as well as several considerations, suggest that the hypnic "escape" of LGB units from the modulating influence of sinewave light may be due to the withdrawal of extraretinal volleys, possibly mediated by reticulo-geniculate pathways.

2321

Pisa U. Inst. of Physiology (Italy)

EFFECT OF SYNCHRONIZED SLEEP ON THE RESPONSE OF LATERAL GENICULATE UNITS TO FLASHES OF LIGHT, by L. Maffei and G. Rizzolatti. [1965] 15p. incl. diagrs. refs. (AFOSR-66-2067) (AF EOAR-64-37) AD 643101 Unclassified

Also published in Arch. Ital. Biol., v. 103: 609-622, 1965.

Units of the dorsal part of the lateral geniculate body (LGB) were recorded in the midpontine pretrigeminal cat. Flashes of light of 100-300 msec in duration were applied every 10 sec, after eliminations of the causes of error due to pupillary changes and eye movements. The LGB unit responsiveness to light flashes was calculated as signal to noise ratio (where the signal is the response correlated with the stimulus, and noise is the spontaneous activity before the stimulus). The LGB unit responsiveness resulted always greater during behavioral and EEG alertness, independently from the changes of the background firing. When the light pulse was decreased by means of neutral filters, a stimulus still evoking a clear-cut response during wakefulness, became uneffective during synchronized sleep. It was necessary to increase the intensity of the stimulus more than 10 times to have again a response. Control experiments have shown that this difference between sleep and wakefulness is not retinal in origin. The hypothesis of an inhibitory mechanism acting through interneurons on LGB units is discussed as a possible explanation of the striking decrease of responsiveness found during synchronized sleep

2322

Pittsburgh U. Dept. of Chemistry, Pa

PHOTOLYSIS OF TRIARYLPHOSPHINES. by M. I. Kaufman and C. E. Griffin. [1965] [4]p. (AFOSR 65-1129) (AF AFOSR-62-48) AD 619327
Unclassified

Also published in Tetrahedron Ltrs. No. 12: 769-772, 1965.

The photolysis of several triarylphosphines is studied in solutions of benzene, naphthalene and benzene-ethanol. Irradiation of triphenylphosphine in benzene for 1 hr gave diphenylphosphine and biphenylphosphine as major products. Longer irradiation periods did not appreciably increase the extent of decomposition. Analogous results were obtained with naphthalene as solvent; though in the presence of alcohols a different course of reaction occurred. In this case diphenylphosphine and ethyldiphenylphosphine were the major products.

2323

Pittsburgh U. Dept. of Chemistry, Pa.

PHOTOLYSIS OF BENZYLTRIPHENYLPHOSPHONIUM AND TETRAPHENYLPHOSPHONIUM CHLORIDES. by C. E. Griffin and M. L. Kaufman. [1965] [3]p. (AFOSR-65-1130) (AF AFOSR-62-48) AD 619758
Unclassified

Also published in Tetrahedron Ltrs., No. 12: 773-775, 1965.

The photolysis of benzyltriphenylphosphonium (I) and tetraphenylphosphonium (II) is studied in solutions of benzene-ethanol. Irradiation of I led to complete consumption in 3-1/2 hr. None of the several products identified, incorporated chlorine. The products were consistent with a photochemical degradation of the phosphonium cation by a given sequence. This sequence accurately predicted the products of the irradiation of II. The findings confirm the reversible nature of phosphoranyl radical formation in these systems and strongly suggest the occurrence of one-electron transfer processes involving reduction of phosphonium cations.

2324

Pittsburgh U. Dept. of Chemistry, Pa.

FREE RADICAL ATTACK ON TRIVALENT PHOSPHORUS DERIVATIVES. by C. E. Griffin. Final scientific rept. Oct. 1, 1961-Sept. 30, 1965. 15p. incl. refs. (AFOSR-65-2009) (AF AFOSR-62-48 and AF AFOSR-64-470) AD 627269 Unclassified

Summaries are presented of research concerned primarily with 3 areas of organophosphorus chemistry. (1) the photoinduced arylation of trivalent phosphorus compounds, (2) the photolysis of tri- and tetra-valent phosphorus compounds, and (3) studies of the physical properties (uv and nmr spectra) of these structures. This investigation has provided significant new knowledge regarding the free radical chemistry of organophosphorus compounds, particularly with regard to the reversibility of formation and chemistry of phosphoranyl radicals. Additionally, this research and that conducted simultaneously by Horner (Tetrahedron Ltrs. 763 1965) represent the first demonstrations of photochemical reactivity of organophosphorus compounds.

2325

Pittsburgh U. Dept. of Chemistry, Pa.

STUDIES OF INTERMETALLIC COMPOUNDS CONTAINING LANTHANIDES, by W. E. Wallace. Final rept. Dec. 1, 1962-Nov. 30, 1964. Jan. 1, 1965 [51]p. incl. diagrs. tables, refs. (AFOSR-65-0016) (AFOSR-63-187) AD 455668 Unclassified

The magnetic properties of 6 series of intermediate phases of intermetallic compounds, represented by the formulas ANi_2, ACo_2, ANi, ACu, AAg, and $A'Fe_2$, are discussed. The samples studied were prepared for research by extreme heat being applied in order to rid them of extraneous phases. Careful measurements were made on the samples in the paramagnetic region rather than the ferromagnetic phases. The symbol A designates one of the lanthanide metals. Special care was given to ANi and ACo_2. It was found that because there is non magnetism in the ANi_2 compounds, the moment per formula unit is that of the A Component; in the ferromagnetic phase these moments are lower than the free ion moments and the decrease is taken to be a crystal field effect. In the ACo_2 compounds, the measured moments suggested that the A and Co moments were antiferromagnetically coupled for the heavy lantnanides and ferromagnetically coupled for the light lanthanides.

2326

Pittsburgh U. Dept. of Chemistry, Pa.

MAGNETIC CHARACTERISTICS OF LANTHANIDE-COPPER COMPOUNDS, by R. E. Walline and W. E. Wallace. [1965] [19]p. incl. diagrs. tables, refs. (Also bound with its AFOSR-65-0016; AD 455668) (AF AFOSR-63-187) Unclassified

Published in Jour. Chem. Phys., v. 42: 604-607, Jan. 15, 1965.

Magnetic characteristics and structures of 11 intermetallic compounds represented by the formula LnCu are reported. The compounds with Ln = Ce, Pr, Nd and Sm occur in the FeB structure, those with Ln = Y, Gd, Tb, Dy, Ho, Er and Tm have the CsCl structure. YCu is a Pauli paramagnet. The magnetic characteristics of PrCu and NdCu are anomalous and attempts to deduce the nature of the cooperative magnetic phases in these materials, if any, at low temperatures are unsuccessful. Results for the other compounds

suggest that they are antiferromagnetic at low temperatures. TbCu and HoCu exhibit 2 magnetic transitions; the nigh temperature transition is interpreted as the Neel point and the one at the lower temperature as an order-order transition in the antiferromagnetic state. In the paramagnetic region effective moments in good agreement with the free tripositive ion values are observed in all cases except for GdCu and ErCu A variable moment is observed for ErCu whereas for GdCu a moment of 8.46 μ_B is obtained.

2327

Pittsburgh U. Dept. of Chemistry. Pa

A ROUTE TO ALDEHYDES AND KETONES BY A FOUR ELECTRON DECARBOXYLATIVE OXIDATION UTILIZING PURIDINE N-OXIDE, by T. Conen, H. Song and J. H. Fager. [1965] [6]p. (AFOSR-65-0538) (AF AFOSR-63-344) AD 614718 Unclassified

Also published in Tetrahedron Ltrs., No. 4: 237-241, 1965.

A 4-electron decarboxylative oxidation is reported. A probable reaction mechanism for the case of phenylacetic acid is presented which involves the nucleophilic rather than electrophilic attack of the α-position of a carboxylic acid. The results of reactions of anhydrides and acids with pyridine n-oxide are given in a table.

2328

Pittsburgh U. Dept. of Chemistry, Pa.

DEOXYGENATION REACTIONS OF AMINE OXIDES AND SULFOXIDES, by T. Cohen. [Final rept.] [1965] [52]p. incl. diagrs. refs. (AFOSR-65-1729) (AF 49(638) 788 and AF AFOSR-63-344) AD 625414 Unclassified

Research was conducted to determine the scope and nature of reactions of pyridine N-oxide with electrophiles. Reactions of dimethylsulfoxide with epoxides were also investigated. A new synthesis of α-hydroxyaldehydes and ketones was discovered, involving the oxidation of epoxides by dimethylsulfoxide which acts as a solvent. This new preparative procedure appears to require different reaction conditions for each epoxide used. The discovery of the oxidation of carboxylic acids by pyridine N-oxides to form aldehydes and ketones led to a new mechanistic concept involving activation of carboxylic acids toward nucleophilic attack at the α-position. Side products of this novel 4-electron decarboxylative oxidation, when phenyl-acetic acid is used, are diphenylmaleic anhydride, mandelic acid acetate and phenylglyoxylic acid. Evidence has been adduced that the currently accepted radical-pair mechanism for the reaction of acetic anhydride with 2- and 4-picoline oxide is probably incorrect and that the reaction occurs rather by an ion pair mechanism. Other observations made in the course of the work are discussed.

2329

Pittsburgh U. Dept. of Chemistry, Pa.

THE REACTIONS OF 2-AND 4-PICOLINE N-OXIDE WITH PHENYLACETIC ANHYDRIDE, by T. Cohen and J. H. Fager. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-66-0318) (AF AFOSR-63-344) AD 625035 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 5701-5710, Dec. 1965.

The reactions of 2- and 4-picoline N-oxide with phenylacetic anhydride yield the oxidation-reduction products, benzaldehyde, carbon dioxide, picolines, and small quantities of diphenylmaleic annydride, in addition to rearrangement products. The latter consist predominantly of 2-pyridinemethanol phenylacetate and 2-phenylethylpyridine, in a ratio of about 1.5:1 in the case of 2-picoline N-oxide, and of 4-pyridinemethanol phenylacetate and 4-phenyletnylpyridine, in a ratio of about 0.06:1 in the case of 4-picoline N-oxide. The product composition is unchanged when the reactions are performed in the presence of the radical trap m-dinitrobenzene. The rearrangement but not the oxidation products are thought to arise via anhydrobase intermediates. The ester products in this case (and in the corresponding acetic annydride reaction with 2-picoline N-oxide) are thought to be formed by nonradical paths while the phenyletnylpyridines are probably formed by geminate recombination of benzyl and picolyl radicals or ions which are produced by fragmentation of the anhydrobases. (Contractor's abstract)

2330

Pittsburgh U. Dept. of Chemistry, Pa.

PHOSPHONIC ACIDS AND ESTERS. XI. A PHOTOINDUCED ARBUXOV REARRANGEMENT OF TRIALKYL PHOSPHITES, by R. B. LaCount and C. E. Griffin. [1965] [4]p. incl. table. (AFOSR-65-2135) (AF AFOSR-64-470) AD 629803 Unclassified

Also published in Tetrahedron Ltrs., No. 35: 3071-3074, 1965.

Photolysis of trimethyl, triethyl, tri-1-propyl, and tri-n-butyl phosphites yielded the corresponding dialkyl alkylphosphonates as the major product, indicating the reaction is effectively an example of photoinitiation of the Arbuzov rearrangement.

2331

Pittsburgh U. Dept. of Pharmacology, Pa.

[ATROPINE DETOXICATION DURING HYPOTHERMIA BY THE ISOLATED PERFUSED RAT LIVER], by S. C. Kalser. Final technical rept. Mar. 3, 1965 [6]p. (AFOSR-65-0459) (AF AFOSR-64-87) AD 614068 Unclassified

Experiments have been performed on the isolated perfused rat liver in an attempt to obtain a perfusing medium which would be devoid of plasma protein. It was considered that if such a medium could be perfected, it would overcome any hindrance to drug uptake by the liver which might occur due to plasma binding of the drug. Results of this experimentation are outlined. Several exploratory type experiments were performed on the isolated liver in which blood flow through the liver was maintained constant by the readjustment of vascular resistance of the arterialized portal vein. In preparation for a contemplated Air Force Grant request in which the correlation of the toxicity of atropine with its metabolism in acute hypothermia and in cold acclimatization will be studied, work was attempted on a surgical technique which would allow a chronically prepared rat to be intravenously injected and have bile collected without the use of anesthesia.

2332

Pittsburgh U. Dept. of Pharmacology, Pa.

DRUG METABOLISM ATROPINE IN HYPOTHERMIA. I. BILIARY EXCRETION OF C^{14}-ATROPINE METABOLITES IN THE INTACT AND NEPHRECTOMIZED RAT, by S. C. Kalser, E. J. Kelvington and others. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-0961) (AF AFOSR-64-87) AD 619618 Unclassified

Also published in Jour. Pharmacol and Exper. Ther., v. 147: 252-259, 1965.

Bile was collected from pentobarbitalized rats, both intact and nephrectomized, at various time intervals after the intravenous injection of C^{14}-atropine, and at body temperatures of 37°, 25°, and 17° C. Urine was collected and analyzed at the end of the 4-hr experiment. As much as 70% of the atropine is excreted by the biliary system within 4 hr in the 37°C, nephrectomized preparation; 50% appears in the biliary system of the intact animal in this time interval. It is found that the liver is able to metabolize increased amounts of the drug in the absence of kidney function. Deep hypothermia appears to more markedly impair renal excretion of atropine and/or metabolites than it does hepatic excretion.

2333

Pittsburgh U. Dept. of Pharmacology, Pa.

DRUG METABOLISM IN HYPOTHERMIA. II. C^{14} ATROPINE UPTAKE, METABOLISM AND EXCRETION BY THE ISOLATED PERFUSED RAT LIVER, by S. C. Kalser, E. J. Kelvington and others. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-0962) (AF AFOSR-64-87) AD 619617 Unclassified

Also published in Jour. Pharmacol. and Exper. Ther., v. 147: 260-269, 1965.

The uptake, metabolism and excretion of C^{14}-atropine by the isolated perfused rat liver were studied at 37 and at 2 hypothermic temperatures, 25 and 17 C.

The uptake of C^{14}-atropine by the liver was decreased from a half-time of 6 min to a half-time of 20 min as the temperature was decreased from 37°C to 17°C. All of the C excreted into the bile appeared as atropine metabolites which were more polar than the parent compound. None appeared as unchanged atropine or as the hydrolysis product, tropic acid. These results are compared with those obtained from the nephrectomized bile-fistula rats at the same temperatures.

2334

Pittsburgh U. [Dept. of Physics] Pa.

INTERPRETATION OF THE SOFT X-RAY EMISSION SPECTRUM OF LITHIUM METAL, by D. C. Goodings. [1965] [11]p. incl. diagrs. refs. (AFOSR-65-2204) (AF AFOSR-63-196) AD 625546 Unclassified

Also published in Proc. Phys. Soc. (London), v. 86: 75-85, 1965.

The shape of the soft x-ray emission spectrum of lithium has been calculated in the Hartree-Fock approximation taking into account the fact that an atom about to emit a K x-ray is a point defect in the otherwise periodic potential of the lattice. The perturbation from the 1s hole was treated in the 'localized approximation' of the Koster-Slater theory, its effect being expressed by a single parameter. Starting from Ham's calculated density-of-states function and gradually increasing the strength of the perturbation one observes the formation of a resonance state (virtual bound state) and then a real bound state. For reasonable values of the perturbation parameter the results show a peak about 1 ev below the Fermi energy, a feature which resembles the measurements of Crisp and Williams and others. The calculations also provide a plausible explanation of the measurements of Catterall and Trotter on the satellite K emission spectrum of lithium. (Contractor's abstract)

2335

Pittsburgh U. Dept. of Physica, Pa.

MEASUREMENT BY NMR OF THE DIFFUSION RATE OF HF IN ICE, by M. Kopp, D. E. Barnaal, and I. J. Lowe. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-66-0234) (AF AFOSR-63-196) AD 629656 Unclassified

Also published in Jour. Chem. Phys., v. 43: 2965-2971, Nov. 1, 1965.

An experiment is described by which the diffusion of fluorine in monocrystalline ice cylinders is followed quasicontinuously, using the proton magnetic resonance spin-lattice relaxation time T_1 to measure the HF concentration along the sample. The diffusion coefficient D_F was evaluated for various temperatures between -30° and -4°C. The results show more scatter than the experimental error can account for. A least-squares fit of the data yields D_F (-10°C) = 0.8x10-6 cm^2/sec for the diffusivity and E = 0.58 ev = 13.4 kcal/mol for the activation energy, with root-mean-

square deviations of 0.5×10^{-6} cm^2/sec and 0.08 ev, respectively. The highest concentration of diffused HF which can be absorbed by monocrystalline ice is about 4×10^{-5} HF/H_2O. A possible explanation is offered for the large value and dispersion of the diffusivity. (Contractor's abstract)

2336

Pittsburgh U [Dept. of Physics] Pa.

HIGH-FREQUENCY CYCLOTRON RESONANCE IN METALS (Abstract), by H. Scher and T. Holstein. [1965] [1]p. [AF AFOSR-63-196) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.
Published in Bull. Amer. Phys. Soc., Series II, v. 10: 111, Jan. 27, 1965.

The authors calculated the surface impedance of an isotropic electron-phonon gas in the presence of a large static magnetic field and high-frequency electromagnetic wave ($\omega \sim 10^{12} - 10^{13}$ cps). The genesis of the calculation is a recently derived quantal transport equation, modified to include the effects of the external magnetic field. Resultant expressions for the frequency- and wave-vector-dependent bulk conductivity $\sigma(\omega, q)$, are inserted into the standard expression for surface impedance in the extreme anomalous limit. Justification for this procedure is attained by an alternate semiclassical treatment of the transport equation with account taken of diffuse boundary scattering. Results for the surface impedance include (a) a frequency-dependent line shift, which is most pronounced for $\omega \sim \omega_D$ (ω_D - Debye frequency), and (b) changes in the shape of the lines associated with frequency-dependent collision processes.

2337

Pittsburgh U. Dept. of Physics, Pa.

SPIN-DISORDER THERMAL RESISTIVITY OF THE FERROMAGNETIC TRANSITION METALS, by L. Colquitt, Jr. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-2093) (AF AFOSR-63-196) AD 627380 Unclassified

Also published in Phys. Rev., v. 139: A1857-A1865, Sept. 13, 1965.

Data of White and Woods (Philos. Trans. Roy. Soc. (London), v. A251: 273, 1965) for the thermal resistivity W of the transition metals show that W for Fe, Co, and Ni displays an anomalous persistent temperature dependence in the region just below and through the Debye temperature. Since W for the nonferromagnetic transition metals is approximately constant in this region, it is reasonable to attribute the additional temperature dependence to the well-known spin-disorder scattering of conduction electrons. It is shown, however, that a model which treats the magnetic d electrons as localized and neglects s-d transitions cannot account for the anomalous behavior of W, while a model which treats magnon-induced s-d interband transitions presents a plausible explanation.

2338

Pittsburgh U. Dept. of Physics, Pa.

ELECTRICAL AND THERMAL RESISTIVITIES OF THE NONMAGNETIC TRANSITION METALS WITH A TWO-BAND MODEL, by L. Colquitt, Jr. [1965] [5]p. incl. diagrs. tables. (AFOSR-65-2101) (AF AFOSR-63-196) AD 629655 Unclassified

Also published in Jour. Appl. Phys., v. 36: 2454-2458, Aug. 1965.

A 2-band spherical model is used to represent the conduction electrons of the nonmagnetic transition metals with an incomplete d shell. It is shown by comparison with experimental results that phonon-induced interband s-d transitions are the major contributor to the electrical and thermal resistivities p and W at all but the lowest temperatures. Consequently, the momentum gap between the s and d bands is an important parameter of the theory and may be used to classify the behavior of p and W. At the lowest temperatures it is found that the experimental data for p of all the transition metals studied may be consistently interpreted if it is assumed that electron-electron scattering processes are important.

2339

Pittsburgh U. Dept. of Physics, Pa.

VARIATIONAL APPROACHES TO THE ANTIFERROMAGNETIC LINEAR CHAIN, by H. Falk and T. W. Ruijgrok. [1965] [6]p. incl. diagrs. refs. (AFOSR-66-0230) (AF AFOSR-63-196) AD 629657 Unclassified

Also published in Phys. Rev., v. 139: A1203-A1208, Aug. 16, 1965.

Within the framework of a somewhat general free-energy variational calculation the autnors find that a solution with an energy gap and spontaneous long-range order is favored. However, if on the basis of recent results one disallows the gap, then Bulaevskii's solution, without spontaneous long-range order, is obtained. From Bulaevskii's coupled integral equations and the condition for maximum entropy with respect to variation of the external field h at fixed temperature , the authors obtain a pseudophase boundary in the h, plane. The analysis indicates that asymptotically along the boundary, $(2-h)/$ → positive constant as → 0, and $h/\theta_0 -)^{1/2}$ → positive constant as → $_0$, where (h = 0, = $_0$) is the intersection of the boundary with the axis. Qualitatively similar behavior is displayed by the exactly soluble X-Y model for which the pseudophase boundary is also given here. The boundary curves are compared with one obtained for a finite chain by Bonner and Fisher. (Contractor's abstract)

2340

Pittsburgh U. Dept. of Physics, Pa.

EFFECT OF SURFACE PINNING ON THE MAGNETIZATION OF THIN FILMS, by J. A. Davis. [1965] [6]p. incl. diagrs. refs. (AFOSR-66-0233) (AF AFOSR-63-196) AD 629654 Unclassified

Also published in Jour. Appl. Phys., v. 36: 3520-3525, Nov. 1965.

The effect of surface pinning, as manifested by a surface anisotropy field, on the magnetization of thin films is examined in detail for a simple cubic lattice of atoms having spin 1/2 coupled by pure exchange. The magnetization-versus-temperature curve is found to lie above that obtained in the absence of pinning. For very weak pinning (surface anisotropy field much less than surface exchange field), the magnetization is sensitive to film thickness falling off more rapidly than for bulk, in qualitative agreement with some experiments. For intermediate pinning, the magnetization is essentially independent of film thickness, following the bulk behavior, in qualitative agreement with other experiments. For very strong pinning (surface anisotropy field on the order of or greater than surface exchange field), the magnetization falls off slower than for bulk, again with a thickness dependence. As a consequence, one may interpret experimental results in terms of the degree of surface spin pinning. Physically it is not yet clear why the degree of pinning should behave in the required fashion. (Contractor's abstract)

2341

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

SOME PROBLEMS ON THE PERFORMANCES AND MEASUREMENTS IN A WIND TUNNEL AT LOW VELOCITY, by E. Mattiolo. Apr. 1965, [21]p. incl. illus. diagrs. (Technical rept. no. 26) (AFOSR-65-1321) (AF EOAR-63-98) AD 621604 Unclassified

Research has been conducted on the pressure gradient effect on boundary layer transition along a flat plate. Many inconveniences were encountered regarding the turbulence of the free stream, the measurement of differential pressures and of extremely low velocities, and the interference of noises on the hot wire signal. These factors and efforts to remove some of their effects are discussed. (Contractor's abstract, modified)

2342

Politecnico di Torino [Laboratorio di Meccanica Applicata] (Italy)

THE INTERNAL STRUCTURE OF THE SHOCK WAVE I. HOMOGENEOUS GASES, by G. Jarre. June 1965, [20]p. incl. diagrs. table, refs. (Technical note no. 29) (AFOSR-65-2185) (AF EOAR-63-98) AD 626349 Unclassified

A critical review of the continuum theories on the structure of the shock wave, leads to simplified estimates of the shock thickness further improved after discussing the variability of the mean-free-path and the dynamics of the energy conversion. Possible residual discontinuities through the shock are briefly analyzed and discarded for common gases. The analysis of the entropic balance provides a simple general rule for estimating the thickness when irreversible phenomena are involved through the shock wave. (Contractor's abstract)

2343

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

A blunt axisymmetric body in a low density hypersonic flow was considered. The stagnation region was studied, taking into account both the transport phenomena (viscosity, thermal conductivity, diffusion) and the gas dissociation (in chemical non-equilibrium); a method is shown to determine the behavior of the various quantities, and the wall skin friction and heat transfer, for various wall temperatures and catalytic efficiencies. Some numerical results at mach number 10 are reported, where the dissociation effects are neglected. (Contractor's abstract)

2344

Politecnico di Torino. [Laboratorio di Meccanica Applicata] (Italy).

ON THE TURBULENCE DEVELOPMENT IN THE BOUNDARY LAYER WITH PRESSURE GRADIENT, by E. Mattioli. July 1965, [38]p. incl. illus. diagrs. tables, refs. (Technical note no. 30) (AFOSR-65-2187) (AF EOAR-63-98) AD 625361 Unclassified

This report presents an experimental research on the effect of pressure gradient on the boundary layer transition. The research included: (1) a theoretical-experimental research on working of the pressure gradient wind tunnel (which was especially built for this purpose); (2) speed and turbulence intensity measurements in the boundary layer of a flat smooth plate, with different values of pressure gradient, or in the presence of turbulence in the undisturbed stream, (3) a study on the variations of displacement thickness, momentum loss thickness, shape parameter; (4) speed fluctuation recording within the boundary layer during the transition; (5) control of the whole phenomenon by means of the china-clay method. Conclusions are given about the disturbed boundary, origin and nature of the transition and modification of the shape parameter. (Contractor's abstract)

2345

Politecnico di Torino. [Latoratorio] di Meccanica Applicata (Italy).

DISSOCIATION EFFECTS ON THE STAGNATION REGION PAST AN AXISYMMETRIC BLUNT BODY IN A HIGH MACH NUMBER AND LOW REYNOLDS NUMBER HYPERSONIC FLOW. by A. Muggia. July 1965, 4p. incl. diagrs. (Technical note no. 31; Scientific rept. no. 7) (AFOSR-65-2294) (AF EOAR-63-98) AD 628142 Unclassified

The study on the stagnation region past an axisymmetric blunt body in a low Reynolds number hypersonic flow, defined in a previous paper, is accomplished with some numerical results at Mach number 20. The behavior of temperature, velocity and atom concentration is shown, as well as the effects of the wall catalytic efficiency on the aerodynamic heating.

2346

Politecnico di Torino. [Laboratorio] di Meccanica Applicata (Italy).

THEORETICAL INVESTIGATIONS ON THE BOUNDARY LAYER WITH PRESSURE GRADIENT, by E. Mattioli. Aug. 1965, 18p. incl. diagrs. refs. (Technical note no. 32; Scientific rept. no. 8) (AFOSR-65-2736) (AF EOAR-63-98) AD 629212 Unclassified

Some recent investigations about the boundary layer, with pressure gradient, in the incompressible fluid flow along a flat, smooth plate, are briefly summarized. The results of those investigations are compared with the experimental ones found by the author. Some considerations are drawn on the Tollmien-Schlichting theory of instability, the transtion Reynolds number, the origin of the spots and the outline of the turbulent boundary layer.

2347

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

FREE MOLECULE SURFACE SOURCES AND SINKS AND APPLICATIONS. PART I., by S. Nocilla. Apr. 1965, [20]p. incl. diagrs. (Technical note no. 27) AFOSR-66-0120) (AF EOAR-63-98) AD 631101 Unclassified

Also published in Atti. Accad. Sci. Torino, v. 99: 1965.

A discussion is given of the concept of free molecule sources and sinks, characterized by an elementary surface in the space with oriented normal, by their temperature and by the distribution function of the molecules which respectively start from or impinge on them. This concept is an extension of the basic concepts of the Maxwellian kinetic theory of gases and it has application in the study of the interaction between stream and body in free molecule flow. (Contractor's abstract, modified)

2348

Politecnico di Torino. [Laboratorio di Meccanica Applicata] (Italy).

EXPERIMENTAL RESEARCH ON THE EFFECT OF PRESSURE GRADIENT AND FREE STREAM TURBULENCE ON THE BOUNDARY LAYER OF A FLAT ROUGH PLATE, by E. Mattioli. Nov. 1965, [28]p. incl. diagrs. (Technical note no. 33) (AFOSR-66-0339) (AF EOAR-63-98) AD 630799 Unclassified

Presented at the National Cong. of AIDA (19th) Naples, Oct. 25-28, 1965.

A determination was made of displacement thickness and momentum loss thickness in the boundary layer of a rough flat plate at low velocities, at various conditions of wall roughness, pressure gradient and free stream turbulence. The opportunity is discussed to assume y = zero at the 'top plane' of the rough surface, taking as additional parameter the flow velocity at the wall. New results are indicated about the slowing down of the stream near the wall, about the turbulence mainly initial effect, about the presence of a boundary layer above the boundary layer, as a consequence of the combined action of pressure gradient and free stream turbulence. (Contractor's abstract, modified)

2349

Politecnico di Torino. [Laboratorio] di Meccanica Applicata (Italy).

THE INTERNAL STRUCTURE OF THE SHOCK WAVE. PART II. MULTICOMPONENT MIXTURES, by G. Jarre. Dec 1965, 29p. incl. tables. (Technical note no. 34, Scientific rept. no. 10) (AFOSR-66-2596) (AF EOAR-63-98) AD 643874 Unclassified

The diffusional mass flux of each component of a mixture, is explicitly expressed by resorting to a simplified acceptable form of the binary diffusion coefficient. Following the extropic way, the simple Kohler-Dyakov formula is synthetically extended from binary to multicomponent mixtures. The result is that the shock thickness is amplified by the diffusional effects in a multicomponent mixture, but never more so than in the binary mixture composed by the only lightest and heaviest gases. Numerical examples on rare gases are worked

2350

Politecnico di Torino. [Laboratorio di Meccanica Applicata] (Italy).

FREE MOLECULE SURFACE SOURCES AND SINKS AND APPLICATIONS. PART II. COMPARISON WITH EXPERIMENTAL RESULTS. by S. Nocilla. Dec. 1965, [20]p. incl. diagrs. tables. (Technical note no. 36) (AFOSR-66-2741) (AF EOAR-63-98) AD 643879 Unclassified

In this second part a comparison is made between the theory developed in the first part and the experimental results obtained with the technique of the molecular beams by Datz, Moore and Taylor; Jawtusch; Smith and Fite. Some theoretical diagrams of magnitudes so far not measured experimentally are plotted.

2351

Politecnico di Torino. [Laboratorio di Meccanica Applicata] (Italy)

HIGHLY SIMPLIFIED CALCULATION OF THE INCOMPRESSIBLE LAMINAR BOUNDARY LAYER, by G. Jarre. Dec. 1965, [16]p. incl. diagrs. tables. (Technical note no. 35) (AFOSR-66-2742) (AF EOAR-63-98) AD 644129 Unclassified

A highly simplified calculation of the incompressible laminar boundary layer under any variable pressure gradient, is outlined and satisfactorily applied to accelerated and retarded flows. The method allows the direct derivation of the shear stress at the wall from the outer velocity law. The method is very promising in the field of the aeronautical slender bodies. (Contractor's abstract)

2352

Polytechnic Inst. of Brooklyn [Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

THE EFFECT OF VARIABLE TRANSPORT PROPERTIES ON A DISSOCIATED BOUNDARY LAYER WITH SURFACE REACTION, by G. S. Janowitz and P. A. Libby. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR-65-0553) (AF 49(638)217) Unclassified

Also published in Internat'l. Jour. Heat and Mass Transfer, v. 8, 7-18. 1965.

A study is carried out on the alteration in surface heat transfer and in the profiles of the flow variables associated with several descriptions of the transport properties of a dissociating gas. A boundary layer of the similar type is considered, a reasonably accurate description of the viscosity, conductivity and diffusivity of a mixture of atoms and molecules is employed along with several approximate descriptions which have been employed in the past. Numerical examples corresponding to high altitude hypersonic flight are considered and indicate that alterations of heat transfer of up to 60% and of the profiles of possible significance can occur depending on the description of the transport properties employed. (Contractor's abstract)

2353

Polytechnic Inst. of Brooklyn [Dept. of Aerospace Engineering and Applied Mechanics] N. Y.

HIGH-FREQUENCY COMBUSTION INSTABILITY AND SCALING OF LIQUID PROPELLANT ROCKETS MOTORS, by V. D. Agosta, S. S. Hammer and W. T. Peschke. [1965] 15p. incl. diagrs. table. (AFOSR-65-2501) (AF 49(638)1263) AD 628014 Unclassified

The following theoretical and experimental programs are in progress which are related to the instability and scaling problems in rocket motors: A steady-state aero-thermo-chemical analysis for a liquid bipropellant rocket motor with small contraction ratio employing droplet ballistics for both fuel and oxidizer. A nonlinear wave propagation analysis in a droplet burning heterogeneous combustion field. A nonsteady droplet evaporation analysis and concomitant experimental verification. The paper includes the experimental results obtained thus far from investigating the oscillatory behavior of the 500 lbm thrust JP5-Lox rocket motor.

2354

Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

LONG CYLINDRICAL SHELL UNDER CONCENTRATED LOADS APPLIED TO A CENTRAL REINFORCING RING, by A. Allentuch, K. Brady, and J. Kempner. Apr. 1965, [78]p. incl. diagrs. tables, refs. (PIBAL rept. no. 680) (AFOSR-65-0984) (AF 49(638)1360) AD 618306 Unclassified

The stresses and displacements were determined in an infinite circular cylindrical shell reinforced at its midlength by a single frame. Acting at the ends of a diameter of the ring were 2 self-equilibrating radial forces and moments. Stress distributions and displacements in the shell are presented along 3 generators. They indicated high stresses in the neighborhood of the ring. For the values of the parameters considered, these stresses become negligible at a distance from the ring of approximately 0.15 times the radius of the shell so that the length of shell which acts with the ring is 0.30 times the radius of the shell Stress and displacement distributions in the circumferential direction are also presented for the shell and the ring. (Contractor's abstract)

2355

Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

CREEP ANALYSIS OF CIRCULAR PLATES BY ENERGY METHODS, by J. Bentson, S. A. Patel, and B. Venkatraman. Mar. 1965, [20]p. incl. diagrs. (PIBAL rept. no. 698) (AFOSR-65-0985) (AF 49(638) 1360) AD 618310 Unclassified

The paper investigates the creep bending of circular plates using energy theorems of elasticity. Firstly, the theorem of minimum potential energy is used to derive, in terms of rectangular coordinates, the governing differential equations and the natural boundary condition for laterally loaded thin plates. Next, these equations are transformed into polar coordinates for application to rotationally symmetric circular plate problems. For such plates, the theorem of minimum total complementary potential is then used to derive the governing moment equation and the corresponding boundary conditions. This is followed by a brief discussion of Reissner's variational theorem as applied to circular plates problems. The use of each of these 3 theorems is then illustrated by obtaining solutions to the problem of a simply supported circular plate. Finally, these solutions are graphically compared with exact solutions obtained previously. (Contractor's abstract)

2356

Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

AN ITERATIVE SOLUTION FOR ROTATIONALLY SYMMETRIC NONLINEAR MEMBRANE PROBLEMS. by M. A. Goldberg. July 1965, [41]p. incl. diagrs. refs. (PIBAL rept. no. 906) (AFOSR-65-1504) (AF 49(638)1360) AD 620738 Unclassified

An improved iterative technique for the large deflection analysis of rotationally symmetric membranes is presented. This procedure takes advantage of the complementary aspects of 2 previously suggested relaxed iteration procedures. The resulting method utilizes the Keller-Reiss type functional for each iterate. In analogy to a technique previously suggested the relaxation parameter is then evaluated from an auxiliary equation. The iterative procedure is employed to obtain an approximate solution for an internally pressurized shallow spherical membrane, which is held at the boundary. Numerical results obtained herein are in agreement with previous solutions to this problem

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Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

RESEARCH STUDIES CONDUCTED UNDER CONTRACT NO. AF 49(638)1391 AT THE POLYTECHNIC INSTITUTE OF BROOKLYN AEROSPACE INSTITUTE, by R. J. Cresci and M. H. Bloom. Final rept. Oct. 1965. 10p. incl. refs. (Rept. no. PIBAL 898) (AFOSR-66-0572) (AF 49(628)1391) AD 630557 Unclassified

The report presents a brief review of a series of studies performed in connection with the flow over slender configurations at high Mach numbers and low Reynolds numbers. Two particular problem areas were emphasized in this research, these are the near wake of axisymmetric bodies and viscous-inviscid interactions that occur along the intersection of planar surfaces aligned with the stream. The results of both theoretical and experimental studies related thereto are presented

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Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

SIMILAR SOLUTIONS FOR THE HYPERSONIC LAMINAR BOUNDARY LAYER NEAR A PLANE OF SYMMETRY. by M. Trella and P. A. Libby. Feb. 1964. 50p. incl. diagrs. tables, refs. (PIBAL rept. no. 825) (AFOSR-64-0566) (AF AFOSR-62-409) AD 438832 Unclassified

The laminar hypersonic boundary layer near a plane of symmetry is treated from the similarity point of view. Cases of favorable and adverse pressure gradients in the plane of symmetry and of inflow to and outflow from that plane are considered. The similarity parameters are related to physical observables so that the results may be applied at least in terms of local similarity, to determine the boundary layer characteristics in practical problems. It is found that crossflow has significant effects on the boundary layer in the plane of symmetry when the pressure gradient is adverse (Contractor's abstract)

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Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

A REVIEW OF RESEARCH PERFORMED AT THE POLYTECHNIC INSTITUTE OF BROOKLYN, AEROSPACE INSTITUTE UNDER GRANT AF AFOSR-62-409, by M. H. Bloom and R. J. Cresci. [Final rept.] Sept. 1, 1963-Sept. 30, 1965, Oct. 1965. 12p. (PIBAL rept. no. 897) (AFOSR-65-2230) (AF AFOSR-62-409) AD 628472 Unclassified

Research is summarized on a theoretical analysis of continuum flow fields about hypersonic vehicles. Study of the asymptotic inviscid flow field about slender bodies is emphasized. Since indications are that for slender bodies transition in the boundary layer occurs at high altitudes, the turbulent regime is given special attention. A consistent asymptotic solution is obtained for flows of perfect gases at infinite Mach number, and qualitative features of flows at large discussed. It is found that only in the 2 limiting cases of low and infinite external Mach number

is boundary-layer similarity possible. Problems relating to chemical reactions in the boundary layer are also investigated. For the analysis, an approximate technique is used based on linearization about the Blasius solution.

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Polytechnic Inst. of Brooklyn. [Dept. of Aerospace Engineering and Applied Mechanics] N. Y.

LAMINAR BOUNDARY LAYER WITH UNIFORM INJECTION, by P. A. Libby and K. Chen. [1968] [7]p. incl. diagrs. refs. (AFOSR-64-1395) (AF AFOSR-63-1) AD 606074 Unclassified

Also published in Phys. Fluids, v. 8: 568-574, Apr. 1965.

The nonsimilar velocity distribution in a two-dimensional laminar boundary layer with uniform external stream and with either uniform suction or injection is obtained by a series expansion in terms of a mass transfer parameter. The results are compared with more accurate analysis and shown to be in good agreement for a range of values of this parameter. The solution for the velocity distribution is then employed for the calculation of the distributions of energy and element mass fraction when there are imposed requirements for energy and mass balance at the exposed surface of a porous plate with uniform injection. As one example of several possible applications of these solutions, there is computed the flow associated with the injection of hydrogen into an air stream according to the flame sheet model. (Contractor's abstract)

2361

Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

REVIEW OF THEORETICAL INVESTIGATIONS ON THE EFFECT OF HEAT TRANSFER ON LAMINAR SEPARATION, by M. Morduchow. July 1964, 38p incl. diagrs. tables, refs. (PIBAL rept. no. 831) (AFOSR-64-1658) (AF AFOSR-63-1) AD 609575 Unclassified

Also published in AIAA Jour., v. 3: 1377-1385, Aug. 1965.

A review is made of theoretical investigations on the effect of heat transfer on laminar separation in classical steady two-dimensional high-speed or low-speed boundary-layer flow. Particular emphasis is placed on the effect of wall temperature on the location of the separation point. An Appendix gives a review of results on the effect of Mach Number on the laminar separation point for a linearly diminishing external velocity and zero heat transfer.

2362

Polytechnic Inst. of Brooklyn. [Dept. of Aerospace Engineering and Applied Mechanics] N. Y.

A MOMENT METHOD FOR COMPRESSIBLE LAMINAR BOUNDARY LAYERS AND SOME APPLICATIONS, by P. A. Libby and H. Fox. [1965] [17]p. incl. diagrs. refs. (AFOSR-64-1786) (AF AFOSR-63-1) AD 612081 Unclassified

An integral method based on moment techniques and especially useful for compressible laminar flows is presented. The describing partial differential equations are first transformed to the Levy-Lees variables and then converted to integral conditions with u^m as a weighing factor. A technique for handling the variation in transport properties which explicitly arises for $m>0$ is described. The resultant equations are applied for $m=0, 1$, with the commonly employed fourth and fifth degree polynomial profiles for velocity and stagnation enthalpy. The distinct classification of similar and nonsimilar flows within the same analytic framework is emphasized. The analysis is applied to a variety of flows for which more accurate results are available and is found to yield satisfactory results in most cases. Therefore, the present method is considered to improve somewhat the conventional integral method ($m=0$) without excessive labor. (Contractor's abstract)

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[Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.]

THE VISCOUS INCOMPRESSIBLE FLOW INSIDE A CONE, by R. C. Ackerberg. [1965] [35]p. incl. diagrs. refs. (AFOSR-65-0577) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-1, National Science Foundation and Office of Naval Research) AD 614492 Unclassified

Also published in Jour. Fluid Mech., v. 21: 47-81, 1965.

The steady, axisymmetric, converging motion of a viscous incompressible fluid inside an infinite right circular cone is considered. It is shown that the exact solution of the Navier-Stokes equation for the stream function ψ is of the form $\psi(r, \theta) = AF(r\nu A, \theta)$, where (r, θ) are spherical polar co-ordinates chosen so $r=0$ is the apex and $\theta = 0$ is the axis of the cone, $2\pi A$ is the volumetric flow rate, and ν the kinematic viscosity of the fluid. Asymptotic expansions of the stream function are found for large and small $r\nu/A$. For large $r\nu A$, Stokes's method for slow motions is generalized to obtain a complete asymptotic expansion. Except for cones of special angles, all terms in this expansion may theoretically be found. For small $r\nu/A$ a solution is constructed in 2 parts, namely, an inner expansion which starts from boundary-layer type equations as well as the no-slip condition at the wall, and an outer expansion in unstretched variables $r\nu A$ and $\cos\theta$ which satisfies the boundary conditions at the axis of the cone. The condition that the inner solution merge with the outer solution with an exponentially small error requires an outer solution near the

apex which is not potential sink flow, as might perhaps have been expected from the solution for 2-dimensional flow in a wedge. The simplest outer flow satisfying the requirement is a vortex motion. Complete inner and outer expansions are developed and it is shown that they contain only six undetermined constants which must be determined by joining this solution numerically to the Stokes solution upstream. The inclusion of logarithmic terms in these expansions has not been found necessary. (Contractor's abstract)

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Polytechnic Inst. of Brooklyn. [Dept. of Aerospace Engineering and Applied Mechanics] N. Y.

FURTHER SIMILARITY SOLUTIONS OF AXISYMMETRIC WAKES AND JETS, by M. H. Steiger and M. H. Bloom. [1965] [3]p. incl. diagrs. table. (AFOSR-65-1152) (AF AFOSR-63-1) AD 620472 Unclassified

Also published in AIAA Jour., v. 3: 548-550, Mar. 1965.

Further solutions are presented to the similarity equation $[\eta(F'/\eta)]' + F(F'/\eta)' + 2\eta[1-(F'/\eta)2]=0$ subject to boundary conditions $F = (F'/\eta)' = 0$ at $\eta = 0$ and $F'/\eta = 1.0$ as $\eta \rightarrow \infty$. An extension to compressible flow is described which applies rigorously if the density ratio ρ_e/ρ can be a function of the similarity variable η only. Exact and integral method solutions of the similarity equation are presented in the ranges $-1.0 < \beta < -0.5$ and $0.5 < \beta < 4.0$.

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Polytechnic Inst. of Brooklyn. [Dept. of Aerospace Engineering and Applied Mechanics] N. Y.

FURTHER SIMILARITY SOLUTIONS OF TWO-DIMENSIONAL WAKES AND JETS, by M H. Steiger and K. Chen. [1965] [3]p. incl. diagrs (AFOSR-65-1153) (AF AFOSR-63-1) AD 619638 Unclassified

Also published in AIAA Jour., v. 3: 528-530, Mar. 1965.

Solutions of the Falkner-Skan equation $f''' + ff'' + \beta[1 - f'^2] = 0$ subject to boundary conditions $f(0)= f''(0) = 0$ and $f'(\infty) = 1.0$ are derived in the ranges $-1.0 < \beta < - 0.5$ and $1.0 < \beta$. Exact solutions, obtained by a forward numerical integration, and approximate integral method solutions are presented. An initial value problem is formed by systematically specifying $f'(0)$. The exact solution is extracted by requiring both the boundary condition $f'(\infty) = 1.0$ and the auxiliary condition $f''(\infty) = 0$ to be satisfied to 3 significant figures.

2366

Polytechnic Inst. of Brooklyn. [Dept. of Aerospace Engineering and Applied Mechanics] N. Y.

LINEARIZED ANALYSIS OF DIFFUSING, RELAXING GAS FLOW, by P. M. Sforza and M. H. Bloom. [1965] [8]p. incl. diagrs. (AFOSR-65-1232) (AF AFOSR-63-1) AD 622746 Unclassified

Also published in Phys. Fluids, v. 8: 36-43, Jan. 1965.

A linearized model of an ideal diatomic gas with diffusion processes and rate reaction is applied to 1-dimensional unsteady motion generated by initial nonuniformities of state and velocity. The time-dependent system resembles that of steady free-mixing of jet or wake type, with 2 space coordinates. The temporal and spatial character of the profiles of flow variables is studied analytically under 2 sets of conditions. First considered is the case of unit Lewis number and for this case the investigation is subdivided as follows: (1) Zero mass motion with state nonuniformities for planar, cylindrical, and spherical configurations; and (2) nonzero mass motion with state nonuniformities for the planar and cylindrical configurations. Secondly, the case of arbitrary, but constant, Lewis number is considered. In this instance, the investigation is limited to nonzero mass motion with state nonuniformities in the planar geometry. In all cases the Prandtl number is assumed to be an arbitrary constant. Analytic solutions are obtained for all cases and various parametric effects discussed. (Contractor's abstract)

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Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

ON THE SOLUTION OF INITIAL-VALUED BOUNDARY LAYER FLOWS, by M. H. Steiger and P. Sepri. May 1965, 22p. incl. diagrs. refs. (PIBAL rept. no. 872) (AFOSR-65-1415) (AF AFOSR-63-1) AD 619098 Unclassified

This report is concerned with the exact solution of the boundary layer equations, particularly when the initial conditions are not of a simple form. A comparatively new procedure is applied to the forementioned problem, and the preliminary results of the investigation are reported. The theory is restricted to flows which are described by 2 coordinates. By replacing the normal partial derivatives by finite differences, the boundary layer equations are reduced to an initial value system of coupled first order ordinary differential equations. Since these equations are classified as stiff, their solution requires special consideration. As an illustration, the velocity field of 2-dimensional wake is obtained by full finite difference schemes. An improved theory is suggested and possible future studies are discussed. (Contractor's abstract)

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Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

INCOMPRESSIBLE FLOW ALONG A CORNER. PART I. BOUNDARY LAYER SOLUTIONS AND FORMULATION OF CORNER LAYER PROBLEM, by S. G. Rubin. May 1965, 29p. incl. diagrs. refs. (PIBAL rept. no. 876) (AFOSR-65-1420) (AF AFOSR-63-1) AD 621987 Unclass

The incompressible viscous flow along a right-angle corner is considered. The effect of the 3-dimensional geometry on the second-order boundary layer flow away from the corner is determined and an interesting secondary flow is deduced. It is observed that this cross-flow prescribes the necessary asymptotic boundary conditions for the equations governing the flow inside the corner layer. A systematic matching scheme is specified and the corner flow problem is reformulated in terms of the corner layer - boundary layer matching conditions. (Contractor's abstract)

2369

Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

AN EXPERIMENTAL STUDY OF THE TURBULENT MIXING OF A SUBSONIC AND A SUPERSONIC JET IN A CLOSED DUCT, by H. S. Bluston. May 1965, 48p. incl. diagrs. tables, refs. (PIBAL rept. no. 868) (AFOSR-65-1794) (AF AFOSR-63-1) AD 624551 Unclassified

An experimental study is presented of the turbulent mixing of 2 coaxial air jets at subsonic-supersonic speeds in a closed duct. By using a suitable total pressure it is possible to correctly expand the ducted outer jet to ambient conditions. Negligible pressure gradients are found in a considerable region of the duct and all static and stagnation pressure measurements are made in the regime. The axial velocity decay is thus determined and compared with some results of Zakkay. On the basis of the pressure measurements the flow field is divided into 3 mixing regions. In each of these regions the normalized velocity and total pressure profiles are correlated with values of the axial and radial coordinates. Jet boundaries are measured and an eddy viscosity function calculated. Detailed recommendations are made for improvements of this type of experiment.

2370

Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

A REVIEW OF RESEARCH PERFORMED AT THE POLYTECHNIC INSTITUTE OF BROOKLYN, AEROSPACE INSTITUTE UNDER GRANT AF AFOSR-1-63, by M. H. Bloom and R. J. Cresci. [Final rept.] Sept. 1, 1962-Sept. 30, 1965. Oct. 1965, 23p. incl. refs. (PIBAL rept. no. 896) (AFOSR-65-2007) (AF AFOSR-63-1) AD 627688 Unclassified

An experimental and theoretical program with fluid mechanical and dynamical problems emanating from hypersonic flight is reported. Major emphasis was on the viscous free mixing of homogeneous and heterogeneous streams, and the boundary layer flows including effects of separation, mass injection or suction, unsteady flows, surface discontinuities, and vorticity. Reacting flows, space mechanics, and magnetohydrodynamic effects were also considered. The research is summarized and a bibliography of 33 reports and published papers resulting from this work is presented.

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Polytechnic Inst. of Brooklyn. [Dept. of Aerospace Engineering and Applied Mechanics] N. Y.

STUDIES IN THREE-DIMENSIONAL FREE-MIXING: I. FINITE DIFFERENCE SOLUTIONS. II. EXPERIMENTAL RESULTS, by M. H. Steiger, W. Hinzand and others. [1965] [64]p. incl. diagrs. tables, refs. (AFOSR-66-0118) (AF AFOSR-63-1) Unclassified

Presented at AIAA Second Aerospace Sciences Meeting, New York, Jan. 25-27, 1965.

This paper presents numerical and experimental studies of 3-dimensional viscous free-mixing, i.e., non-axisymmetric flows which require 3 space coordinates for their description. Both wakes (flows in moving ambients regardless of whether the profiles have velocity excesses or defects) and jets (flows in motionless surroundings) are treated. Flows of this type decay to axisymmetric form, however, their analysis is difficult due to non-similarity, nonlinearity (particularly in jets) and absence of rigorous compressibility transformations. The numerical investigations employ finite difference methods to derive solutions. First exact and difference solutions are presented for the incompressible wake equation. This provides a comparison between the explicit and implicit schemes and a measure of their accuracy. Next compressibility effects on wakes are studied. Finally, experimental results for cold jets are presented, and compared to difference solutions and approximate momentum integral solutions.

2372

Polytechnic Inst. of Brooklyn. [Dept. of Aerospace Engineering and Applied Mechanics] N. Y.

OPTIMUM ORBITAL TRANSFER BY TWO IMPULSES OF UNEQUAL SPECIFIC IMPULSE, by M. Pierucci. [1965] [3]p. incl. diagrs. (AFOSR-66-0622) (AF (AF AFOSR-63-1) AD 631128 Unclassified

Also published in Astronaut. Acta., v. 11: 268-270, 1965.

The study of optimization of transfer, from a circular to a nonintersecting elliptical orbit with the use of 2 impulses with different specific impulse, is presented. The results obtained are a generalization of

The results obtained for the case where λ is equal to one (λ is equal to the ratio of the first and second specific impulse). The transfer orbit is always of the HOHMANN type and it has been found to always end at its apogee. For $\lambda < 1$ (where λ is a function of α, α and is less than unity), this corresponds to the perigee of final orbit, while for $\lambda > 1$ it is the apogee of final orbit. (Contractor's abstract)

2373

Polytechnic Inst. of Brooklyn. Dept. of Aerospace Engineering and Applied Mechanics, N. Y.

APPROXIMATE HEAT CONDUCTION SOLUTIONS FOR NONPLANAR GEOMETRIES, by T. J. Lardner. [1965] [3]p. (AFOSR-5320) (AF 49(638)1360, and AF AFOSR-63-419) AD 419885 Unclassified

Also published in Jour. Heat Transfer, pp. 423-425, Aug. 1965.

Evidence is presented to show that the use of the variational principle for problems of nonplanar geometry required the selection of temperature profiles which included the steady-state form and the introduction of a function to enforce the condition of zero heat flux at the penetration point. An application of the Biot variational principle to one-dimensional heat conductor problems is also shown.

2374

Polytechnic Inst. of Brooklyn. [Dept. of Mechanical Engineering] N. Y.

DAMPING PARAMETERS OF LAYERED PLATED AND SHELLS, by Y-Y. Yu and N. Ren. [1965] [29]p. incl. diagrs. tables, refs. (AFOSR-64-2087) (AF 49(638)1290) AD 610140 Unclassified

Also published in Acoustical Fatigue in Aerospace Structure, Proc. of the Second Internat'l. Conf., Dayton, Ohio (Apr. 29-May 1, 1964), ed. by W. J. Trapp and D. M. Forney, Jr. Syracuse Univ. Press, 1965, p. 555-584.

The concept of the damping parameter is clearly applicable to all types of layered plates and shells and to all types of vibrations. Thus, expressions for the damping parameters are now available for extensional vibrations of sandwich plates and axially symmetrical vibrations of sandwich cylindrical shells as well as for flexural vibrations of sandwich plates. A comprehensive review of these is given in this paper. In addition, the damping parameters for the 2-layered plate are discussed. They are important because the 2-layered plate represents a basic situation in which damping of the vibration of a plate by an added viscoelastic layer was first adopted in practice. In all cases considered, expressions are given for the frequencies together with the damping parameters.

2375

Polytechnic Inst. of Brooklyn. [Dept. of Mechanical Engineering] N. Y.

VIBRATIONS OF PLATES AND SHELLS, by Y.-Y. Yu. Final rept. Jan. 1965, 4p. (AFOSR-65-0205) (AF 49(638)1290) Unclassified

This paper investigated the dynamics and vibrations of homogeneous and layered plates and shells. A study was also made of sandwich construction. By use of the generalized Hamilton's principle, a variety of approximate methods for solving plate problems were found. The principle was applied to both anistropic plates and isotropic elastic shells. Much research was performed on vibrations of 2-layered plates, sandwich cylindrical shells and conical shells.

2376

Polytechnic Inst. of Brooklyn. [Dept. of Mechanical Engineering] N. Y.

ON LINEAR EQUATIONS OF ANISTROPIC ELASTIC PLATES, by Y-Y Yu. [1965] [4]p. (AFOSR-65-0556) (AF 49(638)1290) AD 613863 Unclassified

Also published in Quart. Appl. Math., v. 22: 357-360, Jan. 1965.

The generalized Hamilton principle and the associated variational equation of motion for linear and anisotropic elastic plates are deduced from their counterpart in general elasticity theory given in a previous paper (Jour. Acoust. Soc. Amer., v. 36: 111, 1964), through expansion of the displacement and strain in infinite power series in the manner of Cauchy and Mindlin and by carrying out the integration in the thickness direction of the plate. The Euler equations of the variational principle then yield the complete system of plate equations of all orders as were obtained by Mindlin by a different procedure. Some zero-order and first-order equations for an isotropic plate have been derived before from the generalized variational equation of motion.

2377

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

APPLICATION OF VARIATIONAL EQUATION OF MOTION TO THE NONLINEAR ANALYSIS OF DYNAMIC BUCKLING, by Y-Y Yu. June 1965, [25]p. incl. diagrs. table, refs. (Scientific rept. no. 4) (AFOSR-65-1421) (AF 49(638)1290) AD 627961 Unclassified

An integrated procedure has been proposed for applying the variational equation of motion to the analysis of nonlinear vibrations of solids. In this paper, the procedure is extended to the analysis of nonlinear dynamic buckling. Example is given for a simply supported sandwich or homogeneous plate in plane-strain motion, one edge of which is fixed and the

other subjected to a longitudinally oscillating displacement. Response curves for the parametrically excited, lateral vibration corresponding to the first instability region are presented. Results show that the transverse shear effect cannot be neglected for the sandwich plate, as in the case of ordinary, nonlinear lateral vibration of the plate. The transverse shear effect is negligible for the homogeneous plate (timoshenko beam), at least for the first instability region. (Contractor's abstract)

2378

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

ON THE AXISYMMETRICAL VIBRATIONS OF CONICAL SHELLS, by Y. Kagawa. June 1965, [19]p. incl. diagrs. tables. (Scientific rept. no. 6) (AFOSR-65-1422) (AF 49(638)1290) AD 627963 Unclassified

It is shown that the fundamental frequencies of the axisymmetrical vibrations of conical shells can be predicted quite accurately by the extensional theory as long as the thickness of the shell is small compared with its length and the apex angle is not too wide. This is confirmed by comparing the results of the extensional theory with those of experiment and with those of the more exact theory including bending effect.

2379

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

VIBRATIONS OF TWO-LAYERED PLATES, by S. Ren and Y-Y. Yu. June 1965, 28p. incl. diagrs. tables, refs. (Scientific rept. no. 5) (AFOSR-65-1423) (AF 49(638)1290) AD 627962 Unclassified

Four approximate theories of 2-layered plates nave been presented. Among these the 2 uncoupled classical theories of flexure and extension are the simplest. For the infinite plate the flexural theory gives the flexural branch and the extensional theory the equivoluminal and extensional branches of the frequency spectrum. The 3 branches all start from the origin and are in an ascending order as just stated. The classical theory that includes the effect of coupling between flexure and extension produces the same 3 branches of the frequency spectrum, in fact with little improvement over the uncoupled theories up to, say, 20,000 cps. The important thing to note, however, is that flexure and extension are in general coupled. Therefore, either type of excitation will induce both types of motion simultaneously, which can only be accounted for by the coupled theory.

2380

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

ON THE FORM OF VARIATIONALLY DERIVED SHELL EQUATIONS, by Y-Y. Yu. [1965] [4]p. incl. refs. (AFOSR-66-0571) (AS 49(638)1290) AD 631389 Unclassified

Also published in Jour. Appl. Mech., v. 32: 223-238, Trans. ASME, v. 86: Ser. E., June 1965.

The report gives a variational derivation of shell equations. A variational formulation of the 3-dimensional elasticity theory is discussed. This formulation is used to derive shell equations which do not make use of the conflicting assumptions of zero transverse normal stress and strain. Several observations concerning the significance of shell theories are concluded.

2381

Polytechnic Inst. of Brooklyn. [Dept. of Physics] N. Y.

POSITION AND THERMAL PARAMETERS OF OXYGEN ATOMS IN CALCITE, by H. Chessin, W. C. Hamilton and B. Post. [1965] [5]p. incl. diagrs. tables. (AFOSR-65-1989) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)827 and Atomic Energy Commission) AD 626868 Unclassified

Also published in Acta Cryst., v. 18: 689-693, Apr. 1965.

The position and thermal parameters of the oxygen atoms in calcium carbonate (calcite) at room temperature, 215° and 130°K, were determined. Reflections to which only oxygen atoms contribute were measured by counter methods. Parameters were refined by least-squares methods. The C-O bond length is 1.283 ± 0.002 at room temperature and does not change significantly between room temperature and 130°K. (Contractor's abstract)

2382

Polytechnic Inst. of Brooklyn. [Dept. of Physics] N. Y.

SURFACE THERMAL DIFFUSE SCATTERING FROM TUNGSTEN, by J. Aldag and R. M. Stern. [1965] [4]p. incl. illus. diagrs. refs. (AFOSR-65-1992) (AF 49(638)1369) AD 626876 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 68-69, Jan. 28, 1965.

Also published in Phys. Rev. Ltrs., v. 14: 857-860, May 24, 1965.

An anisotropic diffuse background was observed, superimposed on the expected low-energy electron diffraction pattern from the clean (110) surface of a tungsten single crystal. The observations were made using a Varian system with 230- to 700-ev electrons over a temperature range of 300° to 1600°K. No such structured background appears in X-ray diffraction patterns from tungsten. It was concluded that the observations were of thermal diffuse scattering from anisotropic surface modes and that this phenomena should be of value in investigating dispersion relationships for surface phonons.

2383

Polytechnic Inst. of Brooklyn. [Dept. of Physics] N. Y.

ADSORPTION OF OXYGEN ON (110) TUNGSTEN SURFACE (Abstract), by R. M. Stern and I. Cantarell. [1965] [1]p. [AF 49(638)1369) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 69, Jan. 28, 1965.

A clean tungsten (110) surface is observed in post-accelerated low-energy electron diffraction during the adsorption of oxygen. Pressure changes following flash desorption are monitored with a residual-gas analyzer. The results are strongly dependent on the ubiquitous presence of CO. The flashoff pressure rise contains no oxygen, but is composed of CO and H_2. After flashoff, the equilibrium O_2 pressure decreases, indicating adsorption of oxygen on the tungsten surface. Linear adsorption, $dN/dT = S_0(1-\theta)$ is observed; S_0 is the absolute sticking probability (S_0=0.5 ± 0.1) and θ the coverage. Oxygen adsorption is accompanied by the appearance of additional diffraction features, interpreted as revealing island growth. The appearance of the additional diffraction features can be completely inhibited by the presence of CO, which must compete with oxygen for adsorption sites. CO is desorbed at 1000°C; the oxygen associated diffraction features are altered at 1700°C and removed, accompanied by no oxygen pressure rise, at 1890°C. Removal of the adsorbed CO is followed by the immediate appearance of any latent oxygen-diffraction features, if any, or after suitable oxygen adsorption otherwise.

2384

Polytechnic Inst. of Brooklyn. [Dept. of Physics] N. Y.

EVOLUTION OF THE CATHODE SHEATH IN A GLOW DISCHARGE (Abstract), by H. Veron and N. Wainfan. [1965] [1]p. [AF 49(638)1369] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 476, Apr. 26, 1965.

Time resolved spectroscopic measurements and electrostatic-probe measurements were used to investigate the evolution of the cathode sheath of a pulsed hydrogen glow discharge in the annular gap between the cathode and the Pyrex walls of a discharge tube. The cathode sheath started to propagate into the annular gap at the time that the electric field at the cathode face reached its maximum value. It is proposed that the initial positive space-charge sheath distributed over the cathode face produces a fringing field at its perimeter and that the axial component of this fringing field provides the primary driving mechanism for the propagation of the sheath into the annular gap. For annular gap sizes of the order of several-ion mean-free path lengths, the velocity of propagation of the sheath is approximately $1/2(2\ ev/m_+)_{1/2}$. The propagation velocity is discussed as a function of pressure, applied voltage, and annular-gap size.

2385

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

NETWORK THEORY OF SEMICONDUCTOR HALL-PLATE CIRCUITS, by J. M. Garg and H. J. Carlin. [1965] [15]p. incl. diagrs. tables, refs. (AFOSR-65-2271) (AF 18(603)105) AD 625740 Unclassified

Also published in IEEE Trans. on Circuit Theory, v. CT-12: 59-73, Mar. 1965.

The paper deals with purely electrical realization of of the network element, the Gyrator, at low frequencies. It discusses the utilization of Hall effect in semiconductors and the properties of nonreciprocal devices based on this effect. The systematic study of the Hall plate, the best that can be expected from it and the conditions under which the best performance can be expected are established; and some new theoretical and practical schemes are suggested which permit better understanding of device performance and yield better devices. The Hall devices are nonreciprocal, passive, and stable but dissipative. They permit the extension of frequency range from dc to several magacycles over which the nonreciprocal devices can be used. In this sense they are complementary to the microwave Faraday-effect devices such as isolators and circulators and will permit greater flexibility and choice of elements for complex circuit designs, if the loss can be tolerated. This paper presents basic limitations, from an insertion loss standpoint, on the performance of Hall-plate circuits imbedded in resistance or reactance networks. (Contractor's abstract)

2386

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

SMALL SAMPLE SEQUENTIAL DETECTION OF RICEAN DISTRIBUTED SIGNALS, by J. Wakeley, Jr. June 1965, [57]p. incl. diagrs. tables, refs. (Research rept. no. PIBMRI-1248-64) (AFOSR-65-0154)

(Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research under AF 49(638)1402) AD 615545
Unclassified

This paper is concerned with a method of evaluating small average sample size (1.0 to 1.2) sequential detection of Ricean distributed signals. A solution is presented for this method of testing and the results compared to Wald's approximation. In addition, this testing method is compared with fixed sample size and null-zone detection. The results of this report show that sequential detection has a significant improvement over fixed sample testing and may be approximated by the null-zone detector for small average sample sizes. Some remarks are included on truncating the sequential detector after the second sample

2387

Polytechnic Inst. of Brooklyn. Microwave Research Inst. N. Y.

STOCHASTIC TIME-OPTIMAL CONTROL, by P. N. Robinson. June 1965, [58]p. incl. diagrs. tables, refs. (Research rept. no. PIBMRI-1268-65) (AFOSR-65-1718) (AF 49(638)1402)
Unclassified

The problem under study is the stochastic time-optimal control problem. Basically the object is to determine a control input which causes the output of a stochastic system to reach some region R of the origin in such a way that the expected value of the time required to reach R is minimized. The system is assumed to satisfy a stochastic differential equation. This problem has already been considered by a few authors, however in most cases serious errors were made in their analysis and problem statement. In this study a careful problem statement is made, appropriate optimization equations derived, and an iterative method of solution technique (approximation in policy space) is applied to solve certain specific problems. (Contractor's abstract)

2388

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

ELECTRIC FIELD PATTERNS IN A FERRITE LOADED WAVEGUIDE, by P. de Santis. [1965] 43p. incl. diagrs. (Rept. no. PIBMRI-1281-65) (AFOSR-65-1719) (AF 49(638)1402) AD 624077
Unclassified

A rectangular waveguide loaded with a transversely magnetized ferrite slab is analyzed. The diagram, longitudinal propagation constant vs distance of the ferrite slab from the side wall, is studied to get some information on the electric field patterns in the cross-section of the guide. A numerical case of interest is studied with parameters having values between those used by Barzilai and Gerosa and those by Lax and Button. It is concluded that the desired waveguide requirements and the necessity of only one propagating mode in the same direction can be met with the help of a design based on the present analysis. (Contractor's abstract)

2389

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

APPLICATION OF GAME THEORY TO THE SENSITIVITY DESIGN OF SYSTEMS WITH OPTIMAL CONTROLLER STRUCTURES, by P. Dorato and A. Kestenbaum. [1965] [11]p. incl. diagrs. (AFOSR-65-2102) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham) and Office of Naval Research] under AF 49(638)1402 and [Army Research Office (Durham)] under DA-31-124-AROD-316) AD 628296
Unclassified

The theory of games is applied to the sensitivity design of systems with unknown plant parameters. It is assumed that a controller structure is known and furthermore this controller is optimal when the controller parameters are equal to the plant parameters. The performance index then becomes a function of plant and controller parameters. This function is treated as a pay-off function with the antagonists represented by the controller and plant parameters. (Contractor's abstract)

2390

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

E-MODE PROPAGATION IN A PLANT-STRATIFIED PLASMA, by P. Hirsch and J. Snmoys. [1965] [7]p. incl. diagrs. (AFOSR-65-2448) (AF 49(638)1402) AD 625969
Unclassified

Also published in Radio Sci. Jour. Research NBS USNC-URSI, v. 69D: 521-527, Apr. 1965.

The problem of propagation of plane electromagnetic waves polarized in the plane of incidence in a plane-stratified isotropic plasma (regarded as a dielectric) is dealt with by reducing it to the solution of an ordinary differential equation which is singular at the level of plasma resonance. The absorption of power in the resonant layer is calculated approximately in 2 cases involving a linear profile. In the first, the relative dielectric constant varies linearly in a thin transition layer between 2 homogeneous regions. In the second, the dielectric constant is linearly varying over a large interval. (Contractor's abstract)

2391

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

PROCEEDINGS OF THE SYMPOSIUM OF SYSTEM THEORY, New York, Apr. 20-22, 1965, ed. by J. Fox, M. Crowell and R. Krieger. Brooklyn

Polytechnic Press, 1965 [406]p. incl. diagrs. tables, refs. (Microwave Research Inst. Symposia Series, v. 15) (In cooperation with Inst. of Electrical and Electronics Engineers and the Society for Industrial and Applied Mathematics) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research under AF 49(638)1402) Unclassified

This symposium was geared toward the review of the idea of system theory, the advances that have been made in the area of system theory and the role theory will play in the newly emerging computer age.

2392

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

PROGRESS REPORT TO THE JOINT SERVICES TECHNICAL ADVISORY COMMITTEE, by E. Weberand W. K. Kahn. Progress rept. no. 28, Apr. 1, 1965-Sept 30, 1965. [1965] [224]p. incl. diagrs. tables, refs. (AFOSR-66-1059) (AF 49(638) 1402) Unclassified

This report is the twenty-eighth in a series of progress reports, now issued semi-annually, which summarizes the research programs at the Microwave Research Institute of the Polytechnic Institute of Brooklyn from April 1, 1965 to September 30, 1965. The programs involve academic research activity of faculty and students, and cover a broad spectrum ranging from basic theoretical physics, mathematics, and engineering, to experimental investigations involving basic measurement development of devices, and materials. Each activity reports in summary fashion specific results obtained during the period in question: the sponsoring agency for the activity is individually acknowledged. Contributions are compiled under five headings: Electromagnetics, Plasma Electrophysics and Electronics; Solid State and Materials Research; Networks and Waveguide Techniques; and Systems, Communications and Control.

2393

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

EXPERIMENTAL RESULTS IN GROOVE GUIDE, by J. M. Ruddy. [1965] [2]p. incl. diagrs. (AF 49(638)-1402) Unclassified

Published in IEEE Trans. on Microwave Theory and Techniques, v. MTT-13: 880-881, Nov. 1965.

This report discusses the following developments in low-loss groove guide: (1) Development of a transducer from rectangular H_{10} mode to groove guide H_{11} (low-loss mode; (2) experimental determination of transducer performance; and (3) experimental verification of the attenuation constant obtained from the approximate theory developed by Ruddy and Griemsmann at the Polytechnic Institute of Brooklyn.

2394

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

FORMATION OF THE CATHODE-FALL REGION IN A PULSED GLOW DISCHARGE, by M. Nanemow, N. Wainfan, and A. L. Ward. [1965] [5]p. incl. illus. diagrs. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research] under AF 49-(638)1402) Unclasified

Published in Phys. Rev., v. 137: A56-A60, Jan. 4, 1965.

Results are presented of an experimental and theoretical study of the formation of the cathode-fall region of a pulsed glow discharge in hydrogen at large overvoltages. The calculations are based upon a Townsend avalanche model that takes explicit account of space charge. Both the experimental data and theoretical results give a minimum delay of about 35 nsec for the start of the formation of the cathode-fall region of the discharge. Profiles of the electric field as a function of time at the face of the cathode are given and calculated profiles of the number density of free electrons are compared with experimentally measured intensity profiles. In both cases there is good agreement between theory and experiment. Since the model used accounts for the observed features of the high-current pulsed discharge, there is no apparent need to invoke any other mechanism to account for the propagating luminous fronts and the short formative times of the cathode-fall region. (Contractor's abstract)

2395

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

MATHEMATICAL MODELS FOR DRIFT FAILURE ANALYSIS, by M. L. Snooman. [1965] 11p. incl. diagrs. tables, refs. (AFOSR-65-0623) (AF AFOSR-62-280) AD 614847 Unclassified

Also published in Proc. Eleventh National Symposium on Reliability and Quality Control, Miami Beach, Fla., Jan. 12-14, 1965.

Several mathematical techniques which are available for the analysis of drift failures are discussed. The conventional techniques of drift failure analysis are 'stacking-up-to-the-tolerance', worst case analysis and expansion of the performance function in a Taylor series which is truncated after the linear terms. These techniques are simple to apply but are rather inaccurate in many cases. The very general approach involving the change of random variables theorem is discussed; however, the resulting integral expressions are only amenable to solution and interpretation in special cases. The specific moment relationships are computed for Gaussian and rectangular distribution models. A discussion of how one can estimate parameter moments from manufacturer's specifications is included. The probabilistic expressions including the quadratic terms are derived. The partial

derivative coefficients in the Taylor series are related to sensitivity functions used in system theory. A probabilistic interpretation is given to stacking up the tolerance, and worst case analysis.

2396

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

ANALYSIS AND SYNTHESIS OF NON-UNIFORM TRANSMISSION LINES INCORPORATING LOSS, by H. A. Stadmore [1965] [11]p. (AFOSR-65-2336) (AF 49(638)1373) and AF AFOSR-62-280) AD 629172 Unclassified

Also published in IEEE Internat'l. Conv. Rec., Part 7: 7-17, 1965.

A method of analysis and synthesis of a lossy, passive, reciprocal non-uniform transmission line is presented. Solutions to the assumed telegrapher's equations are cast in terms of a volterra integral equation to make use of the inherent convergence properties when iterative methods are applied. Utilizing complex normalization it is possible to formulate a scattering matrix referenced to arbitrary generator and load impedances. The first order approximation to the input scattering coefficient, is derived and specialized to the case of parallel loss. A synthesis procedure for this is outlined. Higher order approximations to the coefficient in the general loss case are indicated for the analysis problem. (Contractor's abstract)

2397

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

[MICROWAVE, ELECTROMAGNETIC THEORY, AND INFORMATION PROCESSES, by J. Fox. Final rept. June 10, 1965 [86]p. incl. refs. (Rept. no. PIBMRI-1277-65) (AFOSR-65-1492) (Sponsored jointly by the Air Force Office of Scientific Research, [Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-62-295) AD 624297 Unclassified

Abstracts are given of significant research results in electromagnetic theory and information processes. Contributions are listed of technical literautre in the fields of control systems, electromagnetics, electrophysics, communication theory, and physics. A review of research carried out by the Joint Services Electronics Program during the period of the grant is presented.

2398

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N Y.

THE INTERCHANGE OF SOURCE AND DETECTOR IN LOW-POWER MICROWAVE NETWORK MEASUREMENTS, by H. M. Altschuler. [1965] [7]p. incl. diagrs. (AFOSR-65-2400) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under AF AFOSR-62-295) AD 625768 Unclassified

Also published in IEEE Trans. Microwave Theory and Techniques, v. MTT-13: 84-90, Jan. 1965.

The technique for interchanging generator and detector in the impedance measurement of microwave 1-ports is a useful, known procedure often applied when low powers are indicated. The necessary and sufficient conditions for the validity of such measurements are examined critically and direct extensions of this technique to measurements of reciprocal 2-ports are given. A completely separate analysis is necessary when such an interchange is made in the case of an interference bridge which is to be used for the determination of the scattering parameters of arbitrary (active or passive, and reciprocal or nonreciprocal) 2-ports. This analysis, presented in detail, results in a new low-power-level version of a method of measuring arbitrary 2-ports as outlined in an earlier paper. The measurement technique and the subsequent data analysis of the 2 versions are found to be identical, except that the 2 scattering parameters S_{12} and S appear in interchanged positions. (Contractor's abstract)

2399

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

[MICROWAVE, ELECTROMAGNETIC THEORY AND INFORMATION PROCESSES], by J. Fox. Final rept. May 1, 1963-Apr. 30, 1964. June 11, 1965 [35]p. incl. refs. (Rept. no. PIBMRI-1278-65) (AFOSR-65-1493) (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under AF AFOSR-63-453) AD 624297 Unclassified

The contributions of the Joint Services Electronics Program at the Polytechnic Inst. during the last 10 years are reviewed. Included are a listing of doctor's dissertations, papers partially supported by the grant, and abstracts of papers directly supported. The research program included the 5 areas of electromagnetics microwave networks and techniques, information processes, feedback and control, and nonlinear circuits.

2400

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

MINIMUM-SCATTERING ANTENNAS, by W. K. Kahn and H. Kurss. Apr. 7, 1964 [12]p. incl. diagrs. (Rept. no. PIBMRI-1215-64; memo no. 96) (AFOSR-65-1726) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-453, Army Research Office (Durham), Office of Naval Research, and National Science Foundation) AD 624080 Unclassified

Also published in IEEE Trans. Antennas and Propagation, v. AP-13: 671-675, Sept. 1965.

Antennas with identical patterns differ to the extent in which they modify an incident wave, i.e., in the amount they scatter. An antenna is completely described by an (infinite dimensional) scattering matrix. The concept of a minimum scattering antenna introduced by Dicke is generalized to include antennas with a finite number of accessible waveguide ports and with non-reciprocal components. A canonical minimum scattering antenna is defined as one which becomes 'invisible' when the accessible waveguide terminals are open circuited. Such an antenna is shown to be unique once the independent radiation patterns have been specified. Neither an impedance nor an admittance matrix for such an antenna exists. The physical significance of the minimum scattering antenna concept is examined from several points of view. Appropriate generalizations of Dicke's results are derived for multiport and non-reciprocal antennas. The 'scattered power', is introduced as a convenient measure of scattering. It is demonstrated, for a large class of antennas, that the scattered power is quite generally greater than the absorbed power, equality being attained for minimum scattering antennas of this class. This result further justifies the minimum-scattering terminology. Arrays of canonical antennas are discussed briefly.

2401

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

NONLINEAR EFFECTS IN THE TWO-STREAM INSTABILITY, by J. P. Freidberg. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-2451) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-453 and Rome Air Development Center) AD 628729 Unclassified

Also published in Phys. Fluids, v. 8: 1031-1038, June 1965.

The problem of the nonlinear interaction of 2 cold interpenetrating electron and ion streams is treated. By seeking traveling-wave-type solutions to the nonlinear twofluid system of equations, an amplitude dependent dispersion relation is obtained. An examination of the solution and the dispersion relation indicates that there is a range of values for k, where the 2-stream stability levels off before the onset of overtaking.

2402

Polytechnic Inst. of Brooklyn. [Microwave Research Inst.] N. Y.

A NOTE ON THE UNIFIED THEORY OF NONLINEAR OSCILLATIONS OF A COLD PLASMA, by J. P. Freidberg and R. Sasiela. [1965] [3]p. incl. diagrs. (AFOSR-66-2360) (Sponsored jointly by Air Force Systems Command and Joint Service Technical Advisory Comm. under AF AFOSR-63-453) AD 642815 Unclassified

Also published in Jour. Math. Anal. Appl., v. 12: 488-490, Dec. 1965

It is shown that Dolph's time-dependent solutions to the cold plasma equations are based on an assumption which is not completely general. For the case of a plasma consisting of 2 mobile species, a more general form of Poisson's equation is required to account for an inhomogeneous initial distribution of ions.

2403

Pomona Coll. [Dept. of Physics] Claremont, Calif.

SOME NOTES ON ULTRASOFT X-RAY FLUORESENCE ANALYSIS-10 TO 100 A REGION, by B. L. Henke. [1965] [16]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2825) (AF AFOSR-62-415) AD 628745 Unclassified

Also published in Advan. in X-Ray Anal., v. 8: 269-284, 1965.

Methods and instrumentation were developed for the extension of x-ray fluorescence analysis into the light element region, magnesium through beryllium. Examples of current values for the minimum detectable limits for these elements and associated instrumental parameters are presented. Some specific techniques are described for the use of an ultrasoft x-ray vacuum spectrograph, for the development of large D-spacing multilayer analyzers, and for the construction of thin window systems. (Contractor's abstract)

2404

Pomona Coll. Dept. of Physics, Claremont, Calif.

OXYGEN DETERMINATIONS IN SILICATES AND TOTAL MAJOR ELEMENTAL ANALYSIS OF ROCKS BY SOFT X-RAY SPECTROMETRY, by A. K. Baird and B. L. Henke. [1965] [3]p. incl. diagrs. tables, refs. (AFOSR-65-2150) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-689 and National Science Foundation) AD 629074 Unclassified

Also published in Anal. Chem., v. 37: 727-729, May 1965.

New developments in forming thin film x-ray tube and detector windows and building large d-spacing analyzing crystals have resulted in 30- to 50-fold increases in the counting rates for oxygen Kα in silicates using a vacuum-path x-ray spectrometer. A test of the precision of oxygen determinations over the range 44 to 54% shows that it is now possible to achieve better than 1% relative standard deviation in routine rock analyses. This improved precision allows the detection of significant biases in calibration which seem to be caused by an inadequate knowledge

of the concentrations of the other elements present and by the lack of adequate standards. (Contractor's abstract)

2405

Pomona Coll. [Dept. of Physics] Claremont, Calif.

15-150 A ULTRASOFT X-RAY REGION, by B. L. Henke. [1965] [14]p. incl. illus. diagrs. tables, refs. (AFOSR-67-2782) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-689 and National Science Foundation) Unclassified

Also published in Optique des Rayons X et Microanalyse; X-Ray Optics and Microanalysis; Proc. of the Fourth Internat'l. Congress (Sept. 7-10, 1965) Orsay , ed. by R. Castaing, P. Deschamps and J. Philbert. Paris, Hermann, p. 440-453, 1965.

Methods and instruments have been developed for efficient spectroscopic analysis in the ultrasoft x-ray region of 15 to 150 A (100-to-1000 ev energy range). The spectral lines included are O-K (23.6 A) through Be-K (114 A) and Fe-L (17.6 A) through Si-L (136 A). The measurement of many of these wavelengths has been applied to light element fluorescence analysis, chemical valence state determination, and high temperature plasma analysis. Specially developed Langmuir-Blodgett type multilayer analyzers are used with a flow proportional counter system. Simple adaptations of the basic vacuum spectrograph of Philips are employed with a high intensity demountable x-ray excitation source. Typical analysis sensitivities as currently obtained and corresponding instrumental parameters are presented. (Contractor's abstract)

2406

Princeton U. Dept. of Aeronautical Engineering, N. J.

THEORIES OF THERMAL TRANSPIRATION AND MOLECULAR EFFUSION, by Y. Wu. Feb. 1965, 23p. incl. diagrs. refs. (Rept. no. 718) (AFOSR-65-0645) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1271 and National Science Foundation) AD 616285 Unclassified

Revised theories of thermal transpiration and molecular effusion are presented in a rigorous treatment. It is a modified version of the classical laws of Reynolds and Graham. A set of invariants and a new geometrical property, isotropicity, have been found in a system with non-uniform temperature distribution on the boundary in the Knudsen regime. The reciprocal transmission probability theorem has been proved to be valid in this stationary state system according to the invariant of number flux throughout the region. The application of thermal transpiration to rarefied gas kinetics has been found in many problems, i.e., heat conduction between 2 parallel plates and co-axial cylinders, thermal creep effect, and temperature jump effect.

2407

Princeton U. [Dept. of Aeronautical Engineering] N. J.

FLOW OF A COLLISIONLESS PLASMA OVER A CONE, by S. H. Lam and M. Greenblatt. [1965] 19p. incl. diagrs. refs. (AF 49(638)1271) AD 456113 Unclassified

Presented at AIAA Second Aerospace Sciences Meeting, Jan. 25-27, 1965, New York.

Published in AIAA Jour., v. 3: 1850-1855, Oct. 1965.

In a flowing low-density plasma, the presence of a solid body introduces electrostatic as well as gasdynamics disturbances. A general theory was presented recently for these electrogasdynamic problems with the assumptions that the ion thermal speed is negligible compared to the flow speed and that the characteristic length of the problem is much greater than the Debye length. The present paper considers the flow of a collisionless plasma over a right circular cone within the framework of this theory. By confining attention to the case when the flow speed is greater than the ion wave speed (the supersonic case), the conical self-similar solutions for a large range of flow velocities and cone angles are constructed. The ion saturation current density to the cone surface and the potential at the edge of the sheath are computed. The limiting behavior of the solution near various singular points in the governing equation is analyzed and discussed.

2408

Princeton U. [Dept. of Aeronautical Engineering] N. J.

ON THE HYDRODYNAMIC STABILITY OF PARALLEL DUSTY GAS FLOWS, by J. T. C. Liu. [1965] [7]p. incl. diagrs. (AF 49(638)1271) Unclassified

Published in Phys. Fluids, v. 8: 1939-1945, Nov. 1965.

The physical implications of the stability of parallel flows of a dusty gas are studied. The over-all (gas-plus particle) disturbance kinetic energy balance is contributed by dissipation due to the usual gas viscosity and augmented by the work done due to particle-gas interaction and energy conversion from the mean flow to the disturbances by both the gas and particle Reynolds shear stresses. The viscous sublayer structure, where viscosity is known to be destabilizing, is obtained. The Reynolds shear stresses of both phases are derived from considering the relaxative nature of the disturbance vorticity diffusion process.

2409

Princeton U. [Dept. of Aeronautical Engineering] N. J.

A UNIFORMLY VALID ASYMPTOTIC THEORY OF

RAREFIED GAS FLOWS UNDER NEARLY FREE MOLECULAR CONDITIONS, II, by Y-P. Pao. [1965] [15]p. incl. refs. (AF 49(638)1271) Unclassified

Also published in Rarefied Gas Dynamics; Proc. Fourth Internat'l. Symposium, Toronto U. (Canada) (July 14-17, 1964), ed. by J. H. de Leeuw. New York, Academic Press, v. 1; 296-311, 1965.

For a rarefied gas flow of infinite extent over a submerged body, at very large Knudsen number, the free molecular solution is not a uniformly valid approximation throughout the flow field. This nonuniform validity will necessarily invalidate the collisional corrections obtained (even in the vicinity of the submerged body) by any iteration procedure based on the free molecular solution as the order of correction becomes higher. In the present study, a uniformly valid asymptotic theory is developed, based on the BGKW model equation, for the simple nearly free molecular flow problem of a 2-dimensional cylinder rotating in an infinite gas otherwise at rest. The asymptotic solutions given by this theory will be uniformly valid approximate solutions. (Contractor's abstract)

2410

Princeton U. [Dept. of Aeronautical Engineering] N. J.

THE GAS-PHASE DECOMPOSITION OF HYDRAZINE AND ITS METHYL DERIVATIVES, by I. Glassman and I. K. Eberstein. [1965] [10]p. incl. illus. diagrs. refs. (AFOSR-66-1098) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-90 and National Science Foundation) Unclassified

Also published in Tenth Symposium (Internat'l.) on Combustion, Cambridge (Gt. Brit.) (Aug. 17-21, 1964), Pittsburgh, Combustion Inst., 1965, p. 365-374.

The decomposition of hydrazine, hydrazine-water mixtures, UDMH, and monomethyl-hydrazine was studied in the Princeton adiabatic flow reactor. The over-all reaction order of all 3 monopropellants was very close to unity. A study of hydrazine-water mixtures showed their rates to be slower than those of the anhydrous material by approximately a factor of 10 and independent of the amount of water added. Slightly wet hydrazine behaved kinetically like the hydrazine water mixtures. Thus it seems that water inhibits the gaseous decomposition of hydrazine by very effectively suppressing some reaction step. A comparison of reaction rates of the 3 monopropellants shows that, in the temperature regime of this study, UDMH decomposition is the fastest, hydrazine decomposition is the slowest, and the monoethylhydrazine-decomposition rate is intermediate. (Contractor's abstract)

2411

Princeton U. [Dept. of Aeronautical Engineering] N. J.

UNIFIED THEORY FOR THE LANGMUIR PROBE IN A COLLISIONLESS PLASMA, by S. H. Lam. [1965] [15]p. incl. diagrs. table. (AF AFOSR-63-112) Unclassified

Published in Phys. Fluids, v. 8. 73-87, Jan. 1965.

An asymptotic analysis is presented of the Langmuir-probe problem in a quiescent, collisionless plasma in the limit of large body dimension of Debye length ratio. The structures of the electric potential distribution about spheres and cylinders are analyzed and discussed in detail. It is shown that when the probe potential is smaller than a certain well defined value, there exists no sheath adjacent to the solid surface. At large body potentials, for which a sheath is present, the electric potential distribution is given in terms of several universal functions. Master current-voltage characteristic diagrams are given which exhibit clearly the effects of all the pertinent parameters in the problem. An explicit trapped-ion criterion is presented. The general problem with an arbitrary body dimension to Debye length ratio is qualitatively discussed.

2412

Princeton U. [Dept. of Aerospace and Mechanical Sciences] N. J.

IGNITION OF AN EVAPORATING FUEL IN A HOT, STAGNANT GAS CONTAINING AN OXIDIZER, by C. E. Hermance, R. Shinnar, and M. Summerfield.. [1965] [9]p. incl. diagrs. refs. (ASOSR-66-1789) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1267 and National Aeronautics and Space Administration) AD 639878 Unclassifid

Presented at AIAA Solid Propellant Rocket Conf., Palo Alto, Calif., Jan. 29-31, 1964.

Also published in AIAA Jour., v. 3: 1584-1582, Sept. 1965.

Experimental evidence indicates that the ignition of a solid propellant by conventional agents occurs in the gaseous reaction zone adjacent to the propellant surface and that, in such heterogeneous systems, the gas composition, pressure, and temperature strongly influence the ignition delay. This paper, in contrast to extensive past study of ignition in homogeneous mixtures, describes some of the key theoretical properties of ignition in heterogeneous systems through similarity theory and numerical analysis of the mathematical model. Certain common simplifying assumptions and ignition criteria, valid for homogeneous systems, were found to be invalid in heterogeneous systems. In heterogeneous systems with igniter gas temperatures near E/R, the particular choice of ignition criterion affects the formula connecting the ignition delay and the chemical or

physical parameters of the gas phase. Furthermore, a log-log plot of ignition delay vs concentration of gaseous oxidizer exhibits a slope that varies over a wide range of negative values; this slope is not a simple multiple of the controlling reaction order. These theoretical results require verification by critically designed experiments.

2413

Princeton U. Dept. of Aerospace and Mechanical Sciences, N. J.

THE HOMOGENEOUS GAS PHASE KINETICS OF REACTIONS IN THE HYDRAZINE-NITROGEN TETROXIDE PROPELLANT SYSTEM, by R. F. Sawyer. 1965, [315]p. incl. illus. diagrs. tables, refs. (Tech. rept. no. 761) (AFOSR-66-0855) (AF 49(638)1266) AD 634277 Unclassified

The reaction of hydrazine and nitrogen tetroxide is affected strongly by reactant decompositions. Hydrazine can decompose to hydrogen, ammonia, and nitrogen. Nitrogen tetroxide can decompose to nitrogen dioxide, nitric oxide, oxygen, and nitrogen. The gas phase homogeneous reactions of hydrazine, hydrogen, ammonia, and hydrogen/ammonia mixtures with nitrogen dioxide, oxygen, nitric oxide, and oxygen/nitric oxide mixtures were studied in an adiabatic flow reactor at temperatures of from 800° to 1300 K. Heats of reaction, reaction orders, and reaction rates were determined for 11 reactions involving combinations of the above reactants. Arrhenius rate constants were calculated and overall activation energies determined from the measured reaction rates. The reaction of hydrogen and oxygen is about 2 times more rapid than the reaction of hydrogen and nitrogen dioxide. The hydrogen/nitrogen dioxide reaction reaction produces nitric oxide which inhibits the further oxidation of hydrogen. Ammonia reacts about 10 times more rapidly with nitrogen dioxide than with oxygen. Hydrazine and nitrogen dioxide react with a 2 step behavior; the rapid reduction of nitrogen dioxide to nitric oxide is followed by a slower reduction of the nitric oxide. The first step occurs without hydrazine decomposition. The second step requires the decomposition of hydrazine. The reaction of hydrazine and oxygen occurs with simultaneous decomposition and oxidation.

2414

Princeton U. [Dept. of Aerospace and Mechanical Sciences] N. J.

HIGH TEMPERATURE CHEMICAL KINETICS (Abstract), by I. Glassman. [1965] [3]p. incl. table. (Bound with its AFOSR-65-2238) [AF 49(638-1268] Unclassified

The abstract is presented in 2 sections as the thesis work of R. F. Sawyer and J. W. Rich, respectively. The first section discusses the gas phase reactions of hydrazine, $N_2O_4 \rightleftharpoons 2NO_2$, and their decomposition products. A whole matrix of reactions is suggested by the decomposition products of hydrazine and NO_2 which is the favored equilibrium product of N_2O_4 at the temperature of concern. Reaction orders and rates have been measured in an adiabatic flow reactor 12 reactions; no observable reaction was found for the 4 remaining combinations. The hydrazine/NO_2 combination exhibited the unique behavior of a 2-step reaction. The reduction of NO_2 to NO occurs about 20 times more rapidly than the subsequent reduction of NO. In combination with previous studies of hydrazine decomposition, evidence was obtained that the first step of the hydrazine/NO_2 reaction occurs without the decomposition of hydrazine while other hydrazine reactions either require hydrazine decomposition or involve simultaneous decomposition and oxidation. The second section discusses the dissociation of diatomic molecular systems; a vibrational "ladder-climbing" model of molecular dissociation, which assumes that the probability of vibrational excitation upon molecular collision could be described by near-adiabatic distorted wave treatment was investigated. Transition matrix elements for the Morse oscillator were used and an exponentially repulsive intermolecular potential was adopted. It was assumed that the range of the repulsive potential could be approximately related to the range of the Morse intramolecular potential. This approximation yielded a collisional selection rule in which only single vibrational quantum transitions were allowed, yet the effect of anharmonicity was retained in the matrix elements. The cascaded kinetic equations for molecular dissociation in the presence of an inert diluent were formulated and solved. In the normal dissociation temperature range, a quasi-steady state was quickly attained. An analytical expression for the quasi-steady state dissociation rate was obtained and compared with shock tube experimental results.

2415

Princeton U. Dept. of Aerospace and Mechanical Sciences, N. J.

EXPERIMENTS ON ANNEALED ALUMINUM, by M. J. Kenig. [1965] [175]p. incl. illus. diagrs. tables, refs. (Rept. no. 737) (AFOSR-65-0983) (AF 49(638)1306) AD 618088 Unclassified

This investigation is a study of the quasi-static stress-strain relation for the case of biaxial stress in annealed commercially pure aluminum, and its implications with respect to the speed of propagation of disturbances caused by incremental stresses. Tubes of 1100 aluminum are subjected to combined tension and torsion loads applied by means of a very slow loading technique. It is concluded that annealed 1100 aluminum is a mechanically unstable material and that current theory of plasticity cannot possibly apply to mechanically unstable materials. Shock wave theory, as developed in this dissertation, can be generally applied to mechanically unstable materials prestressed into the plastic region to predict the speed of propagation of the leading edge of disturbances caused by incremental stress.

2416

Princeton U. Dept. of Aerospace and Mechanical Sciences, N. Y.

THERMOELASTICITY WHEN THE MATERIAL COUPLING PARAMETER EQUALS UNITY, by O. W. Dillon, Jr. [1965] [5]p. incl. diagrs. (AFOSR-65-2480) (AF 49(638)1306) AD 628258 Unclassified

Also published in Jour. Appl. Mech., pp. 378-382, June 1965.

Presented at Applied Mechanics/Fluids Conf., Washington, D. C., June 7-9, 1965.

Analytical solutions of 3 problems in coupled thermoelasticity are presented for the case when the material coupling parameter equals unity. The problems considered are: (a) Danilovskaya's problem of a step function in temperature at the surface; (b) a step function in surface strain; and (c) constant velocity impact. Solutions are presented for the case of thin bars (one-dimensional stress) and are obtained by the La Place-transform technique. There is great simplification in the equations when the material coupling parameter equals unity which permits the straightforward inversion of the transformed solutions from the corresponding uncoupled solutions. (Contractor's abstract)

2417

Princeton U. Dept. of Aerospace and Mechanical Sciences, N. J.

COMBUSTION PROCESSES IN LIQUID PROPELLANT ROCKET MOTORS, by I. Glassman. Final rept. Sept. 1, 1962-Aug. 31, 1963. Dec. 22, 1965. [8]p. incl. refs. (AFOSR-65-2933) (AF AFOSR-63-111) AD 627712 Unclassified

Princeton University has been engaged in a long range program on combustion processes in liquid propellant rocket motors. Aspects of this program are still continuing. During the period of September 1, 1962 to August 1963, the work was supported by Air Force Office of Scientific Research Grant 111-63. The detailed technical accomplishments have been published in the open literature as listed in the section on publications. The report reviews the history, results, and publications of the research program up to August 31.

2418

Princeton U. Dept. of Aerospace and Mechanical Sciences, N. J.

SOLID PROPELLANT COMBUSTION INSTABILITY: OSCILLATORY BURNING OF SOLID ROCKET PROPELLANTS (U), by R. H. W. Warsche and M. Summerfield. June 1, 1963-Sept. 30, 1964. Aug. 1965, [308]p. incl. diagrs. illus. tables, refs. (AMS rept. no. 751) (AFOSR-66-0937) (Sponsored jointly by Advanced Research Projects Agency and Air Force Office of Scientific Research under AF AFOSR-63-448) Unclassified

This research was concerned with the problem of combustion instability in solid propellant rocket motors and, in particular, the nature of the dynamic coupling between the oscillating pressure and the combustion process at the propellant surface. A T-tube rocket motor was used to generate a high amplitude pressure oscillation, in the range from 75 to 1600 cycles/second and 250 to 1150 psi mean pressure. Various test specimens of ammonium perchlorate composite propellants were exposed to this oscillating pressure field in a combustion chamber connected to the T-motor. Through windows in the chamber, observations of flame gas temperature were made by measuring the luminous radiation with a photocell receiver, and spatial gas temperature variations (entropy waves) were investigated by high speed photography. It was found that, for all the different propellants, in the entire range of frequency and pressure noted above, the flame temperature responded isentropically to the oscillating pressure, and no entropy waves were seen in the combustion gas stream. This is completely contrary to theoretical expectations and it obviously means that the physical nature of the pressure-flame interaction is not well understood. Because of the importance of this interaction, further experiments with a different approach are proposed.

2419

Princeton U. [Dept. of Astronomy] N. J.

THERMAL INSTABILITY IN NON-DEGENERATE STARS, by M. Schwarzschild and R. Harm. [1965] [13]p. incl. diagrs. table. (AFOSR-66-0381) (AF 49(638)1555) AD 630098 Unclassified

Also published in Astrophys. Jour., v. 142: 855-867, Oct. 1, 1965.

In the numerical investigation of the evolution of a star of 1 solar mass through the phases in which it contains a helium-burning shell as well as a hydrogen-burning shell, an unexpected type of thermal instability has been encountered. This instability is somewhat reminiscent of the helium flash even though degeneracy plays no role in the models considered. The existence of the instability has been made reasonably certain both by a physical analysis and by a direct mathematical derivation. The new instability appears to have the character of a thermal runaway in a non-degenerate shell containing a highly temperature-sensitive nuclear-energy source. Such a shell will be unstable only if it is sufficiently thin not to affect the over-all hydrostatic structure of the star noticeably. Under this condition the pressure within the shell cannot greatly increase during the thermal runaway, and hence cooling by an adiabatic expansion cannot stabilize the shell. Some speculations are presented regarding whether this instability could have substantial consequences for a star's evolution. (Contractor's abstract)

2420

[Princeton U. Dept. of Astronomy, N. J.]

[NUMERICAL RESEARCH ON STELLAR EVALUATION], by R. Harm and M. Schwarzschild. Final rept. Feb. 12, 1965, 2p. (AFOSR-65-0575) (AF AFOSR-63-152) Unclassified

The question whether the helium flash causes mixing of hydrogen into the helium core is examined by computing detailed model sequences for 3 stars different in mass and composition. These sequences, derived by the Henyey method, cover the entire helium-flash phases. The numerical results indicate that the convective core, though greatly extended during the later cooling phases after the helium flash, misses reaching the hydrogen-rich layers, but only by a very narrow margin. In view of the narrowness of this margin and because of the fact that a number of physical complications have not yet been taken into account in these computations, the question still cannot be answered regarding mixing caused by the helium flash. The main result of the entire investigation is that for the type of star considered the helium flash is a very sudden but nevertheless apparently harmless transition from the hydrogen burning phase the subsequent phase in which both helium and hydrogen burn simultaneously.

2421

Princeton U. Dept. of Biology, N. J.

BIOLOGICAL CLOCKS, by C. S. Pittendrigh. (1965) [16]p. incl. diagr. [AF AFOSR-63-340) Unclassified

Published in Science in the Sixties; Tenth Anniversary AFOSR Scientific Seminar, Cloudcroft, N. M. (June 14-25, 1965), ed. by D. L. Arm. Albuquerque, New Mexico U. Office of Publications, 1965, 96-111.

The nature of biological periodicity has been of interest to scientists as early as 1729 when De Mairan noted that periodic movements of certain plants persisted even in a periodic environment. Some of the more recent discoveries and experimental results concerned with circadian oscillations are presented. The behavior of certain organisms to a fixed stimulus is markedly different at different circadian phases. The precision and temperature compensation of the rhythmicity are among its most striking features. The rhythmicity is, moreover, innate to the organism. A significant result has been the demonstration that De Mairan's rhythms do not depend on the greater complexity of multicellular organization. Many attempts to manipulate circadian rhythmicity chemically have been singularly unsuccessful. The only unequivocal demonstrations of manipulation of the clock concern either the phase period or a steady-state rhythm. It is noted that light cycles are universally effective in entraining circadian oscillations and oscillations and observations have shown that the light is transduced by the eye. Time-compensated sun orientation has been discovered in a remarkedly diverse array of metozoa; this does not account however, for the initial evolution of circadian oscillations - it has exploited already existing rhythmicity. The primary functional significance of the oscillations and the importance of new experimental work in this field are discussed.

2422

Princeton U. Dept. of Chemistry, N. J.

SOLVENT EFFECTS ON THE INFRARED FREQUENCY OF INORGANIC CARBONYL AND NITROSYL BANDS, by W. D. Horrocks, and R. H. Mann. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-0689) (AF AFOSR-63-242) AD 615669 Unclassified

Also published in Spectrochim. Acta, v. 21: 399-408, 1965.

The infrared spectra of a number of transition metal carbonyl and nitrosyl compounds have been recorded in a series of solvents. The behavior of the various bands is discussed in terms of the relative frequency shift plots of Bellamy and co-workers. The magnitude of the frequency shifts is correlated with the relative electron density around the metal atom in a series of compounds in which the ligands are varied. Solvent effects on N—O and C—O vibrators appear to be fairly similar in character with the N—O band shift greater in magnitude. This is discussed in terms of dative metal-ligand π-bonding in these complexes. It is found that in molecules with more than one C—O band, the frequency shifts of these bands correlate fairly well among themselves but do not correlate with those of complexes having only one C—O band. The bridging carbonyl band in $Co_2(CO)_2$ has a solvent shift benavior very similar to organic ketones. In certain solvents, however, there is evidence for the formation of the $Co(CO)_4^-$ anion. (Contractor's abstract)

2423

Princeton U. [Dept. of Mathematics] N. J.

INTRINSIC ANALYTIC CONTINUATION AND ENVELOPES OF HOLOMORPHY, by S. Bochner. [1965] [4]p. [AF 49(638)578] Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 53: 904-907, May 1965.

A system $\mathcal{F} = \{S;f^\alpha\}$ is introduced in which S is called a base space; it is a connected real-analytic manifold of a fixed dimension n; and $\{f^\alpha\}$ is a family of analytical functions on S and α is an enumerative index which transverses an arbitrary but fixed index set A. By means of "Zorn's lemma" it was concluded that any such system has at least one continuation which is maximal in partial ordering. A second conclusion drawn was a one-one holomorphic map of the domain D into another domain of C^n, also maps the corresponding envelopes of holomorphy, even if the latter are many-sheeted. This conclusion rests on the proposition that if a domain D of C^n, the function becomes

a natural completion when S = D and f^{∞} consisted of all one-component holomorphic functions, scalars or densities.

2424

Princeton U. [Dept. of Psychology] N. J.

VISUAL VELOCITY DISCRIMINATION: EFFECTS OF "BLANKING" THE STIMULUS, by F. J. Mandriota. [1965] [2]p. incl. diagr. (AFOSR-65-1306) (AF 49(638)381) AD 621190 Unclassified

Also published in Psychon. Sci., v. 2: 159-160, 1965.

Weber ratios were obtained for visual velocity discrimination under 2 stimulus conditions which differed only with regard to the presence of visible continuous motion. Discrimination of velocity under normal conditions was compared with discrimination under blanked conditions. In the latter, the subjects saw only the initial and final positions of a target separated in time by intervals comparable to the duration of the motions seen under the former condition. Difference thresholds for blanked motion are approximately double those for continuous motion over a wide range of velocities. (Contractor's abstract)

2425

Princeton U. [Dept. of Psychology] N. J.

ABSOLUTE AND DIFFERENTIAL CUING OF SUCCESSIVE REVERSALS, by M. Goldstein and B. G. Galef, Jr. [1965] [8]p. incl. diagrs. tables. (AFOSR-65-2660) (AF AFOSR-62-197) AD 629146 Unclassified

Also published in Perceptual and Motor Skills, v. 21: 159-166, 1965.

Successive reversals for a single pair of stimulus alternatives were signalled by means of a 'differential' cuing method for 1 of 2 'absolute' curing methods, under differential cuing, there were 2 extra stimuli that corresponded to reversal and nonreversal, respectively. Under absolute cuing, there was only 1 extra stimulus, but its cuing absence served as 1 signal and its presence served as another. Both possible ways of pairing presence vs absence with reversal vs nonreversal were studied. There were 30 human Ss divided equally among the 3 methods. Differential cuing was the most difficult method. Absolute cuing was least difficult when presence of the extra stimulus was coupled with reversal and absence of the extra stimulus with nonreversal. (Contractor's abstract)

2426

Princeton U. [Dept. of Psychology] N. J.

CONTINGENT DISCRIMINATION IN HUMANS, by M. Goldstein and R. J. Weber. [1965] [6]p. incl. diagr. table. (AFOSR-65-2662) (AF AFOSR-62-197) AD 629144 Unclassified

Also published in Perceptual and Motor Skills, v. 21: 171-176, 1965.

Six groups of 10 human Ss, 14- to 18-yr-old, performed 4-display contingent discrimination tasks in which reinforcement was governed by 1 of 2 possible extra stimuli added to otherwise conventional discrimination displays. Each extra stimuli was related either to the identity or the position of the correct choice. Few errors occurred when identity of correct choice was relevant, but many more errors and some failures to reach criterion occurred when position of correct choice was relevant for some or all of the displays. (Contractor's abstract)

2427

Princeton U. [Dept. of Psychology] N. J.

COMPLEX DISCRIMINATION WITH TWO STAGES OF SOLUTION, by M. Goldstein and W. B. Turpin. [1965] [6]p. incl. diagrs. tables. (AFOSR-65-2663) (AF AFOSR-65-965) AD 629829 Unclassified

Also published in Perceptual and Motor Skills, v. 21: 491-496, Oct. 1965.

A 4-display contingent identity discrimination design was combined with a 4-display contingent position discrimination design to produce a merged task whose 8 displays appeared repeatedly over a sequence of trials. Human Ss solved the contingent identity portion of the task first in nearly all cases and maintained a high level of accuracy on the solved portion while coping with the remainder. Experimental variations related to the visual distinctiveness of the 2 portions proved unimportant. (Contractor's abstract)

2428

Princeton U. [Dept. of Psychology] N. J.

LEARNING SET WITH INTRA-PROBLEM STIMULUS VARIATION, by M. Goldstein and R. J. Weber. [1965] [7]p. incl. diagrs tables. (AFOSR-66-1164) (AF AFOSR-65-965) AD 640940 Unclassified

Also published in Perceptual and Motor Skills, v. 21: 799-805, 1965.

Thirty-six discrimination problems of a new type were presented to teenage human Ss. Each problem contained four trials, and each trial involved a choice between a constant and varied stimulus. The constant stimulus appeared on all trials within a problem. The varied stimulus was different on every trial. There were 6-experimental groups, representing orthogonal combination of a 3-treatment reinforcement variable and a 2-treatment response vs non-response variable. The reinforcement variable involved the following treatments, listed in ascending order of difficulty: constant stimulus correct on all problems, varied stimulus correct on all problems, constant and varied

stimuli correct alternately over problems. The response vs nonresponse variable was applied only to Trial 1, and its effects were evaluated on later trials, which showed that the nonresponse treatment was more difficult.

2429

Princeton U. Palmer Physical Lab., N. J.

IMPLICATIONS OF SU(6) SYMMETRY FOR TOTAL CROSS SECTIONS, by K. Johnson and S. B. Treiman. [1965] [3]p. incl. refs. (AFOSR-65-0838) (AF 49(638) 1333) AD 616047 Unclassified

Also published in Phys. Rev. Ltrs., v. 14. 189-191, Feb. 8, 1965.

It is of value to apply SU(6) notions to questions involving scattering reactions among particles, which entails coming to grips with the meaning of SU(6) in a relativistic context. The forward elastic scattering of pseudoscalar mesons on baryons is considered. The implication is explored of assigning to the full meson fields the definite SU(6) transformation properties of the meson states themselves. Because of the mass difference between K and π mesons, attention is restricted to the high energy region.

2430

Princeton U. Palmer Physical Lab., N. J.

SELF-CONSISTENT, NONDEGENERATE MULTIPLETS, by L. F. Cook and J. E. Paton. [1965] [14]p. incl. diagrs. (AFOSR-65-1061) (AF 49(638) 1333) AD 619626 Unclassified

Also published in Phys. Rev., v. 137: B1267-B1280, Mar. 8, 1965.

The restrictions of self-consistency are investigated for 2 sets of interacting particles, vector and scalar or pseudoscalar, with unequal masses. Self-consistency is studied within a field-theoretic framework and within a bootstrap framework. It is assumed that solutions exist when the particles of a given set have equal masses and the coupling constants are proportional to the structure constants of SU_3. The unequal-mass case is studied by perturbing the equal-mass solutions and retaining only first-order terms in the mass and coupling-constant shifts. It is found that fully self-consistent solutions do not exist in either case, but it is seen how such solutions can come about in the field-theoretic case. In the bootstrap analysis it is very difficult to understand how self-consistent solutions develop unless hidden identities are satisfied. (Contractor's abstract)

2431

Princeton U. Palmer Physical Lab., N. J.

BOUNDS FOR A CLASS OF BETHE-SALPETER AMPLITUDES, by G. Tiktopoulos and S. S. Treiman. [1965] [6]p. incl. diagrs. (AFOSR-65-1063) [AF 49(638)1333] AD 620639 Unclassified

Also published in Phys. Rev., v. 137: B1597-B1602, Mar. 22, 1965.

For a certain wide class of kernels involving trilinear coupling of scalar particles, the absorptive part of the Bethe-Salpeter amplitude for forward scattering is bounded from above and below. The bounds are expressed in the form $B_1 \alpha 1 < A(S) < B_2 S \alpha 2$, where S is the scattering energy and B_1 and B_2 are positive constants. Expressions for the exponents of α_1, and α_2 are given as functions of the coupling constant g. For the straight-ladder model, α_1 and α_2 coincide for all values of g, the common expression agreeing with an exact result of Nakanishi. For the more complicated models, α_1 and α_2 do not in general coincide. However, in the strong coupling limit $g \to \infty$, it is found that $\alpha_2/\alpha_1 \to 1$; moreover, the common asymptotic behavior $\alpha_1, \alpha_2 \to g \to \infty g/4\pi M$ is the same for all the models, including the straight-ladder model. (Contractor's abstract)

2432

Princeton U. Palmer Physical Lab., N. J.

FLUCTUATIONS WITH TIME OF SCATTERED PARTICLE INTENSITIES, by M. L. Goldberger and K. M. Watson. [1965] [14]p. incl. diagrs. refs. (AFOSR-65-1064) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)1333] and Atomic Energy Commission) AD 620640 Unclassified

Also published in Phys. Rev., v. 137: B1396-B1409, Mar. 8, 1965.

The fluctuations in counting rate of a particle detector are studied. These may be used to study the coherence properties of the beam. For the case of electromagnetic radiation they may be used to study spectral line shapes. The Fluctuations in intensity of scattered particles provide a means of studying fluctuation phenomena in the target. (Contractor's abstract)

2433

Princeton U. Palmer Physical Lab., N. J.

ENERGY OF INFINITELY LONG, CYLINDRICALLY SYMMETRIC SYSTEMS IN GENERAL RELATIVITY, by K. S. Thorne. [1965] [16]p. incl. illus. diagr. refs. (AFOSR-66-0813) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638) 1333] and National Science Foundation) AD 639986 Unclassified

Also published in Phys. Rev., v. 138: B251-B266, Apr. 12, 1965.

A definition of energy is proposed for systems invariant under rotations about, and translations along, a symmetry axis. This energy (which is called "cylindrical energy" or "C" energy) takes the form of

a covariant vector P^i, which obeys the conservation law P^i, $i = 0$. C energy is localizable and locally measurable: The component of P^i along the world line of an observer is the C-energy density he measures. Near the symmetry axis of a static system, where strong gravitational fields are absent, C-energy density reduces to proper mass density $T_0{}^0$. C energy is propagated by Einstein-Rosen gravitational waves and by cylindrical electromagnetic waves. In vacuo and in the presence of electromagnetic fields the C energy on a space-like hyper-surface is minimized when the system is static; and the differences between the "potential" part and the "kinetic" part is a Lagrangian for the Einstein-Maxwell field equations. C energy can be a powerful tool in the analysis of finite as well as infinite cylindrically symmetric systems. Here it is used to elucidate the nature of Einstein-Rosen gravitational radiation, and to suggest and support the conjecture of flux resistance to gravitational collapse: In any configuration of electromagnetic fields collapsing toward a singularity, each electric and magnetic-field line is either entirely ejected from the collapsing region or entirely swallowed by it as collapse proceeds; there can be no flux threading a collapsed region. (Contractor's abstract)

2434

Princeton U. Palmer Physical Lab., N. J.

NOTE ON POSITRONIUM, by G. Tiktopoulos [1965] [5]p. incl. refs. (AFOSR-66-0825) (AF 49(638)1333) AD 639983 Unclassified

Also published in Jour. Math. Phys., v. 6: 573-577, Apr. 1965.

By means of an inequality providing an upper bound for the norm of integral operators, it is shown that the Bethe-Salpeter equation for bound states of the electron-position system (in the ladder approximation) admits solutions associated with a discrete spectrum of binding energies. It is found that in the weak coupling limit the spectrum approaches asymptotically the Coulomb spectrum. (Contractor's abstract)

2435

Princeton U. Palmer Physical Lab., N. J.

INELASTIC N/D PROBLEMS AND CASTILLEJO-DALITZ-DYSON CUTS, by J. B. Hartle and C. E. Jones. [1965] [3]p. incl. diagrs. (AFOSR-66-0827) (AF 49(638)1333) AD 639985 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 801-803, May 10, 1965.

Calculations indicate that the Frye-Warnock equations and the Froissart and Ball-Frazer methods all give the same result as many-channel N/D. It is also established that the Frye-Warnock equations are correct at high angular-momentum variable (l), from there the research went to include solutions to lower values of l. Cuts are introduced in the D function. These cuts emerge gradually from the inelastic cuts as l is decreased. These Castillejo-Dalitz-Dyson (CDD) cuts are an inelastic phenomenon. This report illustrates the origin of such cuts.

2436

Princeton U. Plamer Physical Lab., N. J.

CLUSTER PROPERTIES OF MULTIPARTICLE SYSTEMS, by W. Hunziker. [1965] [5]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)1333] and Swiss National Fund) Unclassified

Published in Jour. Math. Phys., v. 6: 6-10, Jan. 1965.

A system of N particles in nonrelativistic quantum mechanica is investigated. The particles interact via two- or many-body potentials, for which a sufficient condition is that they be square integrable in the relative coordinates of the interacting particles. Cluster properties are derived for the time translation operator, for the wave operators, for the transition probabilities, and for the S operator. (Contractor's abstract)

2437

Princeton U. Palmer Physical Lab., N. J.

HIGH-ENERGY LARGE-ANGLE SCATTERING BY SINGULAR POTENTIALS, by G. Tiktopoulos. [1965] [9]p. incl. diagrs. refs. [AF 49(638)1333] Unclassified

Published in Phys. Rev., v. 138: B1550-B1558, June 21, 1965.

An attempt, based on potential scattering, to understand the recent experimental results on high-energy large-angle proton-proton scattering is presented. Potentials of the form $g\, e^{-i\Delta r}\, r^{-n}$, representing strong absorption ($\tau > \Lambda \geq 0$; $n \geq 2$) at short distances r ($g > 0$ may depend on the energy), are studied in order to obtain the asymptotic form of the associated scattering amplitude at high energies and fixed (nonforward) angle. This form is found to display the rapid (experimental) decrease of the (elastic) differential cross section with increasing scattering angle which is typical of the p-p experiments. (Contractor's abstract)

2438

Princeton U. [Palmer Physical Lab.] N. J.

HYDROSTATICS AND STABILITY OF STARS IN GENERAL RELATIVITY, FROM AN ENERGY POINT OF VIEW (Abstract), by K. S. Thorne and J. A. Wheeler. [1965] [1]p. [AF 49(638)1333] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Energy concepts are applied to the study of the structure and stability of spherically symmetric equilibrium configurations of perfect fluid. It is shown that, a amongst all momentarily static configurations of perfect fluid containing a fixed number of baryons, those configurations that extremize the mass as observed from outside are the configurations of hydrostatic equilibrium. Moreover, if an equilibrium configuration is radially perturbed, the (second-order) change in the mass can be divided into a kinetic part K plus a potential part P, whose difference is a Lagrangian for the equation governing radial motion. The equilibrium configuration is stable if and only if P is positive definite. The relation between this stability criterion and that of Chrandrasekhar is exhibited.

2439

Princeton U., Palmer Physical Lab., N. J.

INELASTIC RESONANCES AND CASTILLEJO-DALITZ-DYSON SINGULARITIES, by J. B. Hartle and C. E. Jones. [1965] [5]p. incl. refs. [AF 49(638) 1333] Unclassified

Published in Phys. Rev., v. 140: B90-B94, Oct. 11, 1965.

By considering many coupled 2-body-channel scattering amplitudes that possess a unique continuation in the angular-momentum variable l, we show: (1) that several methods of obtaining the single-channel N/D solution for the elastic amplitude with an inelasticity factor agree with the corresponding many-channel matrix N/D solution at high l; (2) that in order to preserve agreement when continuing to low angular momentum one must generally introduce Castillejo-Dalitz-Dyson (CDD) cuts or poles into the single-channel D function, (3) that the integral equations for N/D may be continued in l, automatically yielding the CDD cuts mentioned above. Finally, we introduce a distinction between elastic and inelastic resonance poles based on continuation in l and show that the latter will not appear in calculations that fail to include the requisite CDD singularities. (Contractor's abstract)

2440

Princeton U. [Palmer Physical Lab.] N. J.

SOME PHYSICAL CONSIDERATIONS OF THE HYDRODYNAMIC STABILITY OF PARALLEL TWO-PHASE FLOW (Abstract), by J. T. C. Liu. [1965] [1]p. [AF 49(638)1333] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Ser. II, v. 10: 537, Apr. 26, 1965.

The change in over-all (fluid + particle) disturbance kinetic energy is due to the balance between energy conversion from the mean flow to the disturbance by fluid and particle Reynolds shear stresses (τ, τ_p, respectively) and fluid viscous dissipation augmented by the net work done due to particle-fluid interaction. Near the wall, where fluid viscosity destabilizes, augmented phase shift of fluid velocity components decreases τ_r but is eventually offset by their relative magnitude increase, τ_p conspires with τ towards that of a single heavier gas and (disturbance frequency) x (particle relaxation time) is the rate controlling parameter. The information is derived from relaxation of fluid disturbance vorticity diffusion process from "frozen" with diffusivity of a pure gas $\nu = \mu/\rho$ when the vorticity layer is too thin to contain sufficient particles for interaction towards "equilibrium" with diffusivity $\tilde{\nu} = \mu/(\rho+\rho_p)$ of a heavier gas, in which simple perturbation of a pure gas cannot properly describe regardless how small ρ_p/ρ is.

2441

Princeton U. Palmer Physical Lab., N. J.

VARIATIONAL PRINCIPLE FOR THE HYDROSTATIC EQUILIBRIUM OF A RELATIVISTIC, ROTATING FLUID, by J. B. Hartle and D. H. Snarp. [1965] [3]p. incl. refs. [AF 49(638)1333] Unclassified

Published in Phys. Rev. Ltrs., v. 15: 909-911, Dec. 13, 1965.

A variational method was proposed to answer the question: How are the limits of stability of cold "white" dwarf stars and neutron stars for non-rotating stars, affected by rotation. Derivations and applications are forthcoming.

2442

Purdue U. Dept. of Chemistry, Lafayette, Ind.

ULTRATRACE DETERMINATION OF METALS USING COORDINATION CHAIN REACTIONS, by D. W. Maugerum and R. K. Steinnaus. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-0882) (AF AFOSR-63-134) AD 617584 Unclassified

Also published in Anal. Chem., v. 37: 222-228, Feb. 1965.

A chemical kinetic method is proposed for the detection and determination of ultratrace quantities of metal ions. A coordination chain reaction system involving the exchange of triethylenetetramine-nickel (II) and (ethylenedinitrilo) tetraacetatocuprate (II) is used. This exchange proceeds by a chain mechanism where the chain centers are the free ligands, EDTA and trien. The rate of the exchange reaction is followed by its color change and is responsive to 10^{-9}M concentration changes of EDTA. The theoretical limits for metal determinations suggest that analysis down to the 10^{-9}M level with ±5% accuracy should be possible. Experimental results are given down to 10^{-9}M. As little as 10^{-10} mole of sample can be analyzed with the theoretical limit around 10^{-11} mole. Any metal ion which complexes EDTA can be determined. (Contractor's abstract)

2443

Purdue U. Dept. of Chemistry, Lafayette, Ind.

REMOTE LIGAND SUBSTITUENTS IN NICKEL (II) COMPLEXES AFFECTING THE RATE OF LOSS OF COORDINATED WATER, by D. W. Margerum and R. K. Steinhaus. [1965] [2]p. incl. table, diagrs. (AFOSR-65-2767) (AF AFOSR-65-134) AD 627936 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 4643-4644, 1965.

Substituents on position 5 of the ligand in mono(1, 10-phenanthroline) nickel (II) complexes influence the rate of replacement of water molecules coordinated to the nickel. Reactions were studied with diethyl triamine (DIEN) and with nitrilotriacetate (NTA) leading to the formation of mixed complexes without displacement of the 1, 10-phenanthroline or 5-substituted 1, 10-phenanthroline.

2444

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE ACTION OF ACIDS ON NITRONIC ESTERS AND NITROPARAFFIN SALTS. CONCERNING THE MECHANISMS OF THE NEF AND THE HYDROXAMIC ACID FORMING REACTIONS OF NITROPARAFFINS, by N. Kornblum and R. A. Brown. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-1260) (AF AFOSR-65-122) AD 621470 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 1742-1747, Apr. 20, 1965.

Nitronic esters are rapidly decomposed by acids. The course which the reaction follows is strongly dependent on the acid concentration. Thus, the ethyl nitronic ester of p-nitrophenylnitromethane gives p-nitrobenzaldehyde in 80% yield on treatment with 4 N H_2SO_4 while, in contrast, 31 N H_2SO_4 converts it into p-nitrobenzhydroxamic acid in 98% yield. The reaction of nitroparaffin salts with H_2SO_4 also exhibits this dependence on acid concentration. The mechanisms of these new nitronic ester reactions, and of the Nef and the hydroxamic acid forming reactions of nitroparaffins, are discussed in the light of these facts. (Contractor's abstract)

2445

Purdue U. [Dept. of Electrical Engineering] Lafayette, Ind.

A COMPUTER-SIMULATED ON-LINE EXPERIMENT IN LEARNING CONTROL SYSTEMS, by J. D. Hill, G. J. McMurtry, and K. S. Fu. [1965] [10]p. incl. diagrs refs. (AFOSR-65-0325) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-351, and National Science Foundation) AD 611730 Unclassified

Also published in Proc. Joint Automatic Control Conf., Stanford, Calif. (June 1964), p. 315-325.

Also published in Simulation, v. 4: 117-126, Feb. 1965.

The structure of a learning control system combines digital memory and logic circuitry with an adaptive system. Data obtained through adaptation is stored (remembered) and later utilized to improve the system performance. The general learning system operation is outlined in this paper and a simple experimental system which illustrates the improved performance is discussed. The example system is a second order plant in which the damping ratio and undamped natural frequency are considered to be affected by the environment in a piecewise constant manner. The system was simulated on a GEDA analog computer and the memory and logic functions were supplied by an IBM 1620 through IBM 1711 and 1712 analog to digital and digital to analog equipment

2446

Purdue U. [Dept. of Electrical Engineering] Lafayette, Ind.

A HEURISTIC APPROACH TO REINFORCEMENT LEARNING CONTROL SYSTEM, by M. D. Waltz and K. S. Fu. [1965] [9]p. incl. diagrs. refs. (AFOSR-66-1509) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-35[illegible], Collins Radio Fellowship, and National Science Foundation) AD 640188 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10: 390-398, Oct. 1965.

This paper describes a learning control system using a reinforcement technique. The controller is capable of controlling a plant that may be nonlinear and nonstationary. The only a priori information required by the controller is the order of the plant. The approach is to design a controller which partitions the control measurement space into sets called control situations and then learns the best control choice for each control situation. The control measurements are those indicating the state of the plant and environment. The learning is accomplished by reinforcement of the probability of choosing a particular control choice for a given control situation. The system was stimulated on an IBM 1710-GEDA hydrid computer facility. Experimental results obtained from the simulation are presented. (Contractor's abstract)

2447

Purdue U. [Dept. of Physics] Lafayette, Ind.

UNITARY SYMMETRY AND WEAK INTERACTIONS. III. NONLEPTONIC HYPERON DECAY, by S. P. Rosen. [1965] [7]p. incl. tables, refs. (AFOSR-66-0067) (Sponsored jointly by Air Force [Office of Scientific Research] under [AF AFOSR-64-274] and National Science Foundation) AD 630213 Unclassified

Also published in Phys. Rev., v. 137: B431-B437, Jan. 25, 1965.

It is shown that B. W. Lee's relation for nonleptonic hyperon decay can be derived from T-L invariance and $\Delta T = 1/2$, and that the vanishing of $\sigma(\Sigma^+ \rightarrow n\pi^+)$ requires the additional assumption or R invariance. The vanishing of $\sigma(\Sigma^- \rightarrow n\pi^-)$ cannot be derived from these symmetries, and since there are no others applicable to weak interactions in SU(3), it must result from weak-interaction dynamics. A comparison is made between this theory and those of Cabibbo and Coleman, Glashow and Lee. Mathematical aspects of T-L invariance are discussed in an appendix. (Contractor's abstract)

2448

Purdue U. Dept. of Physics, Lafayette, Ind.

POSSIBLE NEW BARYON STATES OF SU(6) SYMMETRY, by I. P. Gyuk and S. F. Tuan. [1965] [6]p. incl. refs. (AFOSR-66-0068) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-274 and National Science Foundation) AD 630442 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 121-126, Jan. 1965.

A set of solutions is proposed for the mass formulas of Beg and Singh (Phys. Rev. Ltrs., v. 13: 418, 1964) representing the 70 baryon states of SU(6) symmetry, based in part on the postulated existence of an ETA octet of baryon states as well as certain other input experimental information.

2449

Purdue U. Dept. of Physics, Lafayette, Ind.

OPTIMAL VARIATIONAL METHOD FOR PAIR CORRELATIONS IN MANY-FERMION SYSTEMS, by J. C. Porter. [1965] [16]p. incl. refs. (AFOSR-66-0069) [AF AFOSR-64-274] AD 630375 Unclassified

Also published in Phys. Rev., v. 140: A732-A747, Nov. 1,, 1965.

By means of a suitably chosen variational principle, Euler equations are derived which generalize the Hartree-Fock equations in such a way as to include two-particle correlations. For a system of N fermions these equations involve N single-particle functions and 1/2N(N-1) pair correlation functions. The Euler equations are optimal in the sense that a more accurate estimation of the total energy would require the introduction of three-particle correlation functions and the retention of terms nonlinear in the two-particle functions. Although intended primarily for use in the calculation of atomic and molecular electronic structure, the Euler equations are here used to determine the Coulomb correlation energy in the case of the high-density electron gas. The result obtained is shown to have the same leading logarithmic divergence with density as that found previously by Gell-Mann and Brueckner. (Contractor's abstract)

2450

Purdue U. Dept. of Physics, Lafayette, Ind.

HIGH-ENERGY LIMIT OF PION-NUCLEON TOTAL CROSS SECTION, by M. Sugawara and A. Tubis. [1965] [4]p. incl. diagr. refs. (AFOSR-66-0070) (Sponsored jointly by Air Force [Office of Scientific Research] under [AF AFOSR-64-274] and National Science Foundation) AD 630441 Unclassified

Also published in Phys. Rev., v. 138: B242-B245, Apr. 12, 1965.

A simple estimate of the high-energy limit of the pion-nucleon total cross section is given in terms of the mass and the width of the 33 resonance and the S-wave pion-nucleon scattering lengths. The underlying assumptions are that the forward elastic (charge-nonexchange) scattering amplitude satisfies the usual (once-subtracted) dispersion relation, and that the scattering becomes dominantly absorptive in the high-energy region. This estimate gives 23 mb as the limit of the total cross section which is in close agreement with what one obtains from a simple extrapolation of the available high-energy cross-sections. The present analysis strongly suggests that a simple correlation exists between a pronounced low-energy resonance and the high-energy limit of the scattering amplitude. (Contractor's abstract)

2451

Purdue U. Dept. of Physics, Lafayette, Ind.

ORIGINS OF THE LEE TRIANGLE, by S. P. Rosen. [1965] [4]p. incl. refs. (AFOSR-66-0071) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-274] and National Science Foun Foundation) AD 630443 Unclassified

Also published in Phys. Rev., v. 140: B326-B329, Oct. 25, 1965.

The Lee triangle, $\sqrt{3}\langle\Sigma^+|p\pi^0\rangle - \langle\Lambda|p\pi^-\rangle = 2\langle\Xi^-|\Lambda\pi^-\rangle$, is shown to be a consequence of any Hamiltonian which transforms as a member of an SU(3) octet, and which satisfies one simple constraint. If the Hamiltonian is constructed in the form $\Sigma g_n[(\bar{B}XB)_{(n)}X\pi]_{(8)}$, where $n = 8_D, 8_F, 10, 10^*, 27$, the required constraint is $g_{10} = g_{10^*}$. Thus the baryon-antibaryon decuplets must appear with equal weights, but the octets and (27)plet are placed under no restrictions. This result is used to explain why some dynamical models and symmetry arguments predict the Lee triangle, while others do not. Within the framework of SU(6), it also correlates the orbital angular momentum in $\Sigma^+ \rightarrow n_{\gamma}^+$ with the Lee triangle.

2452

Purdue U. Dept. of Physics, Lafayette, Ind.

PHASE TRANSITIONS IN SYSTEMS OF INTERACTING

FERMIONS, by S. Gartenhaus and G. Stranahan. [1965] [11]p. incl. diagrs. refs. (AFOSR-66-0072) [AF AFOSR-64-274) AD 630377 Unclassified

Also published in Phys. Rev., v. 138: A1346-A1356, May 31, 1965.

Girardeau has shown that a particular class of variational approximations for the free energy of a Fermi-Dirac system may be expressed in terms of the exact free energy of a certain soluble 'model Hamiltonian.' This exact formula for the partition function associated with the model system involves the solution of a certain nonlinear integral equation, and in the present work it is shown in detail that there is a correspondence between phase transitions in the system and the existence of multiple solutions of this equation. The connection between the existence of phase transitions and the properties of the interaction is studied, and it is shown that these phase transitions may occur for a very wide class of interactions. It is established that there is an upper bound to the temperature, above which no phase transitions will occur at any density. The extension of these results to a classical and a Bose-Einstein system is indicated, and the lattice-gas model previously studied by Mermin is re-examined in the light of the present results. (Contractor's abstract)

2453

Purdue U. Dept. of Physics, Lafayette, Ind.

MASS FORMULAS AND BARYON STATES IN SU(6) SYMMETRY, by I. P. Gyuk and S. F. Tuan. [1965] [11]p. incl. diagr. table, refs. (AFOSR-66-0073) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-274], Atomic Energy Commission, and National Science Foundation) Unclassified

Also published in Phys. Rev., v. 140: B164-B174, Oct. 11, 1965.

The mass formulas of baryon states in SU(6) symmetry are examined in detail to exhibit (a) the deep structural similarity between the 56- and 70-dimensional representations and (b) the existence of a hierarchy of mass-breaking terms in these formulas which suggest strongly the dominance of the contribution due to the 35 representation. Implications of this form resemblance for the existense of a possible higher symmetry, in particular relativistic generalizations of SU(6), are briefly focussed. Finally a critical analysis is made of the basis for a (70)-representation of baryon states. (Contractor's abstract)

2454

Purdue U. Dept. of Physics, Lafayette, Ind.

DYNAMICAL BASIS FOR BARYON INTERACTIONS, by S. F. Tuan. [1965] [8]p. incl. diagrs. refs. (AFOSR 66-0075) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-274], and National Science Foundation) AD 630378 Unclassified

Also published in Phys. Rev., v. 139: B1393-B1400, Sept. 6, 1965.

Experimental evidence for a rapid rise in production near threshold in the reactions

$$\pi^- + p \rightarrow \Sigma + n \text{ and } K^- + p \rightarrow \Omega + \Delta$$

is analyzed on the basis of a constant-K-matrix formalism. Representative scattering lengths for the π-baryon systems are introduced to illustrate pertinent features of the presently known experimental data. A dynamical basis for the physical situation is discussed in terms of possible new baryon states due to virtual or bound states of the π-baryon systems. Comparison of the results with expectations from a conjectured π octet of baryon (1/2-) states for SU(3) symmetry is briefly referred to. (Contractor's abstract)

2455

Purdue U. Dept. of Physics, Lafayette, Ind.

TRANSIT ACCELERATION OF CHARGED PARTICLES IN AN INHOMOGENEOUS ELECTROMAGNETIC FIELD, by C. S. Shen. [1965] [14]p. incl. diagrs. tables, refs. (AFOSR-66-0076) (AF AFOSR-64-274) AD 630376 Unclassified

Also published in Astrophys. Jour., v. 141: 1091-1104, Apr. 1965.

This paper discusses the transit accelerations of charged particles when they pass through a time varying inhomogeneous magnet field. Detailed calculations are carried out for cases when the varying field is small compared to the homogeneous field. The first order effect of the varying field causes diffusion of particles in the phase space. The net energy gain is proportional to the square of the field intensity. When the characteristic frequency of the field is small compared to the cyclotron frequency of the particle, the energy gain of the particle is proportional to the energy of the particle itself. For fast varying fields, the dependence becomes implicit. Unlike the Fermi mechanism, the transit acceleration depends very little on the displacement velocity of the fields. It accelerates electrons more effectively than it does ions. The efficiency of this mechanism is discussed in the last section. The magnetosphere is chosen as the background because of the availability of relatively reliable data obtained from there. It is found that a 10-kev electron may increase its energy to 100 kev within a few hours through the enhanced random-walk process. (Contractor's abstract)

2456

Purdue U., Dept. of Physics, Lafayette, Ind.

NONLEPTONIC HYPERON DECAY AND THE RELATIVISTIC GENERALIZATION OF SU(6), by

S. P. Rosen. [1965] [4]p. incl. tables, refs. (AFOSR-66-0077) (AF AFOSR-64-274) AD 630381
Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 758-761, May 1965.

It is natural to assume that when an interaction is not invariant under a particular symmetry, that its transformation properties will be as simple as possible. For nonleptonic hyperon decay, this approach is empirically justified in the isospin and unitary-symmetry schemes, but it does not appear valid in SU(6). This report examined the flaws and plausibility of showing the compatibility of the $\Delta T = 1/2$ rule and octet dominance with the experiment, and the assignment of the interaction to a 35-plet.

2457

Purdue U. Dept. of Physics, Lafayette, Ind.

POSSIBLE THEORETICAL INTERPRETATIONS OF THE T 2π - Σ RESONANCE, by I. P. Gyuk, W. A. Simmons and S. F. Tuan [1965] [6]p. incl. refs. (AFOSR-66-0078) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-274 and National Science Foundation) AD 630517
Unclassified

Also published in Nuovo Cimento Ser. X, v. 35, 676-681, Jan. 1965.

Consideration is given to the theoretical implications of a (T 2π -) resonance, with attention given to the bootstrap dynamics of a T-2 resonance and to Y_2^* (1415) and SU(3) symmetry.

2458

Purdue U. Dept. of Physics, Lafayette, Ind.

PHASE TRANSITION IN THE HARTREE-FOCK ELECTRON GAS, by S. Gartenhaus and G. Stranahan. [1965] [3]p. incl. diagrs. (AF AFOSR-64-274)
Unclassified

Published in Phys. Rev. Ltrs., v. 14: 341-343, Mar. 8, 1965.

The purpose of this paper was to point out the fact that for moderately high densities for which it is often assumed that the Hartree-Fock theory is a convenient starting point for the analysis of such a system - the electron gas as described by the Hartree-Fock theory undergoes a phase transition analgous to the familiar liquid-gas transition.

2459

Purdue U. Dept. of Physics, Lafayette, Ind.

WEAK ELECTROMAGNETIC DECAYS OF HYPERONS IN SU(3), by R. H. Graham and S. Pakvasa. [1965] [7]p. incl. tables, refs. (Sponsored jointly by Air Force [Office of Scientific Research] under [AF AFOSR-64-274] and National Science Foundation)
Unclassified

Published in Phys Rev., v. 140 B1144-B1150, Nov. 22, 1965.

Two-body and 3-body weak radiative decays of hyperons are studied in context of the SU(3) scheme. The various sum rules that follow from T-L symmetries as well as those due to R invariance are derived. A pole model is set up for the 2-body decays of both radiative and pionic type and is used to predict the amplitudes and decay rates for the photonic modes. In particular, the rate for $\Sigma^+ \rightarrow p + \gamma$ calculated in this model agrees with the recent experimental value. (Contractor's abstract)

2460

Purdue U., Jet Propulsion Center, Lafayette, Ind.

CONTINUOUS MEASUREMENT OF SOLID PROPELLANT BURNING RATES, by J. R. Osborn, R. J. Burick, and P. Y. Ho. Annual rept. Feb. 1965, 53p. incl. diagrs. tables, refs. (Rept. no. 1-65-2) (AFOSR-65-1623) (AF AFOSR-64-207) AD 616098
Unclassified

The basic operating principles of an experimental system for the direct and continuous measurement of solid propellant burning rates are presented. A continuous burning rate measurement technique, termed the Servomechanism technique is employed for obtaining erosive burning rate data for types BDI and BUU double-base propellants. Burning rate measurements are made with different gas flow velocities parallel to the burning propellant surface; the gas velocities approach the acoustic speed. A feasibility study indicates that a technique employing ultrasonic pulses can be developed for obtaining direct measurements of the burning rate of a solid propellant. The technique is based on measuring the time for an ultrasonic pulse to travel through a propellant sample. Another feasibility study finds microwave techniques not readily adaptable to such burning rate measuremer s.

2461

Purdue U. [Jet Propulsion Center] Lafayette, Ind.

INTERACTION OF A WEAK SHOCK WITH A COMBUSTION REGION, by G. M. Lehmann and S. N. B. Murthy. [1965] [3]p. incl. diagrs. (AFOSR-65-2495) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-753 and Office of Naval Research) AD 626494
Unclassified

Also published in Jour. of Spacecraft and Rockets, v. 2: 828-830, Sept.-Oct. 1965.

The report develops a relation for the propagation of a normal shock through a chemically reactive flowing gas and compares the results obtained with those obtained by numerical integration of the conservation equations with appropriate boundary conditions.

2462

Purdue U. Jet Propulsion Center, Lafayette, Ind.

HIGH FREQUENCY COMBUSTION PRESSURE OSCILLATIONS IN MOTORS BURNING GASEOUS PROPELLANTS, by M. J. Zucrow J. R. Osborn and J. M. Bonnell. Aug. 1965, [75]p. incl. diagrs. tables, refs. (Rept. no. TM-65-5) (AFOSR-66-0900) (AF AFOSR-62-360)and AF AFOSR-65-753)
AD 478023 Unclassified

A series of experiments was conducted for determining the factors that promote combustion pressure oscillations in rocket motors burning either premixed or unmixed gaseous propellants. The influences of the following parameters were investigated: combustion chamber geometry, the chemical differences in the propellants, and several injection variables. Auxiliary investigations were conducted for determining the effects of baffles located in the combustion chambers, and the applicability of linear theories for predicting the occurrence of combustion pressure oscillations in gaseous propellant motors. All of the experiments were conducted with rocket motors of cylindrical geometry; two different chamber diameters of 7 in. and 14 in. were utilized with different chamber lengths ranging from 2 in. to 18 in. The fuels were methane, ethylene, and hydrogen, and in all cases the oxidizer was air. For the premixed gas systems, both concentrated and distributed types of injection systems, as well as injectors mounted at different locations in the motor, were employed. For unmixed gases, concentrated type injection systems were utilized but two different modes of injection ("impinging jets" and "showerhead") having different injection velocities and orientations of the fuel and oxidizer streams were studied. (Contractor's abstract)

2463

Purdue U. School of Mechanical Engineering, Lafayette, Ind.

STABILITY CRITERIA FOR LONGITUDINAL PRESSURE OSCILLLATIONS IN A ROCKET MOTOR, by S. N. B. Murthy and J. R. Osborn. [1965] [7]p. incl. illus. (AFOSR-65-2078) [AF AFOSR-65-753]
AD 627495 Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 37, 872-878, May 1965.

The problem called 'high-frequency combustion instability in rocket motors' has been considered to be one in which the acoustics of the combustion chamber, nozzle, and flame front are significant for determining whether or not a motor will experience pressure oscillations of an acoustic type. To date, no theory has been developed for demonstrating the effects of the location and width of the flame front in the combustion chamber upon the occurrence of pressure oscillations of the longitudinal mode. In the paper, the rocket motor is treated as a constant-diameter duct with a finite width of combustion zone located between two uniform regions. It also is considered to have finite wave-transmission coefficients at the nozzle and the injector ends. For these conditions, stability criteria are established for the longitudinal mode of pressure oscillations. It is shown that, while the energy release rate per unit width of the combustion zone is significant in determining whether the motor will be stable, the location of the combustion zone in the motor, the over-all length of the motor, and the total amount of energy released also influence the stability of the motor in the longitudinal mode. (Contractor's abstract)

2464

Radiation Applications, Inc., Long Island City, N. Y.

RADIATION-INDUCED SOLID PROPELLANT DECOMPOSITION, by [G. Odian]. Final technical rept. Jan. 15, 1965, 25p. incl. diagrs. tables, refs. (Rept. no. RAI-347) (AFOSR-65-0429) (AF 49(638) 1125) AD 612536 Unclassified

A study was initiated on the effect of radiation on ammonium perchlorate composite propellants. This involved the determination of the effect of radiation on the deflagration rates of binder and oxidizer separately from each other and independent of additives or other substances. In addition, the chemical products of ammonium perchlorate radiolysis were studied in detail.

2465

Radio Corp. of America. Astro-Electronics Div., Princeton, N. J.

ELECTRON CYCLOTRON RESONANCE PLASMA ACCELERATOR, by H. Hendel and T. Faith. Final technical rept. Jan. 31, 1965, 27p. incl. diagrs. refs. (AFOSR-65-0430) (AF 49(638)1342) AD 612175 Unclassified

Results are presented ofr a continuously operating electron cyclotron resonance plasma accelerator at a frequency of 2.45 kmc and absorbed power levels of up to 0.5 kw. Langmuir probe measurements indicate that a space charge field set up by energetic electrons (electron temperature approximately 15 ev) accelerates plasma ions to energies of from 35 to 150 ev, as measured by a retarding-field ion-energy analyzer. Langmuir probe plasma potential measurements were made adjacent to the analyzer and the effects of ion acceleration in the plasma beam-analyzer sheath were subtracted from the ion energy measurements. The final ion energy shows a linear relationship to the electron temperature in agreement with the theory. Strong electron confinement along magnetic field lines was observed in the discharge region. At low power approx. 30% of the absorbed microwave power is converted into kinetic energy of the ions. At a power of 0.5 kw, due apparently to strong excitation in the magnetic bottle region, electrons from this region are connected by the magnetic field lines to the waveguide walls and losses for bottle configurations of the magnetic field were found to be high (efficiency of 4%). Constant-magnetic-field experiments indicate that efficiencies with magnetic bottle field should be at least as high as 30% if the accelerator is designed to exclude all field-line connections between wall and plasma. The specific impulse, efficiency, and thrust attainable from a thruster based on electron cyclotron resonance are in the useful range for space propulsion applications, especially in orbit corrective missions. The absence of sensitive accelerating or electron emitting electrodes promises long lifetime for such a thruster.

2466

Radio Corp. of America, Astro-Electronics Div., Princeton, N. J.

ELECTRON CYCLOTRON PLASMA THRUSTOR FOR ORBIT CORRECTIVE MISSIONS, by H. W. Hendel and T. J. Faith, Jr. [1965] 6p. incl. diagrs. table. (AED no. C-2352) (AFOSR-66-1094) (AF 49(638) 1342) AD 639979 Unclassified

Presented at Twenty-sixth Meeting of the Propulsion and Energetics Panel, AGARD, Pisa (Italy), Sept. 6-10, 1965.

This report contains measurements of ion kinetic energy, electron temperature and plasma-potential gradient. These measurements are in good agreement with theoretical predictions based on an ion accelerating mechanism employing a space-charge potential gradient set up by the energetic electrons produced in an electron cyclotron discharge. Electron temperatures (up to 25 ev), ion energies (35 to 150 ev), and propulsive efficiencies greater than 30% have been measured at 50 w. The fuel utilization is better than 50%. Due to the absence of cathodes or ion accelerating structures, life-times expected for the thrustor are of the order of years. Such devices have been run in the laboratory for over 1500 hrs without visible deterioration. On the basis of this measured performance, the electron cyclotron accelerator described compares favorably with other station-keeping systems for those long duration missions where thrustor life is of particular importance.

2467

Radio Corp. of America. Astro-Electronics Div., Princeton, N. J.

PLASMA ACCELERATION BY ELECTRON CYCLOTRON RESONANCE, by H. Hendel, T. Faith, and E. C. Hutter. [1965] [17]p. incl. diagrs. table, refs. (AFOSR-66-1100) (AF 49(638)1342) AD 639012 Unclassified

Presented at Fourth Symposium on Advanced Propulsion Concepts, Palo Alto, Calif., Apr. 26, 1965.

Also published in RCA Rev., v. 26: 200-216, June 1965.

Results are presented for a continuously operating electron cyclotron resonance plasma accelerator at a frequency of 2.45 kmc with absorbed power levels up to 0.5 kw. Langmuir-probe measurements indicate that a space-charge field set up by energetic electrons (electron temperatures from 5 to 25 ev) accelerates plasma ions to energies of from 35 to 150 ev, as measured by a retarding-field ion-energy analyzer. The final ion energy shows a linear relationship to the electron temperature, in agreement with the theory. Strong electron confinement along magnetic field lines is observed in the discharge region. At powers up to 10 w, approx. 30% of the absorbed microwave power is converted into kinetic

energy of the ions when a magnetic bottle is formed at the rear of the accelerator. When a similar bottle is used with a power of 0.5 kw, the efficiency falls to 4%. It is believed that this reduction is due to strong excitation in the magnetic bottle region, where electrons are connected by the magnetic field lines to the waveguide walls. The fact that low-and high-power efficiencies have been found comparable for other magnetic field shapes indicates that an accelerator designed to exclude field-line connections between wall and plasma should yield efficiencies of at least 30% at the higher power levels. The specific impulse, efficiency, and thrust attainable from a thruster based on electron cyclotron resonance are in the useful range for space-propulsion applications, especially in orbit-corrective missions. The absence of sensitive accelerating or electron-emitting electrodes promises long lifetime for such a thruster.

2468

[Radio Corp. of America]. RCA Labs., Princeton, N. J.

THE SIGN OF THE TRIGONAL FIELD SPLITTING OF B-SITE IONS IN SPINEL, by S. B. Berger. [1965] [2]p. incl. tables. (AF 49(638)1223) Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 16-19, 1964.

Also published in Jour. Appl. Phys., v. 36: 1048-1049, Mar. 1965.

A direct determination of the sign of the trigonal field splitting parameter of the Cr^{3+} ion on the B site of natural ruby spinel ($\approx MgAl_2O_4$ with Cr^{3+}) which is 85 to 90% normal is reported. Electron spin resonance experiments were performed at 9.5 to 9.7 and 23.08 Gc/sec and the spin Hamiltonian parameters were determined: $g_\parallel = 1.985 \pm 0.001$, $g_\perp = 1.983 \pm 0.003$, and $2D = +1.83 \pm 0.004$ cm^{-1} (+55 Gc/sec). The g values and absolute value of 2D are in close agreement with those obtained earlier. The present value of 2D was obtained from the M = 1/2 to 3/2 transition and the sign determined by the relative intensity change with temperature of the M = 1/2 to 3/2 and M = -3/2 to -1/2 transitions (hign magnetic field quantum numbers used). The positive sign obtained directly in this work contradicts the previous indirect determination which yielded a negative sign. (Contractor's abstract)

2469

Raytheon Co., Wayland, Mass.

LASER PUMPING TECHNIQUES STUDY, by P. A. Silberg. Final rept. Oct. 1, 1964-Sept. 30, 1965. Oct. 30, 1965 [65]p. incl. illus. diagrs. table, refs. (AFOSR-65-?212) (AF 49(638)1420) AD 632848 Unclassified

In the course of the study of laser pumping techniques. Raytheon developed a reliable calorimeter technique to measure the transfer efficiency of the theta pinch in converting capacitively stored electrical energy to electromagnetic energy. It is shown, with the use of circuit measurements, that the efficient theta-pinch circuit decay consists of a 2-stage circuit decay and that the inefficient theta pinch consists of a 3-stage decay. Using the circuit decay data, a modified transfer efficiency measurement for a 2-stage plasma circuit was developed that is approximately as accurate as the calorimeter technique, but very much faster and easier to make. These measurements have have been used to evaluate the transfer efficiency of the theta-pinch in Argon at pressures of 2 and 5 Torr with different tube sizes and with different coupling impedances. Measurements have shown a transfer efficiency as high as 59% with present measurements. Spectral measurements show that the preionization techniques increase the continuum radiation with the small diameter tubes and are ineffective with the largest diameter tubes used. (Contractor's abstract)

2470

Reed Coll. Dept. of Chemistry, Portland, Ore.

REACTION RATE STUDIES OF GASEOUS UNIMOLECULAR ISOMERIZATIONS, by F. D. Tabbutt. Final rept. Mar. 1965, 4p. incl table. (AFOSR-65-0581) (AF AFOSR-63-119) Unclassified

Kinetic studies of gaseous unimolecular isomerization were conducted at very high pressures (1 to 280 atm). Thus with very short intervals between collisions the active intermediates could be engaged in a collision that might lead to different products, giving some indication of the nature of the intermediates. The studies were conducted with cyclopropane and cyclobutane. At least 19 products of comparable magnitude were obtained in addition to the major product propylene.

2471

[Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.]

REFLECTION AND REFRACTION OF SOUND BY A NONEQUILIBRIUM RELAXING MEDIUM, by K. C. Wang. [1965] [6]p. incl. diagrs. Refs. (AF 49(638)977) Unclassified

Published in Jour. Acoust. Soc. Amer., v. 37: 989-994, June 1965.

The reflection and refraction of a plane sound wave by a nonequilibrium relaxing medium are examined. Since the medium is dissipative, Snell's law of refraction is modified depending not only on the properties of the media, but also on the angle of incidence. The amplitudes of the reflected and refracted waves are complex. Variations of both the angle and amplitude are analyzed and supplemented with calculations for different reaction rates and relative Mach numbers. (Contractor's abstract)

2472

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

BASIC ATOM CHEMISTRY-SURFACE CATALYZED EXCITATION, by P. Harteck. Final rept. Sept. 1962-Aug. 1964. June 1965, 6p. incl. refs. (AF AFOSR-65-1273) (AF AFOSR-63-174) AD 622583 Unclassified

An investigation was made concerning the production of excited molecules on the surface of a catalyst by recombination of atoms. It was found that catalysts such as nickel and cobalt are effective in producing excited molecules from oxygen and/or nitrogen atoms. Conditioned glass or quartz surfaces also frequently and unexpectedly catalyze the formation of excited molecules. Catalyzed excitation of this type was observed when oxygen atoms were present in the gas phase at a total pressure ranging from a few μ to 1 mm. The excited oxygen molecules, $O_2A^3\Sigma_u^+$ were found to emit the characteristic spectra expected, $O_2A^3\Sigma_u^+ \rightarrow O_2X^3\Sigma_g^- + h\nu$; and in addition to react with various other molecules. Additional catalysis reactions and atom studies made in connection with this work as reported in the literature.

2473

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

THE CHEMILUMINESCENT REACTION OF OXYGEN ATOMS WITH SULFUR MONOXIDE AT LOW PRESSURES, by T. R. Rolfes, R. R. Reeves, Jr., and P. Harteck. [1965] [5]p. incl. diagrs. tables. (AF AFOSR-63-174) Unclassified

Published in Jour. Phys. Chem., v. 69: 849-8[illegible], Mar. 1965.

The reaction of oxygen atoms with sulfur monoxide results in a visible blue emission, extending into the ultraviolet. The reaction was studied in the low pressure region up to a total pressure of 20 μ where the emission was found to be due to the simple 2 body reaction, $SO + O \rightarrow SO_2 + h\nu$, analogous to the 2 body reaction of nitric oxide and oxygen atoms. The rate coefficient for this reaction was estimated as 7×10^{-16} cm^3/molecule sec. The SO was produced by reaction with O atoms via $COS + O \rightarrow CO + SO$. This reaction could also be used under certain conditions to titrate the oxygen atoms to obtain a quantitative measure of the oxygen atom concentration.

2474

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

VISCOSITY MEASUREMENTS OF IONIC MELTS AT TEMPERATURES TO 1100°C, by R. D. Reeves and G. J. Janz. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-2200) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-181 and Office of Naval Research) AD 625536 Unclassified

Also published in Rev. Scient. Instr., v. 36: 1124-1129, Aug. 1965

An extension of the theory of the oscillating crucible gives an equation in $\eta^{\frac{1}{2}}$ which is particularly useful as an absolute method for viscosity calculation. While more complex in theory, the oscillating crucible possesses useful advantages for high temperatures, namely, the features of a small flat temperature zone, and of a completely sealed sample container. Use of a closely fitting liner in the crucible offers a further advantage in that an exchange of the melt container is possible without any changes in the experimental assembly. Results are reported for a number of "reference" liquids at 25°C and at 440°C (KNO_3), and for $CaCl_2$(785-970°C) and $BaCl_2$ (985-1040°C). An error analysis shows that the precision is extremely sensitive to the decrement δ_m; this appears as the largest error source. An error of viscosity of ±4% is calculated.

2475

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

VISCOSITY MEASUREMENTS ON FUSED SALTS. PART I. THEORETICAL PRINCIPLES OF THE OSCILLATING HOLLOW CYLINDER METHOD, by R. D. Reeves and G. J. Janz. [1965] [5]p. incl. diagr. (AFOSR-65-2365) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-181, and Office of Naval Research) AD 629652 Unclassified

Also published in Trans. Faraday Soc., v. 61: 2300-2304, Oct. 1965.

The mathematical treatment of the motion of a system consisting of an oscillating hollow cylinder containing a liquid is examined. It leads to a cubic equation in the square root of the viscosity of a form suitable for absolute calculations. The conditions under which this reduces to the forms of the various known empirical and semi-empirical equations for calculating viscosity from the logarithmic decrement of the amplitudes are examined, and the factors for the design of an apparatus suitable for unambiguous results are discussed. (Contractor's abstract)

2476

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

VISCOSITY MEASUREMENTS ON FUSED SALTS. PART 2. SOME ALKALI AND ALKALINE EARTH CHLORIDES, by R. D. Reeves and G. J. Janz. [1965] [7]p. incl. diagrs. tables. refs. (AFOSR-65-2366) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-181, and

Office of Naval Research) AD 629651
Unclassified

Also published in Trans. Faraday Soc., v. 61: 2305-2311, Oct. 1965.

Viscosity measurements by the oscillation hollow cylinder method were carried out at temperatures in the range 650°- 1050°C on the chlorides of calcium, strontium, barium, rubidium and cesium. The results are discussed in the light of current views on viscous flow in ionic liquids.

2477

Rensselaer Polytechnic Inst. Dept. of Electrical Engineering, Troy, N. Y.

OPTIMAL TRAJECTORY, GUIDANCE, AND CONJUGATE POINTS, by I. Lee. [1965] [9]p. incl. refs. (In cooperation with General Electric Research Laboratory, Schenectady, N. Y.) (AF AFOSR-63-279)

Published in Inform. and Control, v. 8: 589-606, Dec. 1965.

Two interesting and important properties of the conjugate points are discussed and illustrated by means of examples. These properties are shown to have significant implications for trajectory and guidance optimization problems. The conjugate point nearest to the initial time determines the maximum duration of an optimal control for a linear process with a quadratic cost functional and for a certain nonlinear process. If there is a conjugate point to the terminal time, then it is not possible to construct the linear, optimal guidance system in a neighborhood of the nominal trajectory. (Contractor's abstract)

2478

Rensselaer Polytechnic Inst. Dept. of Electrical Engineering, Troy, N. Y.

STABILITY OF RANDOM LINEAR SYSTEMS—AN EXAMPLE, by W. G. Tuel, Jr. and P. M. DeRusso. [1965] [2]p. incl. diagr. (Sponsored jointly by Air Force Cambridge Research Laboratory; and Air Force Office of Scientific Research under AF AFOSR-63-279) Unclassified

Published in IEEE Trans. Automatic Control, v. AC-10: 106-107, Jan. 1965.

Stability regions are investigated for systems subject to noise that is neither white nor Gaussian.

2479

Rensselaer Polytechnic Inst. [Dept. of Mathematics] Troy, N. Y.

NEW EIGENFUNCTION EXPANSIONS AND ALTERNATIVE REPRESENTATIONS FOR THE REDUCED WAVE EQUATION, by D. S. Conen. [1965] [9]p. incl. refs. (AFOSR-66-2201) (AF AFOSR-63-182) AD 629649 Unclassified

Also publisned in Jour. Matn. and Mecn., v. 14: 403-412, May 1965.

In this paper the autnor derives the spectral representation of a function f $L^2[0, a]$ associated with the system $r^2u'' + ru' + (k^2r^2 - \nu)u = 0 (0 < r < a)$, $\alpha u(a) + \beta u'(a) = 0$, where $\alpha f(x)$ is defined by any one of the three following equations: (1) $f(x) = f(x)$, (2) $\alpha f(x) = f'(x)$, or (3) $\alpha f(x) = f'(x) + Zf(x)$ where f and Z are given constants. This gives rise to a type of Hankel transform. This result is then applied to find representations of the solutions of the following problems. (1) $\Delta u + k^2u = 0 (0 < r < a, 0 < \theta < 2\pi)$, with boundary conditions $u(a, \theta) = 0 (0 \leq \theta \leq \gamma)$, $u(r, a) = 0 (0 < r < a)$ and $u(r, 0) = f(r) (0 < r < a)$; (2) $\Delta u + k^2u = F(r, \theta) (0 < r < a, 0 < \theta < 2\pi)$, with boundary conditions $\alpha u(a, \theta) = 0 (0 < \theta < 2\pi)$. (Math. Rev. abstract)

2480

Rensselaer Polytechnic Inst. Dept. of Mathematics, Troy, N. Y.

BIMATRIX EQUILIBRIUM POINTS AND MATHEMATICAL PROGRAMMING, by C. E. Lemke. [1965] [9]p. (AFOSR-65-2423) (AF AFOSR-63-339) AD 627771 Unclassified

Also published in Management Sci., v. 11: 681-689, May 1965.

Some simple constructive proofs are given of solutions to the matrix system $Mz - w = q; z \geq 0; w \geq 0$, and $z^T w = 0$, for various kinds of data M, q, which embrace the quadratic programming problem and the problem of finding equilibrium points of bimatrix games. The general scheme is, assuming nondegeneracy, to generate an adjacent extreme point path leading to a solution. The scheme does not require that some functional be reduced.

2481

Rhode Island U., Kingston.

GORDON RESEARCH CONFERENCE ON INORGANIC CHEMISTRY, New Hampton, New Hampshire, Aug. 22-27, 1965, by R. B. Johannesen. Final rept. 1965] 2p. (AFOSR-66-2813) (AF AFOSR-65-940) Unclassified

The program of this conference included "Recent Developments in Synthetic Inorganic Chemistry, Nuclear Resonance Spectroscopy, Unusual Oxidation States, Structure of Halid Complexes, and Complexes of Chromium (II). Five of the invitees were from foreign countries.

2482

RIAS, Inc., Baltimore, Md.

PHOSPHATIDIC ACID AND GLYCERIDE SYNTHESIS BY PARTICLES FROM SPINACH LEAVES, by G. M. Cheniae. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-1283) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)947, and National Institute of Health) AD 620495
Unclassified

Also published in Plant Physiol, v. 40: 235-243, Mar. 1965.

The enzymic synthesis of phosphatidic acid, tri-, di- and monoglyceride from L-a-glycerol-phosphate-1, 3-C^{14} is described. On a specific activity basis a fraction from spinach leaves sedimenting at 104,000 x g had the greatest activity. Requirements for ATP, coenzyme A, fatty acid, and a divalent cation were demonstrated, thus suggesting synthesis of phosphatidic acid by the Kennedy-Kornberg pathway. Replacement of glycerol-phosphate with glycerol resulted in a pronounced decrease of incorporation. Activity could be restored by addition of glycerol kinase thus indicating absence of glycerol kinase in these particles. Kinetic studies on the products indicated that phosphatidic acid was the precursor for glycerides. In addition to these products an unknown labeled phosphatide is observed.

2483

RIAS, Inc., Baltimore, Md.

PLASTOCYANIN PHOTO-OXIDATION BY DETERGENT-TREATED CHLOROPLASTS, by B. Kok and H. J. R. Ruraiński. [1965] [3]p. incl. diagrs. (AFOSR-65-1517) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)947], National Aeronautics and Space Administration, and National Institute of Health) AD 619224
Unclassified

Also published in Biochem. et Biophys. Acta, v. 94: 588-590, 1965.

The time course was measured of the photo-oxidation of 2 concentrations of plastocyanin, 70% of which was in the reduced state at the beginning of the experiment. Despite a 4.5-fold concentration difference, the initial rate of photo-oxidation is equal in both cases. However, the time required for the conversion to be half completed is ≈ 5-fold longer in the case of high substrate concentration. These kinetics closely resemble those reported for cytochrome F and indicate that the rate is proportional to the ratio (plastocyanin) reduced/(plastocyanin) total. Data were also obtained by recording the time courses of plastocyanin photooxidation for 2 light intensities. The saturation rate as well as quantum yield of the process are proportional to the fraction of the substrate in the reduced form. The most reasonable explanation remains that in photosynthesis, plastocyanin and cytochrome F function 'in parallel', both donating to photosystem I electrons generated in the second, O_2-evolving, photo-act.

2484

RIAS, Inc., Baltimore, Md.

FATTY ACID SYNTHESIS BY EXTRACTS OF EUGLENA, by G. M. Cheniae and P. C. Kerr. [1965] [6]p. incl. tables, refs. (AFOSR-65-1518) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)947 and National Institute of Health) AD 619135
Unclassified

Also published in Plant Physiol., v. 40: 452-457, May 1965.

Stearic acid, a major product of fatty acid synthesis by extracts of Euglena, was degraded and shown to be synthesized de novo. Oxidation of products with peracids did not alter subsequent chromatographic behavior thus indicating lack of unsaturation in the products. Avidin did not inhibit incorporation of ^{14}C-acetyl-CoA nor did it alter distribution of products. The fatty acids synthesized were found to occur both in the free and esterified form in approximately equal amounts and with no significant differences in the spectrum of products. The requirement for adenosine triphosphate could not be replaced by adenosine mono- diphosphate but could be partially replaced by other nucleoside triphosphates. The results are discussed on the basis that the phosphoenolate of acetyl-CoA acts as a carbanion for condensations in a variant reaction of the classical malonyl-CoA-acetyl-CoA condensation.

2485

RIAS, Inc., Baltimore, Md.

REDUCING POWER GENERATED IN THE SECOND PHOTOACT OF PHOTOSYNTHESIS, by B. Kok and A. E. Datko. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-66-0290) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)947, and National Aeronautics and Space Administration) AD 639870
Unclassified

Also published in Plant Physiol., v. 40: 1171-1177, Nov. 1965.

The photochemical activities of cell free preparations of Bishop's Scenedesmus mutant no. 8, of the wild type strain and of spinach chloroplasts was compared. The data were largely consistent with the assumption that the mutant lacks photosystem I of photosynthesis. Whereas high potential oxidants such as ferricyanide and benzoquinone sustained oxygen evolution with good yield, lower potential oxidants were reduced with a poor quantum efficiency. A comparative study of a number of oxidants having different normal potentials was made. A distinct transition from high to low quantum yield occurred at a potential value of E' ≈ + 0.18 volt. It was assumed that this potential is equal or close to the normal potential of the primary photoreductant generated inphotoact II of photosynthesis.

2486

RIAS, Inc., Baltimore, Md.

BASIC RESEARCH IN PHOTOSYNTHESIS, by B. Kok. Final rept. Oct. 1, 1960-Dec. 31, 1965 [8]p. incl. refs. (AFOSR-66-0602) (AF 49(638)947) AD 630524 Unclassified

The supported research covered a number of aspects of photosynthesis and related processes. Instrumentation and methodology were developed in the areas of mass spectrometry, sensitive spectroscopy, polarography (O_2 exchange), and further techniques to irradiate photosynthetic materials with high-intensity monochromatic light. The question whether respiration proceeds at the same rate in light as in darkness was studied with different organisms and light of different colors and intensity. It was shown that, depending on the wavelength of illumination, O_2 uptake could be either decreased or enhanced during photosynthesis. Analysis of the 2 photosystems of photosynthesis were also made with isolated spinach chloroplasts. Action spectra have been determined for various chloroplast reaction systems. A long wave chlorophyll component in the chloroplast, which occurs in the low concentration of 1 per 400 total chlorophylls was detected and investigated with the aid of sensitive spectroscopy.

2487

RIAS, Inc., Baltimore, Md.

THE REDUCING POWER GENERATED IN PHOTOACT I OF PHOTOSYNTHESIS, by B. Kok, H. J. Rurainski, and O. V. H. Owens. [1965] 10p. incl. diagrs. refs. (AFOSR-66-0838) (AF 49(638)947) AD 639869 Unclassified

Also published in Biochim. et Biophys. Acta, v. 190: 347-356, 1965.

The photoreduction of biologen dyes having E_0' values between -0.32 and -0.74 V was studied with isolated chloroplasts. Compared to ferricyanide, all compounds mediated photosynthetic oxygen evolution and photophosphorylation with equal rate and efficiency. The concentration required for maximum stimulation increased with decreasing normal potential. Under anaerobic conditions, an accumulation of the reduced viologens could be observed directly. Despite the interference of a back reaction with photosynthetically evolved O_2, compounds with $E_0' > -0.55$ could be reduced completely, lower-potential agents partially. It is concluded that the normal potential of the strong reductant, generated in the long-wave photoact of photosynthesis is as low or lower than -0.7V.

2488

RIAS, Inc., Baltimore, Md.

PROPERTIES OF CONDUCTION ELECTRONS IN IONIC CRYSTALS, by D. Kahn. Final rept. Jan. 15, 1961-Jan. 14, 1965. [36]p. incl. diagrs. tables. (AFOSR-65-0657) (AF 49(638)1017) AD 614091 Unclassified

Investigations in the properties of charge transport and charge interaction in the alkali halide crystals are presented. Studies were made of photoconductivity, space charge formation, photodiffusion, ionic charge diffusion, and electron interaction with the lattice ions of these materials. The alkali halide crystals may be considered as large band gap semiconductors.

2489

RIAS, Inc., Baltimore, Md.

ONE-ELECTRON CRYSTAL POTENTIAL AND OPW BAND ENERGY CALCULATIONS FOR KCl (Abstract), by D. Kahn and F. W. Quelle, Jr. [1965] [1]p. [AF 49(638)1017] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 347, Mar. 24, 1965.

A series of programs for the calculation of electron-energy bands of group IV semiconductors written by one of us (FWQ) has been extended to include different types of atoms in the unit cell. The starting potential for this self-consistent calculation scheme includes the perturbation of the free-ion electronic potential by the neighboring ions in the crystal. A comparison of the potential with a potential obtained from a Hartree-Fock-Slater free-ion calculation and a comparison of some preliminary results for the energy gap in KCl are discussed.

2490

RIAS, Inc., Baltimore, Md.

PHOTODIFFUSION PHENOMENA IN ADDITIVELY COLORED ALKALI HALIDE CRYSTALS (Abstract), by J. N. Maycock and D. Kahn [1965] [1]p. [AF 49(638)1017] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 348, Mar. 24, 1965.

Photodiffusion studies in illuminated, additively colored alkali halide crystals have demonstrated photodiffusion voltages of several hundred microvolts in a number of alkali halide crystals. Observation of the photodiffusion current with chopped light show a dependence on the chopping frequency that may be correlated with the electron mobility in the crystal. Variation of the initial current density with illumination is shown for several crystals.

The formulation of a theoretical model for photodiffusion in crystals with current blocking contacts is also discussed.

2491

RIAS, Inc., Baltimore, Md.

SOME APPLICATIONS OF STOCHASTIC DIFFERENTIAL EQUATIONS TO OPTICAL NONLINEAR FILTERING, by W. M. Wonham. [1965] [23]p. incl. refs. (AFOSR-65-2330) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638) 1206 and National Aeronautics and Space Administration) AD 629271 Unclassified

Also published in SIAM Jour. Control, Ser. A, v. 2: 347-369, 1965.

In control theory it is required to estimate the dynamical state of a physical system on the basis of data perturbed by noise. Solution of the estimation problem is usually immediate if one knows the probability distribution of the system state at each instant of time, conditional on the data available up to that instant. It is thus of interest to ask how this posterior probability distribution evolves with time, and if possible to specify the dynamical structure of a filter (i.e., analog device), which generates the posterior distribution when its input is the time function actually observed. In this paper, filters of this type are defined by means of stochastic differential equations for the posterior distribution in which the observed time function appears as a forcing term. When the function to be estimated is a Markov step process and the noise is white Gaussian, the optimal nonlinear filter equations are discussed in detail. For one example, performance of the optimal nonlinear filter is evaluated numerically and is found to be somewhat better than that of the simpler Wiener filter. The paper concludes with heuristic generalization to a continuous state, and some tentative remarks on the form of the solution.

2492

RIAS, Inc., Baltimore, Md.

NEAR OPTIMAL CONTROL IN THE PRESENCE OF SMALL STOCHASTIC PERTURBATIONS, by H. J. Kushner. [1965] [6]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1206 and National Aeronautics and Space Administration) Unclassified

Presented at the Joint Automatic Control Conf., Stanford, Calif., June 24-26, 1964.

Published in Jour. of Basic Eng., v. 87: 103-108, Mar. 1965.

One considers the stochastic system $\dot{x}(t) = f(x(t), u(t)) + \xi(t)$ where $\xi(t)$ is a noise term, with loss criterion $E\int_0^T g(x,u)dt$. A method of computing a correction to the optimal deterministic control, when the effects of $\xi(t)$ are small, is presented. The method is based on some recent works in the stochastic calculus of variations which prove the applicability of a form of the Lagrange multiplier rule and the Hamiltonian formulation to stochastic extremum problems. The method is quite general and is capable of expansion to a greater degree of control correction as the noise effects increase. (Contractor's abstract)

2493

RIAS, Inc., Baltimore, Md.

NONLINEAR FILTERING THEORY, by R. S. Bucy. [1965] [1]p (AF 49(638)1206) Unclassified

Published in IEEE Trans. on Automatic Control, v. AC-10: 198-199, Apr. 1965.

A partial differential equation governing the temporal evolution of the conditional density is obtained which seems more rigorous and simpler, with more insight into the structure of the answer than that formally obtained by H. J. Kushner. Linearizing the optimum nonlinear problem leads to quite a different and probably more useful approximate solution. First an abstract representation for the conditional density in terms of a functional of the stochastic integral of various functions with respect to the observed random process is obtained, then using Ito's random calculus a random partial differential equation for the conditional density is obtained. There is a marked departure from the usual procedure of first linearizing and then applying the linear theory.

2494

[RIAS, Inc., Baltimore, Md.]

STABILITY AND POSITIVE SUPERMARTINGALES, by R. S. Bucy. [1965] [5]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1206 and National Aeronautics and Space Administration. Unclassified

Published in Jour. Differential Equations, v. 1: 151-155, Apr. 1965.

The problem considered is the stability of solutions of nonlinear difference equations containing random elements. Guided by the Liapunov theory for deterministic systems, the concepts of a random equilibrium point and stability of a random solution in probability, as well as an almost everywhere or almost sure asymptotic stability, are introduced. These concepts seem the natural counterparts for random systems of the Liapunov theory, with positive supermartingales corresponding to Liapunov functions. The results obtained are roughly as follows. A sufficient condition for stability in probability is the existence of a positive definite continuous function which is a supermartingale along solutions, and for asymptotic stability almost everywhere the existence of a decreasing positive supermartingale."

2495

RIAS, Inc., Baltimore, Md.

THEORETICAL AND QUANTUM CHEMISTRY OF BORON COMPOUNDS, by J. J. Kaufman. Final rept. Feb. 1, 1963-Jan. 31, 1965. Jan. 1965. 4p. incl. refs. (AFOSR-65-1057) (AF 49(638)1220) AD 617895 Unclassified

Work has been conducted on both rigorous and semi-empirical molecular orbital calculations for boron compounds. New developments in theoretical and computational methods for application to the stabilities and energetics of these compounds were also investigated. A list of papers completed under the contract is presented.

2496

RIAS, Inc., Baltimore, Md.

SEMIRIGOROUS LCAO-MO-SCF METHODS FOR THREE-DIMENSIONAL MOLECULAR CALCULATIONS INCLUDING ELECTRON REPULSION, by J. J. Kaufman. [1965] [5]p. incl. refs. (AFOSR-66-0315) (Sponsored jointly by Advanced Research Projects Agency and Air Force Office of Scientific Research under AF 49(638)1220) AD 629397 Unclassified

Presented at Internat'l Symposium on Atomic and Molecular Quantum Theory, Sanibel Island, Fla., Jan. 18-23, 1965.

Also published in Jour. Chem. Phys., v. 43: S152-S156, Nov. 15, 1965.

A semirigorous LCAO-MO-SCF method including electron repulsion, for 3-dimensional closed-shell molecular calculations has been derived. The method starts with the complete many-electron Hamiltonian (in which interelectronic interactions are included explicitly) and the self-consistent molecular orbital equations of Roothaan, then makes a series of systematic approximations for the integrals involved. There are several different levels of approximation which evolve depending on how restrictive one makes the conditions for neglecting a'(1)a''(1), where a' and a'' are 2 orbitals on atom A; and a'(1)b''(1), where a is an orbital on atom A and b is an orbital on atom B, $A \neq B$, and for neglecting $(a'c'''|G|b''d''')$, where atom D, and A, B, C, D are, in general, different atoms. The approximations for the core operators are defined and the core Hamiltonian matrix elements are presented in detail for several of the levels of approximation. The complete expressions for $F_{a'a'}$, $F_{a'a''}$, and $F_{ab''}$ for closed-shell systems in the 2 simplest of the approximative schemes are included. The salient details of the more complicated schemes (corresponding to lesser and lesser neglect of the interaction of charge distributions) are indicated. These semirigorous LCAO-MO-SCF schemes hold promise for less-than-rigorous yet better-than-empirical calculations for the whole gamut of 3 dimensional molecules from simple inorganics through complicated organics. An analogous treatment with the same approximations for the neglect of certain integrals can also be applied to an open-shell LCAO-MO-SCF procedure. (Contractor's abstract)

2497

RIAS, Inc., Baltimore, Md.

MOLECULAR ORBITALS OF DIBORANE IN TERMS OF A GAUSSIAN BASIS, by L. Burnelle and J. J. Kaufman. [1965] [6]p. incl. diagr. tables, refs. (AFOSR-66-0360) (AF 49(638)1220) AD 632224 Unclassified

Also published in Jour. Chem. Phys., v. 43: 3540-3545, Nov. 15, 1965.

The molecular orbitals of diborane have been calculated by the nonempirical SCF-LCAO method, taking all electrons of the molecule into account and calculating exactly all the integrals. The basis functions were Gaussians centered on the various atoms of the molecule. Two sets of Gaussians have been used, the largest one containing 54 functions, distributed as follows: $9s + 3p$ on each boron, and 3s on each hydrogen. The ordering of the molecular orbitals on the energy scale agrees with that found by Newton, Boer, Palke, and Lipscomb who have used an almost optimized minimal STO basis. The calculated total molecular energy, -52.753 a.u., is 0.468 a.u. higher than the experimental value. A value of 12.9 ev is obtained for the ionization potential, which is to be compared with experimental results ranging from 11.9 to 12.1 ev. An electron-population analysis indicates the presence of very small gross atomic charges ($q_B = -0.088e$, $q_{H(bridge)} = 0.002e$; $q_{H(terminal)} = 0.045e$). The overlap populations are as follows: $n(B, B) = 0.064$; $n(B, H_{terms}) = 0.880$, $n(B, H_{bridge}) = 0.345$. These suggest a structure involving practically no bond between the borons, the bonding in the central part of the system being mainly concentrated in 3 center banana bonds. (Contractor's abstract)

2498

RIAS, Inc., Baltimore, Md.

LCAO-MO CALCULATIONS ON BORON COMPOUNDS. I. LCAO-MO-SCF CALCULATIONS ON BORAZINES, by O. Chalvet, R. Daudel, and J. J. Kaufman. [1965] [6]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1220, Office of Naval Research, and Ordnance Materials Research Office) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87, 399-405, Feb. 5, 1965.

Molecular orbital calculations for borazines using an LCAO technique have been performed in the framework

of the following 3 different approximations: (1) Huckel, (2) Pariser-Parr (without iteration), and (3) Pople (iterated to self-consistency) utilizing the Pariser-Parr approximations for the integrals. Several different theoretical models for choice of input parameters have been utilized. Modified values for boron electron-repulsion integrals, which take into account electron correlation effects, have been calculated for each different choice of theoretical model. Comparison of the calculated LCAO-MO-SCF results for molecular energy levels against known experimental data and examination of the magnitude of the terms of the final SCF Hamiltonian matrix to be diagonalized indicated a reasonable choice for a calculational model. (Contractor's abstract)

2499

RIAS, Inc., Baltimore, Md.

STABILITY OF NONLINEAR CONTROL SYSTEMS, by S. Lefschetz. New York, Academic Press, Inc., 1965, 150p. incl. diagrs. refs. (Mathematics in Science and Engineering Series v. 13) (AFOSR-65-1390) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1242), Army Ordnance Missile Command, and National Aeronautics and Space Administration) AD 621133
Unclassified

The latest material on nonlinear control theory is presented as it has developed from the direct stability method of Liapunov. The first chapter deals exclusively with dimensions one and two and can be considered elementary. The next 5 chapters present theory from what may be considered the pre-Popov period and leans heavily upon vectors and matrices. The next chapter deals with Popov's contribution, which envolves Fourier transforms and advanced analysis. The last chapter considers a theorem similar to but weaker than Kalman's completion of Popov's second theorem. For the reader, the text presupposes little more than a basic knowledge of standard vector-matrix technique and the existence properties of ordinary differential equations.

2500

[RIAS, Inc., Baltimore, Md.]

ON GENERALIZED SYSTEMS DEFINED BY CONTINGENT EQUATIONS, by E. Roxin. [1965] [18]p. incl. diagrs. (AFOSR-65-2327) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638) 1242, National Aeronautics and Space Asministration, and Office of Naval Research) AD 628719
Unclassified

Also published in Jour. Differential Equations, v. 1: 188-205, Apr. 1965.

The concept of generalized dynamical system studied in a previous paper is combined with notation of contingent equations. A contingent of an attainability function as there defined is introduced, and existence and uniqueness theorems are proved for prescribed contingent with such conditions as compactness, convexity, continuity, and a "finite escape time" prohibition.

2501

RIAS, Inc., Baltimore, Md.

STABILITY IN GENERAL CONTROL SYSTEMS, by E. Roxin. [1965] [37]p. incl. diagrs. refs. (AFOSR-65-2435) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1242, National Aeronautics and Space Administration, and Office of Naval Research) AD 627563
Unclassified

Also published in Jour. Differential Equations, v. 1: 115-150, Apr. 1965.

Such a system is defined by an "attainability function" $F(x_0, t_0, t)$, which intuitively yields the set of points attainable at time t when starting from x_0 at time t_0 under a suitable control. This set-valued function is subject to natural axioms regarding its semigroup property with respect to t_0, t, continuity in t (in the Hausdorff metric), upper semicontinuity with respect to the initial conditions, etc. It is shown that F may be extended "backward" (t preceding t_0), and various natural extensions of concepts pertaining to dynamical systems, such as invariant sets and stability, are defined. A trajectory of the system is, in a natural sense, a continuous selection of $F(x_0, t_0, t)$ as a function of t. Trajectories play an important role with respect to "weak" invariance of sets and "weak" stability. The latter notion is introduced in this paper: a set is weakly stable if, for x_0 sufficiently near to the set, there exists a trajectory starting at x_0 and remaining suitably near the set. Necessary and sufficient conditions for both strong and weak stability, simple or uniform, are formulated in terms of Ljapunov-like functions.

2502

[RIAS, Inc., Baltimore, Md.]

THE CONDITION OF REGULAR DEGENERATION FOR SINGULARLY PERTURBED LINEAR DIFFERENTIAL-DIFFERENCE EQUATIONS, by K. L. Cooke. [1965] [56]p. incl refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1242. National Aeronautics and Space Administration, and Office of Naval Research)
Unclassified

Published in Jour. Differential Equations, v. 1: 39-94, Jan. 1965.

A necessary and sufficient condition for regular degeneration of a singularly perturbed linear differential equation with constant coefficients

$$\sum_{k=1}^{n} c_k \varepsilon^k u^{(k+m)}(t) + \sum_{j=0}^{m} a_j u^{(j)}(t) = 0$$

is that all the roots of an auxiliary polynomial $\theta_R(z) = a_m + \sum_{k=1}^{n} c_k z^k$ have negative real parts. By

regular degeneration one means, roughly speaking, that as $\epsilon \to 0^+$ the solution of the perturbed equation approaches the solution of the unperturbed equation $\sum_{j=0}^{m} a_j u^{(j)}(t)=0$ on any finite interval, and the exponential order as $t \to +\infty$ of the former approaches the exponential order of the later. The author gives an example illustrating that for singularly perturbed linear differential-difference equations with constant coefficients, of the form

$$\sum_{k=1}^{n} \epsilon^k [c_k(\epsilon)u^{(k+m)}(t) + d_k(\epsilon)u^{(k+m)}(t-1)]$$

$$+ \sum_{j=0}^{m} [a_j(\epsilon)u^{(j)}(t) + b_j(\epsilon)u^{(j)}(t-1)] = f(t, \epsilon),$$

where $a_j(\epsilon) \to a_j$, $b_j(\epsilon) \to b_j c_k(\epsilon) \to c_k$, $d_k(\epsilon) \to d_k$, $f(t, \epsilon) \to f(t, 0) = f(t)$ as $\epsilon \to 0^+$, the same condition does not ensure the preservation of exponential order. The author then goes on to prove that such a condition does, in fact, ensure convergence over finite intervals, and formulates a much stronger criterion for regular degeneration for his differential-difference equation. This criterion reduces to the simpler one for the case of ordinary differential equations, and also to the conditions formulated by A. Halanay.

2503

RIAS, Inc., Baltimore, Md.

EQUIVALENCE OF PLANAR DYNAMICAL AND DIFFERENTIAL SYSTEMS, by C. Coleman. [1965] [11]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1242, National Aeronautics and Space Administration, National Science Foundation and Office of Naval Research, Unclassified

Published in Jour. Differential Equations, v. 1: 222-233, Apr. 1965.

The author establishes the "total trajectory equivalence" of $\dot{x} = f(x)$ and $\dot{x} = f(x)+g(x)$ in a neighborhood of the origin when (1) $x = (x_1, x_2)$, (2) f is homogeneous of degree $N(\geq 1)$, (3) g is $0(|x|^N)$, and certain (mild) additional hypotheses hold.

2504

RIAS, Inc., Baltimore, Md

HEREDITARY DEPENDENCE IN THE THEORY OF DIFFERENTIAL EQUATIONS-PART I, by G. S. Jones. Jan. 1965, 42p. incl. refs. (In cooperation with Maryland U., College Park) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1242, National Aeronautics and Space Administration and Office of Naval Research) AD 610842 Unclassified

A general class of differential equations with hereditary dependence is introduced which includes most equations of hereditary type encountered in applications with the notable exception of equations of neutral type. Furthermore, the class introduced allows the development of a strong and tractable qualitative theory closely resembling that of ordinary differential equations. Much of the linear analysis and the stability theory as developed by J. K Hale for a more restricted class of hereditary equations carries over directly. However, only results associated with existence and uniqueness of solutions and dependence on initial data and parameters are considered herein

2505

Rice U Dept. of Mathematics, Houston, Tex

NUMERICAL ANALOGS TO THE SCHWARZ ALTERNATING PROCEDURE, by K Miller [1965] [13]p incl. diagrs. (AFOSR-66-0048) (AF AFOSR-62-233) AD 630897 Unclassified

Also published in Numerische Math. v. 7: 91-103, 1965.

The classical alternating procedure of H. A. Schwarz is a suitable method for solving the Dirichlet problem in the union of 2 overlapping domains $R=R_1 \cup R_2$, provided that the Dirichlet problem in a domain R of the domain R_1 and R_2. The author attempts a numerical method for the Dirichlet problem in a domain R of the above type, discretizing the independent variables, he gives an alternating iteration process. Under 4 formal hypotheses, he proves the convergence and stability of his method, and further, gives the rate of convergence for several examples, e.g., for 2 overlapping rectangles, or an overlapping disc and rectangle. In all examples, the 4 formal hypotheses are certainly satisfied. Although the author treats only Laplace's equations in the plane for simplicity, the method is equally effective for uniformly elliptic equations with an arbitrary finite number of variables. (Math. Rev. Abstract)

2506

Rice U Dept. of Mathematics, Houston, Tex.

SOME PROBLEMS IN NUMERICAL ANALYTIC CONTINUATION, by J R. Cannon and K. Miller (1965) [12]p. (AFOSR-66-0055) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-233 and Atomic Energy Commission) AD 631132 Unclassified

Also published in SIAM Jour. Numer. Anal., Ser B, v. 2. 87-98, 1965.

The paper is concerned with methods of approximate numerical analytic continuation of a bounded analytic function on a disc D. Three problems are considered. In the first case, f(z) is approximated at a finite number of points in D. In the second, f and its derivatives of orders $\leq q$ are approximated at a single point z_0 in D. In the third case, f and its derivatives of order $\leq q$ are given at a finite set of points z_j in D. Error estimates are given and an approximating polynomial is determined by a linear programming problem. (Math. Rev. abstract)

2507

Rice U. Dept. of Mechanical Engineering, Houston, Tex.

THEORY OF OPTIMUM AERODYNAMIC SHAPES. EXTREMAL PROBLEMS IN THE AERODYNAMICS OF SUPERSONIC HYPERSONIC, AND FREE-MOLECULAR FLOWS, ed. by A. Miele. New York, Academic Press, 1965, 455p. incl. diagrs. tables, refs. (International Series of Monographs on Applied Mathematics and Mechanics, v. 9) (AFOSR-65-1929) (AF AFOSR-65-828) Unclassified

Variational problems are treated relative to wings, fuselages, wing-fuselage combinations, and nozzles in supersonic, hypersonic, and free-molecular flows. Contents include (1) an introduction to the calculus of variations, (2) optimum wings and fuselages in linearized supersonic flow, (3) nonlinearized supersonic flows, (4) Newtonian hypersonic flow over wings, fuselages, and wing-fuselage combinations; (5) variational problems involving inequality constraints; and (6) the free-molecular flow regime with particular reference to axisymmetric shapes. The book is made up of contributions by individual scientists which are integrated by the author to make the volume usable as either a textbook or a reference book. The basic organizational scheme is physical rather than mathematical.

2508

Rice U. [Dept. of Mechanical Engineering] Houston, Tex.

THREE-DIMENSIONAL WINGS OF MINIMUM TOTAL DRAG IN NEWTONIAN FLOW, by D. G. Hull and A. Miele. [1965] [7]p. (AFOSR-65-2087) (AF AFOSR-65-828) AD 627668 Unclassified

Also published in Jour. Astronaut. Sci., v. 12: 39-45, 1965.

The problem of minimizing the drag of a slender, 3-dimensional wing in hypersonic flow is considered under the following assumptions: the wing has 2 planes of symmetry; the wing is slender in both the chordwise direction and the spanwise direction; the span is prescribed; the thickness along the leading edge is zero; the angle of attack and the sideslip angle are zero; the pressure distribution is Newtonian, and the skin-friction coefficient is constant. The indirect methods of the calculus of variations in two independent variables are employed, and the minimum drag problem is solved for various conditions. If the volume is free while the trailing edge thickness distribution is given, the optimum surface is obtained by joining corresponding points of the leading edge and the training edge with straight lines, on the other hand, if the volume is given while the trailing edge thickness distribution is free, the optimum surface is obtained by joining corresponding points with a curve such that the complements of the locally normalized coordinates satisfy at 3/2-power law. The above results are valid regardless of the conditions imposed on the planform shape and the planform area. For all of the cases considered, analytical expressions are obtained for the aerodynamic drag and the drag coefficient.

2509

Rice U. [Dept. of Mechanical Engineering] Houston, Tex.

THREE-DIMENSIONAL CONFIGURATIONS OF MINIMUM TOTAL DRAG IN NEWTONIAN FLOW, by D. G. Hull. [1965] [5]p. incl. diagrs. refs. (AFOSR-66-0050) (AF AFOSR-65-828) AD 641238 Unclassified

Also published in Jour. Astronaut. Sci., v. 12: 83-87, 1965.

Variational problems associated with 3 dimensional configurations (wings, bodies, and wing-body combinations) are considered, and the minimum drag problem is solved under the assumption that the base area and the wetted area are given while the length and the volume are free. The following hypotheses are employed: The configuration has 2 planes of symmetry; the angle of attack and the sideslip angle are zero; the pressure distribution is that pertaining to Newtonian flow; and the friction coefficient is constant. It is shown that the optimum configuration is governed by a first order, nonlinear, partial differential equation, and its general solution is presented in parametric form. Furthermore, the aerodynamic drag depends on the base area and the wetted area but is independent of the base shape; therefore, the optimum configuration is not unique. As a particular case, homothetic configurations are considered, (that is, configurations whose transversal contours are geometrically similar to the contour of the base), and the associated optimum geometries are determined.

2510

Rice U. Dept. of Mechanical Engineering, Houston, Tex.

EXTREMAL PROBLEMS IN AERODYNAMICS, by A. Miele. [1965] [13]p. incl. refs. (AFOSR-66-0196) (AF AFOSR-65-828) AD 468758 Unclassified

Presented at Symposium on the Mathematical Theory of Optimal Control, Michigan U., Ann Arbor, Oct. 5-7, 1964.

Also published in SIAM Jour. Control, Ser. A., v. 3: 129-141, 1965.

The advent of jet and rocket engines as aircraft propulsion systems and the parallel increase in flight velocities and altitudes have made it necessary to extend the optimization of aerodynamic shapes to a wider range of mach and Reynolds numbers, thereby including the hypersonic and free-molecular flow regimes. Since the distributions of pressure and skin-friction coefficients depend on the flow regime, a single optimum body does not exist; rather, a

succession of optimum configurations exists, that is one for each flow regime and each set of free-stream conditions. In addition, the optimum geometry depends on the quantity being extremized (aerodynamic drag, lift-to-drag ratio, surface integrated heat transfer rate, sonic boom of an aircraft, thrust of a nozzle, as well as the constraints employed in the optimization process, whether geometric quantities (length, thickness, volume, wetted area, planform area, frontal area) or aerodynamic quantities (lift, bending, moment, pitching moment, position of the center or pressure). The physical models of interest in the theory of optimum aerodynamic shapes are reviewed. The corresponding mathematical models are illustrated for problems involving one independent variable and for problems involving two independent variables. Finally, new trends in the theory of optimum aerodynamic shapes as well as certain problems of interest in the immediate future are outlined.

2511

Rice U., Dept. of Physics, Houston, Tex.

DETECTABILITY OF LUNAR X-RAYS, R. C. Haynes and R. D. Juday [1965] [6]p. incl. diagr. table, refs. (AFOSR-66-0796) (AF AFOSR-65-858) AD 641543 Unclassified

Also published in Planetary and Space Sci., v. 13: 1249-1254, 1965.

Several theories that imply the generation of x-rays by the moon were examined. The x-ray fluxes to be expected at the top of the earth's atmosphere were estimated and compared. For example, it was found that an x-ray flux is to be expected when the moon is full and K_p high, as a consequence of the configuration of the auroral electrons in space deduced from the long tail model of the magnetosphere. The x-ray photons are caused by energetic electrons in the tail that bombard the lunar surface. Alternatively, Gold has suggested that lunar x-rays are produced by the bombardment by solar-wind electrons; this results in a lunar phase dependence that is different from the long tail model. The background is discussed and it is concluded that the lunar x-ray flux may be detectable. Experiments of this kind may provide useful tools for investigating the models. (Contractor's abstract)

2512

Rice U. Dept. of Space Science, Houston, Tex.

RADIOACTIVITY IN SUPERNOVA REMNANTS, by D. D. Clayton and W. L. Craddock. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR-65-1824) (AF AFOSR-65-855) AD 625688 Unclassified

Also published in Astrophys. Jour., v. 142: 189-200, July 1, 1965.

The theory is considered that the nearly exponential decrease after the first 100 days of the light-curves of Type I supernovae is due to nuclear energy released by the spontaneous fission of Cf^{254}. Uncertainty of the correctness of the Cf-hypothesis qualifies any interpretation of (1) supernovae light-curves, (2) the location and mechanism of heavy-element nucleosynthesis by rapid neutron captures, and (3) the present-day energy balance in supernova remnants. It is demonstrated that, if the Cf-hypothesis is correct, the Crab Nebula presently has a radioactive energy input of 1.2×10^{36} ergs sec, of which amount 92% is in the form of kinetic energy of heavy ions. That much energy would be significantly related to observed properties of the nebula. An experimental test of the Cf-hypothesis may be made by searching for gamma-ray lines associated with transbismuth radioactivity. The anticipated line spectrum is complex. The strongest line flux is 9.7×10^{-5} cm^{-2} sec^{-1} from the Crab for the 390-kev line of Cf^{249}. Good angular and energy resolution will be required to resolve the lines from the sky background.

2513

Rice U. Dept. of Space Science, Houston, Tex.

PHOTON-INDUCED BETA DECAY IN STELLAR INTERIORS, by P. B. Snaw, D. D. Clayton, and F. C. Micnel. [1965] [8]p. incl. diagrs. refs. (AFOSR-66-0432) (AF AFOSR-65-855) AD 630449 Unclassified

Also published in Phys. Rev., v. 140. B1433-B1441, Dec. 6, 1965.

Because of the astrophysical importance of beta-decay lifetimes in stellar interiors, calculation was made of the rate of photon-induced beta decay ("photobeta" decay). In the photobeta process the photon can be considered to decay virtually into an electron-positron pair, with the positron being absorbed by the nucleus. The photobeta process is in competition with normal beta decay (if energetically possible), excited-state beta decay, and free-positron capture. An infrared divergence problem for exothermic photobeta decay is discussed, although the exothermic photobeta is is too small to enhance most spontaneous beta decays. Applications are discussed in the driven decay of stable nuclei. As an example, the photobeta lifetime of a nucleus stable by 200 kev drops from 3×10^{10} yr at 3×10^8 K, to 10^5 yr at 1.2×10^9 K for a nuclear transition matrix element characterized by log ft 6 The competition between the photobeta process and excited-state beta decay is discussed. (Contractor's abstract

2514

Rochester U. Dept. of Chemistry, N. Y.

THE PHOTOCHEMISTRY OF METHYL ISOPROPYL KETONE, by A. Zahra and W. A. Noyes, Jr. (1965] [6]p. incl. diagrs tables, refs. (AFOSR-65-0884) (AF AFOSR-63-206) AD 618346 Unclassified

Also published in Jour. Phys. Chem., v. 69 943-948, Mar., 1965.

The photochemistry of methyl isopropyl ketone

(3-methyl-2-butanone), is contrasted with that of 2-pentanone since the former, as distinguished from the latter, may not undergo a Norrish Type II reaction. The main reactions are those expected from photochemical dissociation into radicals but there occurs almost certainly some direct dissociation into acetaldehyde and propylene by a process designated by Norris as Type III. By the addition of oxygen and of biacetyl it is shown that a triplet state as well as a singlet state must be considered in any detailed mechanism of the photochemistry of this ketone. Some suggestions are made as to the role each one plays. Analyses were performed for carbon monoxide, methane, ethane, propylene, and propane. The propylene always exceeds the propane so that these 2 gases are not formed solely by disproportionation of isopropyl radicals.

2515

Rochester U. Dept. of Chemistry, N. Y.

THE FLUORESCENCE OF BENZENE AND BENZENE-d_6, by J. A. Poole. (1965) [5]p. incl. tables, refs. (AFOSR-65-1256) (AF AFOSR-63-206) AD 621469 Unclassified

Also published in Jour. Phys. Chem., v. 69: 1343-1347, Apr. 1965.

A study was made of the quantum yields of fluorescence of benzene and benzene-d_6 in the pressure range 5-15 mm and at the temperatures 30, 60, and 90°C. The exciting lines were monochromatically chosen to correspond to the transition $^1B_{2u} \leftarrow {}^1A_{1g}$. The yields for benzene-d_6 exceeded those for benzene in all cases. The Stern-Volmer plots showed a small but finite slope, and the addition of 80 mm of cyclohexane resulted in a decrease in fluorescence yield except in the case of benzene at 30 C where no such decrease was observed. The high values for the emission yields of biacetyl, sensitized by the benzenes, at 30 C substantiates the hypothesis that the primary process involving $^1B_{2u}$ removal is intersystem crossing to the $^3B_{1u}$ state. The energy required for this process is about twice the difference in zero point energies for benzene and benzene-d_6. Thus, intersystem crossing seems to depend upon vibrational energy content. The fluorescence yields decreased with increasing temperature and decreasing wave length of the exciting line. The nonradiative process involving intersystem crossing appears to be faster for the light benzene.

2516

Rochester U. Dept. of Chemistry, N. Y.

BENZENE d-6-SENSITIZED PHOTOISOMERIZATION OF BUTENE-2 AT LOW PRESSURES BY LONG-PATH INFRARED SPECTROSCOPY, by P. Sigal. [1965] [5]p. incl. diagr. tables, refs. (AFOSR-65-1257) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-206 and National Science Foundation) AD 621472 Unclassified

Also published in Jour. Chem. Phys., v. 42: 1953-1957, Mar. 15, 1965.

The benzene d-6-sensitized trans-cis photoisomerization of butene-2 has been studied by means of long-path infrared spectroscopy. Relative quantum yields at pressures less than 1 mm were determined. Mechanisms for energy transfer in benzene d-6 consistent with the data are presented. (Contractor's abstract)

2517

Rochester U. [Dept. of Electrical Engineering] N. Y.

ON THE BESSEL-FUBINI AND FAY SOLUTIONS FOR PLANE, FINITE-AMPLITUDE WAVES, by D. T. Blackstock. [1965] [4]p. incl. diagrs. (AFOSR-65-2481) (AF 49(638)1320) AD 627957 Unclassified

Presented at Fifth Cong. Internat'l. Acoustic, Liege (Belgium), Sept. 7-14, 1965.

The problem of a plane, originally sinusoidal sound wave of finite amplitude is considered here. Two excellent approximate solutions are regarded as classics. The Bessel-Fubini (1) solution holds prior to shock formation, i.e., in the region $\sigma < 1$, whereas, Fay's (2) analysis pertained to the region where the shocks have already become fully formed and are slowly decaying. In other words (1) holds near the source and (2) rather far from the source. There is a gap, called the transition region, not covered by either. This paper presents a more general solution containing both as limiting cases and covers the transition.

2518

Rochester U. [Dept. of Engineering and Applied Sciences] N. Y.

STABILITY OF MAGNETOHYDRODYNAMIC SHOCKS (Abstract), by M. Lessen and N. Deshpande [1965] [1]p. (Bound with AFOSR-65-1266; AD 622527) (AF 49(638)1540) Unclassified

Presented at Eighth AFOSR Contractor's meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

The stability of plane magnetohydrodynamic shocks in perfectly conducting plasma is investigated in a coordinate system that moves with the shock. The plane of the shock coincides with the y-z plane and the flow is in the x direction with an applied magnetic field in the z direction. The flow is disturbed about the steady state, and the space and time dependence of the disturbance is assumed to be of the form $\exp[i(\alpha_1 x + \alpha_2 y - \beta t]$. Three-dimensional perturbations are considered. The dispersion relation has two branches, one corresponding to the fast waves and the other to the swept wave. Gardner and Kruskal investigated the stability of such shocks, but they did not consider the swept wave. They concluded that the shocks are stable. A solution, corresponding to the fast wave and the swept wave for the downstream region of the shock is obtained. There is no perturbation ahead of the shock. The matching of the solution at the shock gives the allowable disturbance frequencies. It is observed that there exists a growth rate. Shocks

in "cold plasmas" as well as in "hot plasmas" are considered. It is found that the cold plasma shocks are unstable for all Alfven Mach numbers; hot plasma shocks are unstable for large gasdynamic Mach numbers and small Alfven Mach numbers, but are stable for small gasdynamic Mach numbers and large Alfven Mach numbers. These Mach numbers are referred to the downstream region of the shock.

2519

Rochester U. [Dept. of Mathematics] N. Y.

CROSS-EXAMINING PROPOSITIONAL CALCULUS AND SET OPERATIONS, by J. F. Randolph. [1965] [11]p. incl. diagrs. refs. (AFOSR-65-0863) (AF AFOSR-64-481) AD 617475 Unclassified

Also published in Amer. Math. Monthly, v. 72: 117-127, Feb. 1965.

The purpose of this paper is to give an operational method for obtaining the truth value column of a compound proposition without writing any other column of the truth table. This is accomplished by using a combination of crosses and dots in such a manner as to greatly simplify operational steps. As well as making computation shorter and easier, the notation reveals pertinent facts about a proposition much as the graph of an equation displays properties of the equation.

2520

Rochester U. Dept. of Mathematical and Aerospace Sciences, N. Y.

PLASMA DENSITY AHEAD OF PRESSURE DRIVEN SHOCK WAVES, by L. B. Holmes. May 1965, 181p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-65-0974) (AF AFOSR-65-478) AD 622569 Unclassified

The electrical precursor has been investigated in the present experiment using external potential probes in conjunction with a solenoidal magnetic field, and using internal collecting probes which sample electron and ion densities next to the probe. Potential probe experiments in conjunction with a solenoidal magnetic field show that the electrostatic precursor signal is due in part to radial diffusion of electrons to the wall of the shock tube. A theory is presented for the diffusion fusion of the electrons and ions to the grid of the probe and for the motion of the charged particles inside the probe. This theory relates the collected currents to the plasma density in the shock tube. The sensitivity of the collecting probe is such that densities from 10^9 cm^{-3} to 10^{13} cm^{-3} can be measured. The evidence of the existence of a neutral plasma and the high velocity of propagation of the precursor strongly suggests that the gas ahead of the shock wave is photoionized. It is established that multiple step photoionization produces the plasma.

2521

Rochester U. Dept of Physics and Astronomy, N. Y.

COLOR IMAGERY BY WAVEFRONT RECONSTRUCTION, by L. Mandel. [1965] [2]p. incl. diagrs. (AFOSR-66-1273) (AF 49(638)1532) AD 638714 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 55: 1697-1698, Dec. 1965.

It is shown that the method of wavefront reconstruction developed by Leith and Upatnieks can be used virtually without modification to reconstruct images in color from black and white nolograms. The requirement is a laser beam with 3 spectral components corresponding to the 3 primary colors. The color rendering will be undistorted provided the field of view is restricted to an angle of about 10

2522

Rochester U. Dept. of Physics and Astronomy, N. Y.

SCATTERING OF SINGULAR LOGARITHMIC POTENTIALS, by H. H. Aly, Riazuddin, and A. H. Zimmerman. [1965] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-32, and Atomic Energy Commission. Unclassified

Published in Jour. Math. Phys., v. 8: 1115-1117, July, 1965.

Potential of the form $(gr^{-4}\ln^2 r - g^1 r^{-3})\theta(r - r_0)$ is considered in connection with the applicability of peratization technique. The advantage of this potential is the fact that while it is dominated by a logarithmic part near the origin, the exact solution of the zero-energy and s-wave Schrödinger equation is obtained in a closed form. It is shown that the peratization technique gives the correct answers. (Contractor's abstract)

2523

Rochester U. Dept. of Physics and Astronomy, N. Y.

THE ENERGY DEPENDENCE OF THE ABUNDANCE OF LITHIUM, BERYLLIUM, AND BORON IN THE PRIMARY COSMIC RADIATION: OBSERVATIONS AT FORT CHURCHILL, by G. D. Badhwar, S. N. Devanathan, and M F. Kaplon. [1965] [13]p incl. diagrs. tables, refs. (AFOSP-65-1779) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-439 and National Aeronautics and Space Administration) AD 608770 Unclassified

Also published in Jour. Geophys. Research, v. 70 1005-1017, Mar. 1, 1965.

The relative abundances of lithium, beryllium, boron, and the S-group nuclei have been determined at 2 different energies by means of a pure nuclear emulsion

stack flown from Fort Churchill, Canada (- 70.5), on Aug. 4, 1962, under a total of 4.7 g/cm^2 of residual atm. The ratio of the L to S nuclei, T_{LS}, at the top of the atm between 200 and 70 mev/n and > 700 mev/n was determined to be 0.41 ± 0.08 and 0.19 ± 0.03, respectively. The results of both the absolute flux values of L- and S-group nuclei, as well as their ratios, are in accord with other investigations. Combined with the evidence from the measurements of T_{He_3He} in the same stack, results indicate that low energy cosmic ray nuclei have traversed about twice as much hydrogen as high energy particles. The results rule out an accelerating mechanism of the Fermi type but can be explained by a source-trapping mechanism.

2524

Rochester U. Dept. of Physics and Astronomy, N. Y.

SPARK-CHAMBER EXPERIMENT ON COSMIC GAMMA RAYS, by R. Cobb, J. G. Duthie, and J. Stewart. [1965] [5]p. incl. diagrs. refs. (AFOSR-66-0027) (AF AFOSR-63-439) AD 620882 Unclassified

Also published in Phys. Rev. Ltrs., v. 5: 507-511, Sept. 1965.

The intensity and distribution of high-energy cosmic gamma rays and their importance in astrophysics are discussed. Experimental techniques for obtaining data are explained.

2525

Rochester U. Dept. of Physics and Astronomy, N. Y.

A NEW METHOD FOR THE ESTIMATION OF THE PRIMARY ENERGY OF COSMIC RAY JETS, by M. L. Shen and M. F. Kaplon. [1965] [51]p. incl. diagrs. tables, refs. (AFOSR-66-0041) (AF AFOSR-63-439) AD 455836 Unclassified

Also published in Ann. Phys., v. 32. 452-502, May 1965.

Methods of determining the primary energy of cosmic ray jets are reviewed and the corrections which have been developed to improve the basic assumptions are discussed to clarify the limit of this applicability. To avoid the disadvantages inherent in the usual methods, a new method was developed for determining the primary energy of cosmic ray jets based mainly on the constancy of transverse momentum of the charged secondary shower particles and which is free of the usual assumptions employed.

2526

Rochester U. Dept. of Physics and Astronomy, N. Y.

"TARGET MASS" AND "EFFECTIVE TARGET MASS", by M. F. Kaplon and M. L. Shen. [1965] [7]p. incl. diagrs. refs. (AFOSR-66-0046) (AF AFOSR-63-439) AD 608767 Unclassified

Also published in Nuovo Cimento, Ser. X, v. 37: 423-429, May 1965.

The concept of 'target mass' and 'effective target mass' is discussed. Evidence is presented which questions the validity of attempting to relate the 'effective target mass' to the concept of a virtual pion surrounding the nucleon. Relations between the 4-momentum transfer, the quantity (E - P cos θ of the recoil nucleon and the 'effective target mass' are derived which show in conjunction with experimental data that the 'effective target mass' of the order of a pion mass occurs accidentally.

2527

Rochester U. Dept. of Physics and Astronomy, N. Y.

THE FLUX OF PROTONS IN THE PRIMARY COSMIC RADIATION OVER FORT CHURCHILL, by S. N. Devanathan. Jan. 4, 1965, [17]p. incl. diagrs. (AF AFOSR-63-439) Unclassified

Nulcear emulsions exposed to the cosmic radiation over Fort Churchill, Minitoba, Canada (geomagnetic latitude = 73° N) at an altitude of 120,000 ft for 13 min on Aug. 4, 1962 have been used to determine the flux of hydrogen nuclei in the primary cosmic radiation. The flux at the top of the atmosphere is found to be 978 ± 125 protons per sec per meter^2 sterad with kinetic energies greater than $375.3^{+34.7}_{-38.4}$ mev.

2528

Rochester U. Dept. of Physics and Astronomy, N. Y.

BAND STRUCTURE AND ELECTRONIC PROPERTIES OF AgCl AND AgBr, by F. Bassani, R. S. Knox, and W. B. Fowler. [1965] [9]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-611, and Atomic Energy Commission) AD 622919 Unclassified

Also published in Phys. Rev., v. 137: A1217-A1225, Feb. 15, 1965.

A theoretical study of the electronic properties of silver chloride and bromide is reported. The valance bands of AgCl have been calculated by the tightbinding method, using a screened free-electron exchange potential. The spin-orbit splitting in the highest valence band for the state L_3' has been computed and is found to be less than 0.05 ev. Using the AgCl calculation as a starting point, the available optical data is analyzed on both AgCl and AgBr along lines suggested by the work of Phillips in the alkali halides and rare gases. For both crystals, conduction-band structures are proposed which appear to explain the gross features of the data.

2529

Rochester U., Dept. of Physics and Astronomy, N. Y.

THEORY OF OPTICAL ABSORPTION BY VIBRATION OF DEFECTS IN DIAMOND, by R. J. Elliott and P. G. Dawber. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-1967) (AF AFOSR-64-611) AD 626495 Unclassified

Also published in Lattice Dynamics; Proc. Internat'l. Conf., Copenhagen (Denmark) (Aug. 5-9, 1963), New York, Pergamon Press, 1965, p. 479-484.

The optical absorption due to the creation of single phonons is calculated for the perturbed vibrations around a defect of a type thought to occur in type I diamonds. A simple model is taken for the defect consisting of a single layer of nitrogen atoms in a (100) plane, sharing their extra electron with a neighboring layer of carbon atoms. Using as a parameter the weakening of the force constant between these layers, reasonable agreement is achieved with the strongest observed peaks. Some other aspects of the spectrum indicate, however, that the model is not completely adequate.

2530

Rochester U. [Dept. of Physics and Astronomy] N. Y.

DETAILED BALANCE IN OPTICAL TRANSITIONS IN MOLECULES AND SOLIDS, by W. B. Fowler and D. L. Dexter. [1965] [5]p. incl. diagr. refs. (AFOSR-65-2092) [AFOSR-64-611] AD 627483 Unclassified

Also published in Jour. Chem. Phys., v. 43: 1768-1772, Sept. 1, 1965.

Recent theoretical and experimental work has shown that the simplest form of the Einstein equation relating induced absorption and spontaneous emission probabilities (characterized by τ and τ^{-1} is not generally valid for impurities or color centers in solids, liquids, or molecules. Separate computations of these probabilities in systems exhibiting sizeable Stokes's shifts resolve some of the problems, they also disclose the difficulties involved in obtaining any connection between τ and τ. Here is considered how the transition probabilities between a pair of electronic-vibrational states are related. Observable quantities, i.e., integral absorption cross section and the radiative decay time, involve sums and averages over the vibrational states, and no definite theoretical information relates these quantities. However, there is a simple connection between induced and spontaneous emission probabilities. New experiments which could yield information about the rate of lattice relaxation are suggested from this point of view. (Contractor's abstract)

2531

Rochester U. [Dept. of Physics and Astronomy] N. Y.

MODERN SPECTROSCOPY OF SOLIDS, by D. L. Dexter. [1965] [4]p. (AFOSR-66-0238) (AF AFOSR-64-611) AD 629030 Unclassified

Also published in Jour. Appl. Phys. (Japan), Suppl. 1, v. 4: 609-612, 1965.

A qualitative review is presented of selected recent developments in the study of the optical properties of solids from the γ ray region to the far infra-red.

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Rochester U., Dept. of Physics and Astronomy, N. Y.

COHERENCE PROPERTIES OF OPTICAL FIELDS, by L. Mandel and E. Wolf. [1965] [57]p. incl diagrs. refs. (AFOSR-65-2057) (Sponsored jointly by Air Force Cambridge Research Laboratories, Air Force Office of Scientific Research under AF AFOSR-65-237, and Army Research Office (Durham)) AD 627733 Unclassified

Also published in Rev. Modern Phys., v. 37: 231-287, Apr. 1965.

A review is presented of coherence properties of electromagnetic fields and their measurements, with special emphasis on the optical region of the spectrum. Analyses based on both classical and quantum theories are described. The measure of second-order coherence is introduced and some important effects studied. The general statistical description of an optical field is discussed in both the classical and quantum theories, and the generalized phase-space distribution function is found to lead to a formal similarity between the two. The most important higher-order effects are considered, including the Hanburg Brown-Twiss effect. Various transient interference and beat effects produced by independent light beams are also discussed.

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Rochester U. Dept. of Physics and Astronomy, N. Y.

LIGHT FLUCTUATIONS AS A NEW SPECTROSCOPIC TOOL, by E. Wolf. [1965] 14p. incl. diagrs. refs. (AFOSR-66-0394) (AF AFOSR-65-237) AD 629929 Unclassified

Presented at Conf. on Photographic and Spectroscopic Optics, Tokyo and Kyoto, Sept. 7-8, 1964.

Also published in Japan Jour. Appl. Phys., Suppl. 1, v. 4: 1-14, 1965.

In the first part of this lecture, basic concepts relating to the theory of light fluctuations are presented and some features which distinguish the fluctuation properties of thermal and laser light are mentioned. A survey is then made of various new techniques proposed by many authors, for obtaining information about spectra from fluctuation and correlation measurements. In particular, intensity correlation interferometry, photon coincidence methods and pulse counting techniques are reviewed. Current researches

relating to the determination of the phase of the second order complex degree of coherence — the knowledge of which is of importance for an unambiguous determination of asymmetric spectral profiles from some of these experiments—is also discussed. Theoretical methods for obtaining this phase information utilize the analytic properties of coherence functions. Proposed experimental methods make use of the technique of the coherent background and of three point correlation measurements. Finally the notion of spectral correlation function is introduced and it is shown how it is related to higher order coherence functions. The possibility of obtaining some information about spectral correlation from multiple photon coincidence experiments is also mentioned.

2534

Rochester U. [Dept. of Physics and Astronomy] N. Y.

COSMIC γ RADIATION (Abstract), by G. H. Share. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-237] and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 14, Jan. 27, 1965.

Previous balloon borne experiments with a Cerenkov-scintillation telescope indicated an isotropic extrapolated flux of $(5.5\pm0.7)\times10^{-3}\gamma/cm^2 \cdot sr \cdot sec$ produced by γ-rays converting in lead. More-sophisticated models of this detector were flown in 1963 and 1964, making use of simple pulse-height analysis and a cylindrical side-shower guard counter. The 1963 flights from Texas confirm the above flux in the unguarded channel. A lower limit to the isotropic extrapolated γ-ray flux is set at $6\times10^{-4}\gamma$ cm·sr·sec. The 1964 flight was launched from a higher geomagnetic latitude such that the extrapolated charge-particle flux increased by a factor of 2.5 over the 1963 value. Preliminary analysis of the initial ascent indicates that the extrapolated unguarded γ-ray flux is the same as in 1963 ($\phi_{63}=6.5\pm0.6$ counts/min, $\phi_{64}=7.1\pm1.6$ counts/min). A guarded channel that detects both pair-produced electrons in two of the telescope counters yields an extrapolated flux of $(8\pm2)\times10^{-4}\gamma/cm^2 \cdot sr \cdot sec$.

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Rochester U. Dept. of Physics and Astronomy, N. Y.

A NEW PHASE-SPACE DISTRIBUTION FUNCTION IN THE STATISTICAL THEORY OF THE ELECTROMAGNETIC FIELD, by Y. Kano. [1965] [3]p. incl. refs. [AF AFOSR-65-237] Unclassified

Published in Jour. Math. Phys., v. 6: 1913-1915, Dec. 1965.

In a previous paper a certain new probability distribution function q(z) relating to blackbody radiation was introduced. In the present paper the properties of this function for a general radiation field are studied. Unlike the phase-space distribution function of Sudarshan (1963), this function is nonnegative and is an ordinary function. A series expansion for q(z) is given, and it is shown that the series is absolutely convergent for all eigenvalues z of the destruction operator. It is also shown that the density matrix in the Fock representation can be uniquely determined from this probability distribution function, and vice versa. The relation between q(z) and the Sudarshan's phase-space distribution function is discussed. (Contractor's abstract)

2536

Rochester U. [Dept. of Physics and Astronomy] N. Y.

NEW CHARACTERISTIC OF HIGH-ENERGY INTERACTIONS (Abstract), by M. L. Shen and M. F. Kaplon. [1965] [1]p. [AF AFOSR-65-439] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 14, Jan. 27, 1965.

By applying a new method for determining the primary energy of cosmic-ray jets to the analysis of the interactions of the nucleonic particles emerging as fragmentation products of heavy nuclei with energies of the order of 1000 bev/nucleon, it has been observed that the γ_0 (the Lorentz factor of the c m system) values of the fragments belonging to the same break-up process show special ratios among themselves. This can be explained in terms of a new characteristic of high-energy interactions: namely, the coherent interaction of the incoming particle with the nuclear cluster inside the emulsion nuclei. Thus, the impulse approximation does not appear to be valid in this high-energy region and the momentum transfer will take place between the entire incoming particle and the entire target particle. This new phenomena probably is due to the increase in the interaction range in very high-energy nucleon-nucleon collisions and may reflect certain consequences of the multiperipheral model of multiple production.

2537

Rochester U. Inst. of Optics, N. Y.

TRAPPED EXCITONS IN DILUTE RARE-GAS ALLOYS, by G. Baldini. [1965] [6]p. incl. diagrs. table, refs. (AFOSR-65-1112) [AF AFOSR-63-236] AD 612546 Unclassified

Also published in Phys. Rev., v. 137. A508-A513, Jan. 18, 1965.

The ultraviolet absorption spectra of Ar, Kr, and Xe diluted in Ne, Ar, and Kr, have been measured at 6±2°K. The several peaks observed are ascribed to perturbed atomic resonances and transitions to Rydberg states of the impurities. An empirical relation suggests that the modes of vibration of the impurities in the host-lattices are partly responsible for the half-widths of the peaks.

2538

Rochester U. Inst. of Optics, N. Y.

ISOTOPE EFFECTS INDUCED BY LOCAL MODES IN THE U BAND, by G. Baldini, E. Mulazzi and N. Terzi. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-66-1579) (In cooperation with Milan U. (Italy) AF EOAR-65-5) [AF AFOSR-65-236]
Unclassified

Also published in Phys. Rev., v. 140: A2094-A2101, Dec. 13, 1965.

For abstract see item no. 1977.

2539

Rochester U. Inst. of Optics, N. Y.

EXCITED STATES OF SOLID Ar:H. II. LINE SHAPES AND INTERSTITIAL SITES, by T. H. Keil and A. Gold. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-66-1581) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-236] and National Science Foundation) AD 641056
Unclassified

Also published in Phys. Rev., v. 140: A906-A910, Nov. 1, 1965.

The line shape of the 1s-2p transitions of substitutional H and D atoms in solid argon has been analyzed on the basis of a "four-mode model." The impurity is treated as interacting (semiclassically) with a linearly coupled "breathing mode" and with three localized quadratically coupled modes. A full quantum-mechanical treatment of the latter is essential. The experimentally observed isotope shift of the peak is fitted and part of the isotopic width change accounted for by this model. Local-mode infrared absorptions at 0.033 and 0.023 ev are predicted for Ar:H and Ar:D, respectively. It is shown that the relatively high concentration of H (or D) impurities used (2%) simultaneously accounts for the additional width change and the low-energy tail of the spectrum. Excitation energies for the 1s-2p transitions of H atoms trapped at octahedral or tetrahedral interstitial sites are computed using a tight-binding model which was previosuly used to predict the excitation energy for the substitutional site. Within computational accuracy the transitions are found to take place at the same energy as that for substitutional atoms. Although it seems unlikely that interstitials are present in Baldini's work (here analyzed), experiments to verify their absence are suggested. Experimental measurement of the concentration dependence of the linewidths and the intensity of the low-energy tail will provide useful checks of the model. (Contractor's abstract)

2540

Rochester U. [Inst. of Optics] N. Y.

ISOTOPE EFFECTS IN THE U BAND (Abstract), by G. Baldini. [1965] [1]p. [AF AFOSR-65-236]
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 77, Jan. 27, 1965.

The study of the U band in KCl, KBr, and RbCl crystals containing H^- and D^- ions has revealed interesting isotope effects. At liquid-helium temperature, the half-widths of the U_H band and from 3%-16% larger than those of the U_D band in the three crystals investigated. At all temperatures, from 4° to 400°K the peak positions of the U_H band occur at energies ~ 0.02 ev smaller than those of the U_D band. The different half-widths, observed at low temperatures, are attributed to the local vibrational mode introduced by the two isotopes and the peak shift is accounted for in terms of different zero-point energies for the U_H and U_D center. It has been observed also that the U band is not single by a few components, with a spacing of approximately 0.1 ev, appear in both the U_H and U_D band. It is suggested that lattice vibrations can change the cubic symmetry of center enough to remove the degeneracy of the p-like excited state of the center and produce the observed structure.

2541

[Royal Coll. of Science and Tech.] Dept. of Mathematics, Glasgow (Scotland).

RESEARCH ON MAGNETO-GASDYNAMICS, by D. C. Pack. Final scientific rept. Feb. 15, 1965, 4p. (AFOSR-65-1069) (AF EOAR-64-6) AD 618296
Unclassified

An analysis was made of the rectilinear, adiabatic but non-isentropic, unsteady flow of a perfectly conducting ideal gas moving in the presence of a transverse magnetic field. Detailed properties of certain generalized simple waves were obtained. The upstream influence effects in the flow of a perfectly conducting fluid over an insulating wall were found on the basis of linearized theory. The question of the physical realization of the solutions found by Cabannes for flow of perfectly conducting gas past a wedge in a magnetic field aligned with the stream was examined by a combination of analytical and neuristic arguments. Magneto-gasdynamic deflagrations under the Chapman-Jouguet condition were studied and work has been initiated on similarity solutions for cylindrical megneto-gasdynamic detonations and flames.

2542

[Royal Coll. of Science and Tech.] Dept. of Mathematics, Glasgow (Scotland).

UPSTREAM INFLUENCE EFFECTS IN THE FLOW OF A CONDUCTING FLUID OVER AN INSULATING WALL, by G. W. Swan. [1965] [13]p. incl. diagrs. (AFOSR-65-1362) (AF EOAR-64-6) AD 621284
Unclassified

Also published in Quart. Jour. Mech. and Appl. Math., v. 28(Pt. 2): 243-255, May 1965.

In magnetogasdynamics, the 2-dimensional steady supersonic flow of a perfect gas past a straight-edged wall is complicated in situations where disturbances not only propagate upstream in the gas but propagate in all directions in the solid wall. An analysis is presented of an infinitely conducting, non-viscous perfect gas moving over a stationary non-conducting wall of infinite extent with a uniform magnetic field orientated at right angles to the flow. The special case is considered where the flow everywhere is uniform and the disturbances are created only at the boundary between the gas and the nonconducting solid. The analysis is then extended to a flow with the magnetic field orientated at an arbitrary angle to the stream.

2543

[Royal Coll. of Science and Tech. Dept. of Mathematics] Glasgow (Scotland).

ANISENTROPIC ONE-DIMENSIONAL UNSTEADY MATNETOGASDYNAMIC FLOW, by J. B. Helliwell. [1965] [18]p. incl. refs. (AFOSR-66-0049) (AF EOAR-64-6) AD 639527 Unclassified

Also published in Jour. Math. and Mech., v. 14: 523-540, July 1965.

The investigation relates to the rectilinear adiabatic but non-isentropic flow of a perfectly conducting ideal gas with constant polytropic index moving in the presence of a transverse magnetic field. The influences of viscosity, heat conduction and radiation are all supposed negligible. As an example of such a flow one may consider the situation arising when an expansion wave overtakes and interacts with a shock wave thereby causing it to decay. The exact equations of nonisentropic magnetogasdynamic flow are discussed and alternative forms of the characteristic equations derived. It is shown that by the use of Naylor's modified stream function the general problem may again be reduced to the solution of a single quasi-linear partial differential equation which, as a generalization of the case of ordinary gasdynamics, possesses special integrals only for suitable distributions of both the entropy and magnetic field strength. Solutions analogous to Martin and Ludford's degenerate 'simple wave' forms are also discussed.

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[Royal Coll. of Science and Tech.] Dept. of Mathematics, Glasgow (Scotland).

MAGNETOGASDYNAMIC DEFLAGRATION UNDER THE THE CHAPMAN-JOUGUET CONDITION, by A. R. Gordon and J. B. Helliwell. [1965] [8]p. incl. diagrs. (AFOSR-66-0213) (AF EOAR-64-6) AD 639526 Unclassified

Also published in Jour Fluid Mech., v. 23: 779-786, 1965.

An investigation is made into the propagation of a one-dimensional combustion wave, which consists of a flame front and a precursor shock wave which pass down a tube closed at one ene, in the presence of a transverse magnetic field in the undisturbed gas at rest. The snock wave is assumed to be of sufficient strength to ionize completely the initially non-electrically-conducting gas and the conditions at the flame front are taken to satisfy the Chapman-Jouguet condition. Details of the solution are compared with the corresponding results for ordinary gasdynamic defiguration.

2545

[Royal Coll. of Science and Tech.] Dept. of Mathematics, Glasgow (Scotland).

THE STABILITY OF ATTACHED SHOCK WAVES IN MAGNETOGASDYNAMIC FLOW PAST A WEDGE, by D. C. Pack and G. W. Swan. [1965] [7]p. incl. diagrs. (AFOSR-66-0658) (AF EOAR-65-58) AD 639859 Unclassified

Also published in Jour. Inst. Matn. and its Appl., v. 1: 317-322, Dec. 1965.

The question of the physical significance of the new phenomena indicated by Cabannes' work on magnetogasdynamic flow past a wedge is considered from the point of view of the stability of the shock waves. Analytical and heuristic reasons are given suggesting that downstream-facing shocks are stable if the upstream flow is supersonic and unstable if it is subsonic, while upstream facing shocks are always to be considered unstable.

2546

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

TECHNIQUES FOR CALORIMETRIC TITRATIONS IN THE SEMI-MICRO RANGE. PART I. APPARATUS. A SENSITIVE, AUTOMATICALLY RECORDING QUASI-ISOTHERMAL CALORIMETER, by S. Johansson. [1965] [21]p. incl. diagrs. tables, refs. (AFOSR-65-1649) (AF EOAR-63-8) AD 624325 Unclassified

Also published in Arkiv Kemi, v. 24: 189-209, 1965.

An isothermal-jacket calorimeter suitable for the measurement of small heat effects is described. The apparatus is normally used for incremental calorimetric titrations in solution chemistry. The temperature measuring system consists of a conventional Wheatstone bridge with a thermistor assembly in one of the arms. The unbalance voltage is amplified and fed into a recorder which describes the temperature-time curve. The performance of the calorimeter is nearly isothermal but also nearly adiabatic for the heat effects normally encountered. The resulting temperature rise of the system is less than 0.0$\frac{1}{2}$ degrees. The normal temperature sensitivity is about $\pm 2.10^{-5}$ degrees corresponding to ± 0.02 J., which is

close to the practical limit set by the temperature inhomogeneity due to incomplete stirring in the reaction mixture. The precision as judged from the spread of data in a titration is 0.5% or better.

2547

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

STUDY ON THE HYDROLYSIS OF METAL IONS. PART 56. SOLVENT EXTRACTION STUDY OF THE HYDROLYSIS OF ZINC (II) IN 3 M $NaClO_4$ AT LOW CONCENTRATIONS by T. Sekine. [1965] [13]p. incl. tables, refs. (AFOSR-67-1307) (AF EOAR-63-8) AD 653484 Unclassified

Also published in Acta Chem. Scand., v. 19: 1526-1538, 1965.

The mononuclear hydrolysis of Zn(II) in 3 M $NaClO_4$ has been studied by a distribution method. The mono nuclear species, $Zn(OH)_2$, was extracted into a benzene phase containing 5% (by volume) of the long-chain liquid amine Amberlite LA-1. The net distribution ratio of Zn(II) could be explained by the relation $D = [Zn(II)]_{org, total}/[Zn(II)]_{aq, total} = [Zn(OH)_2L_2]_{org}/([Zn^{2+}] + [Zn(OH)_2] + [Zn(OH)_3] + [Zn(OH)_4^{2-}])$ where L denotes the amine. The hydrolysis constants and the distribution constant of the $Zn(OH)_2$ species between the organic and the aqueous phases were calculated by a generalized least squares method, using the LETAGROP VRID computer program.

2548

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

A CALORIMETRIC AND POTENTIOMETRIC STUDY OF THE SYSTEMS Cl^--Hg^{2+} AND Br^--Hg^{2+} AT 25°C IN 3M $NaClO_4$ MEDIUM, by R. Arnek. [1965] [20]p. incl. diagrs. tables, refs. (AFOSR-67-1312) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-8, Swedisn Natural Science Research Council and Swedish Technical Research Council) AD 653429 Unclassified

Also published in Arkiv for Kemi, v. 24: 531-550, 1965.

The calorimeter for enthalpy titration constructed by Schlyter (1959) has been modified: the temperature measureing device now consists of a thermistor. Resistance is measured using an amplifier as a null instrument. This method is thought to be more convenient than the "deflection method" used by Schlyter. By means of enthalpy titration the enthalpy changes ΔH in (kcal/mol) for the stepwise formation of Cl^--Hg^{2+} and Br^--Hg^{2+} complexes have been measured. From the enthalpy titrations it was also possible to obtain values for some of the equilibrium constants. A determination of all the equilibrium constants was performed independently by emf methods.

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Rutgers U Dept. of Physics, New Brunswick, N. J.

THE INTERACTION OF CHARGE CARRIERS WITH THE CRYSTAL LATTICE, by G. M. Rothberg. Final rept. [1965] 4p. (AFOSR-65-1562) (AF 49(638) 1018) AD 621218 Unclassified

This report presents a survey of research conducted on (1) electron-phonon interactions through the use of thermoelectric power; (2) determination of the thermal conductivity of one gas relative to another; and (3) measurement of the effect of pressure on tunneling in superconducting films to see if films and electrical contacts could be made to stand up under high pressures and low temperatures. The thermoelectric power (TEP) of germanium was measured from 100 K to 300 K and at pressures from vacuum to 2000 atm. It is shown theoretically that energy change in the lattice-electron system should contribute to the TEP, and it has also been found that the fractional change in the TEP of n-type germanium produced by 2000 atm pressure is a few tenths of a percent; the change of p-type is less.

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Rutgers U. Dept. of Physics, New Brunswick, N. J.

THERMOELECTRIC POWER OF GERMANIUM. EFFECT OF TEMPERATURE-DEPENDENT ENERGY LEVELS, by P. J. Freud and G. M. Rothberg. [1965] [8]p. incl. illus. diagrs. table, refs. [AF 49(638 1018] Unclassified

Published in Phys. Rev., v. 140: A1007-A1014, Nov. 1, 1965.

A statistical-mechanical treatment of the thermoelectric power of semiconductors is given which includes the interaction energy of the electron-lattice coupling. This interaction modifies the thermodynamic functions of the system and contributes to the electron-diffusion part of the thermoelectric power. The usual expression for the diffusion part of the thermoelectric power is modified by the inclusion of 2 constant terms b and d, the respective extra entropies per electron and hole. New measurements have been made of the thermoelectric power of high-purity n- and p-type germanium from 90°K to 250°K. The essential feature of these measurements is that the potential leads were in regions of well determined temperature and negligible temperature gradient. Although it is difficult to separate the phonon-drag and electron-diffusion parts, it is estimated that $b=40\pm15\mu V/°K$, $d=40\pm15\mu V/°K$. The sum (b+d) should equal the derivative of the energy gap with respect to temperature at constant volume, but our result is more than a factor of four smaller than the value obtained by others from the temperature dependence of the energy gap. It is believed that this discrepancy is due to a remaining deficiency in the theory of ther thermoelectric power. (Contractor's abstract)

2551

Rutgers U., Dept. of Physics, New Brunswick, N. J.

A NEW DETERMINATION OF POTENTIAL PARAMETERS AND SOME VIBRATIONAL PROPERTIES OF SOLID NEON AND XENON, by J. S. Brown. [1965] [4]p. incl tables. (AFOSR-65-0795) (AF AFOSR-62-167) AD 616212 Unclassified

Also published in Proc. Phys. Soc. (London), v. 85: 394-397, 1965.

The intermolecular potential parameters of solid Ne and Xe for a Lennard-Jones m-6 potential are calculated using recent experimental lattice spacing determinations. Values of ϵ, σ, and the de Boer parameter A are tabulated for values of m = 10, 11, 12, 13, and 14 and for 1N, 2N, and AN interactions. Recalculated quasi-harmonic values of Θ_0, O_{-}, and γ_0 are also included. The effect of the strain dependence of the zero-point energy is calculated according to the method of Varron and Klein, and is found to be small.

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Rutgers U. Dept. of Physics, New Brunswick, N. J.

CRITICAL ANALYSIS OF THE THERMODYNAMIC DATA FOR Pt AND A PREDICTION OF $\Theta_{DW}(T)$, by J. L. Feldman and G. K. Horton. [1965] [3]p. incl. diagrs. refs. (AFOSR-65-0796) [AF AFOSR-62-167] AD 616213 Unclassified

Also published in Phys. Rev., v. 137: A1106-A1108, Feb. 15, 1965.

The purpose of this paper is a critical examination of the available measurements of the specific heat, thermal expansion, and compressibility of platinum to see whether reliable predictions can be made for the Debye-Waller factor. A calorimetric equivalent Debye temperature curve is constructed, and in using its values to predict those of $\Theta_{DW}(T)$, the Debye characteristic temperature of the Debye-Waller factor, a Barron plot is constructed as well. The latter value vs temperature curve is plotted by using a Padé approximant to link the high-and low-temperature expansion. The results are compared with an experiment in a preceding paper by Harris, Benczer-Koller, and Rotaberg (Phys. Rev., v. 137: A1101, 1965)

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Rutgers U. Dept. of Physics, New Brunswick, N. J.

CALCULATION OF O_0^c DIFFERENCES FOR THE FACE-CENTRED CUBIC AND CLOSE-PACKED HEXAGONAL LATTICES IN THE IDEAL INERT GAS SOLIDS, by C. Feldman. [1965] [7]p. incl. tables, refs. (AFOSR-66--666) (AF AFOSR-62-167) AD 640185 Unclassified

Also published in Proc. Phys. Soc. (London), v. 86: 865-871, 1965.

O_0^c(cpn) and the ratio K $100[\Theta_0^c(cph) - \Theta_0^c(fcc)]$ / Θ_0^c(fcc) for the ideal inert gas solids was calculated, using the quasi-harmonic approximation and an (m-6) Lennard-Jones all-neighbor force model; K was found to be about $2\frac{7}{7}$. The neglect of explicit anharmonic contributions to K is discussed. A table of the relevant all-neignbor sums is given. It was found that the use of the ideal axial ratio $\gamma_I = \sqrt{(8/3)}$ to characterize the close-packed hexagonal lattice limits the accuracy to which K can be calculated to about one decimal place, and Θ_0^c(cpn) to about 2 decimal places. (Contractor's abstract)

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Rutgers U. [Dept. of Physics] New Brunswick, N. J.

ANHARMONIC TREATMENT OF SPECIFIC HEAT (Abstract), by J. L. Feldman, G. K. Horton, and J. B. Lurie. [1965] [1]p. [AF AFOSR-62-167] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 434, Apr. 26, 1965.

This paper develops an approximate method of calculating anharmonic corrections to the calorimetric properties of solids from known values of the corresponding harmonic quantities. It is assumed that anharmonic effects may be represented by simple temperature- and frequency-dependent shifts, first used by Barron and Overton, in the frequencies appearing in the free energy or the entropy. Numerical results for S^{ah} and $C_v^a - C_v^h$, based on published harmonic calculations, are given for several substances. It is found that $S^a - S^h$ begins to depart from a linear T dependence at $T/\Theta 0.3$. A discussion of how the results may be used as a refinement of Tosi and Fumi's method for analyzing experimental calorimetric data is given. Using this approach, it is demonstrated that the oscillations in $C_v^a - C_v^h$ found in calculations recently reported by Overton for a special model of copper do not occur. Finally, criteria for the existence of oscillations in $C_v^a - C_v^h$ are obtained by studying simplified spectra.

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Rutgers U. Dept. of Physics, New Brunswick, N. J.

A ONE-PARAMETER TREATMENT OF ANHARMONIC SPECIFIC HEAT, by J. L. Feldman, G. K. Horton, and J. B. Lurie. [1965] [10]p. incl. diagrs. refs. [AF AFOSR-62-167] Unclassified

Published in Jour. Phys. and Chem. Solids, v. 26: 1507-1516, Sept. 1965.

This paper develops an approximate method of calculating anharmonic corrections to the calorimetric properties solids from known values of the corresponding harmonic quantities. It is assumed that anharmonic effects may be represented by simple temperature and frequency dependent shifts, first

used by Barron and Overton, in the frequencies appearing in the free energy of the entropy. Numerical results for $S^a - S^h$ and $C_v^a - C_v^h$, based on published harmonic calculations, are given for several substances. It is found that $S^a - S^h$ begins to depart from a linear T dependence at $T \approx 0.3$. A discussion is given of how the results may be used as a refinement of Tosi and Fumi's method for analyzing experimental calorimetric data. Using this approach, it is demonstrated that the oscillations in $C^a - C^h$, found in calculations recently reported by Overton for special model of Cu, do not occur. Finally, criteria for the existence of oscillations in $C_v^a - C^h$ are obtained by studying simplified spectra. (Contractor's abstract)

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Rutgers U. Dept. of Physics, New Brunswick, N. J.

EFFECT OF CRYSTAL ANISOTROPY ON THE THERMAL CONDUCTIVITY OF COPPER ALLOYS, by C. Feldman. [1965] [2]p. (AFOSR-65-2548) (AF AFOSR-65-726) AD 629069 Unclassified

Also published in Phys. Rev., v. 139, A211-A212, July 5, 1965.

The lattice thermal conductivity of copper alloys has been studied, taking account of the anistropy of the crystal by using a modified Debye distribution having angular dependence. This is equivalent to replacing the elastic velocities (V_i) that occur in the usual Debye distribution by $V_i(\theta, \phi)$ and multiplying by $d\Omega/4\pi$. Lindenfeld and Pennebaker assumed an isotropic crystal and so used the usual Debye distribution in their calculation of the conductivity. Using the expressions for K_T and K_L (the contributions to the conductivity from the transverse and longitudinal modes) employed by Lindenfeld and Pennebaker and the elastic velocities found from elastic-constant data, the angular integration for the anisotropic average of the total conductivity was performed by using the Houston's average over the principal crystalline directions. For $T/\rho_0 \cdot 10^6$ (ρ_0 is the residual resistivity), the curves of the (conductivity)/$T_{\rho 0}$ against T/ρ_0 are nearly linear, and in this region the largest departure between theory and experiment occurs. These calculations give a slope which is approximately 5% lower than the Lindenfeld-Pennebaker theoretical result, while their result gave a slope which was about 650% higher than the experimental one. This indicates that the departure of the calculated conductivity from their experimental results cannot, at least for copper be accounted for by anisotropy. (Contractor's abstract)

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Rutgers U. Dept. of Physics, New Brunswick, N. J.

A DETERMINATION OF THE INTERMOLECULAR POTENTIAL PARAMETERS OF THE INERT GAS SOLIDS FOR THE MODIFIED BUCKINGHAM EXP-6 POTENTIAL, by J. S. Brown. [1965] [5]p. incl. tables. (AFOSR-66-1375) (AF AFOSR-65-726) AD 641103 Unclassified

Also published in Canad. Jour. Phys., v. 43, 1831-1835, Oct. 1965.

The intermolecular potential parameters of solid Ne, Ar, Kr, and Xe are calculated for a modified Buckingham exp-6 potential using crystal data of the sublimation energy and lattice spacing extrapolated to 0 K. The parameters ϵ and σ in the exp-6 potential

$\phi(r) = 6\epsilon/(n-6)\,[(1/n)\exp[n(1-r/\sigma)] - (1/6)(\sigma/r)^6]$

are compared for selected AN ("all neighbor") models with those calculated by Mason and Rice (1954) from gaseous data.

2558

St. Louis U. Dept. of Geophysics and Geophysical Engineering, Mo.

THE S WAVE PROJECT FOR FOCAL MECHANISM STUDIES EARTHQUAKES OF 1963, by W. Stauder and G. A. Bollinger. July 31, 1965, 91p. incl. diagrs. tables. (AFOSR-65-2319) (AF AFOSR-62-458) AD 472354 Unclassified

This is the second report of the S wave project, a routine program instituted for the determination of the focal mechanism of the larger earthquakes of each year using methods developed for the use of S waves in focal mechanism studies. In addition to the methods of data analysis described in detail in the previous report for earthquakes of 1962, in studying the earthquakes of 1963 use has also been made of a computer program. The program uses an error surface to search for the position of the axes of a double couple which gives the least standard deviation of the S wave polarization data. Seventy-two earthquakes of magnitude more than 6 1 4 occurred during 1963. Of these thirty-five earthquakes, so located as to afford a distribution of seismographic stations favorable for the use of S wave data, were selected for examination. Satisfactory focal mechanism solutions are here presented for twenty-six of these shocks. Tentative solutions are given for six, and no solution is advanced for the remaining three. (Contractor's abstract)

2559

San Andres U. Laboratório de Física Cosmica de Chacaltaya, La Paz (Bolivia).

SCIENTIFIC CONTRIBUTIONS OF SPACE PHYSICS GROUP. 1965 [96]p. incl. diagrs. tables, refs. (AFOSR-66-0834) [AF AFOSR-64-319] AD 637479 Unclassified

This report is a composite of three individual reports entitled: Solar daily variation recorded at a low latitude station by east and west pointing telescopes during a period of maximum and minimum in solar activity, Characteristic effects of the deformed magnetic field of the earth of medium energy cosmic rays, and A case of transient anisotropy during the recovery phase of a Forbush decrease.

2560

San Andres U. Laboratório de Física Cósmica de Chacaltaya, La Paz (Bolivia).

A CASE OF TRANSIENT ANISOTROPY DURING THE RECOVERY PHASE OF A FORBUSH DECREASE, by H. S. Ahluwalia. 1965 [ ]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-319 and National Aeronautics and Space Administration) Unclassified

Presented at Ninth Internat'l. Conf. on Cosmic Rays, London (Gt. Brit.), Sept. 6-17, 1965.

Published in Scientific Contributions of Space Physics Group, La Paz (Bolivia), Laboratório de Física Cósmica de Chacaltaya, 1965, p. 32-59.

On July 18, 1959 a short-lived highly anisotropic cosmic ray increase was observed by some of the I.G.Y. network of recording stations during recovery from the third of the series of three closely spaced Forbush decreases. Characteristic features and the solar and terrestrial relationships of this increase are studied. Mechanisms proposed thus far for this increase are critically examined. Arguments are presented to the effect that this could not be a solar flare-type increase. It is suggested that this increase was probably produced by galactic cosmic rays which got reflected from receding blast wave and co-rotating shock wave formed during the explosive heating of solar corona following the west limb 3+ solar flare of July 16, 1959. The corresponding features of associated heliophysical, geophysical and cosmic ray phenomena were studied and thereby derived the velocity of the blast wave to be 1700 Km/s and its total thickness to be about 0.14 A. U. Also there is belief that this blast wave had considerable fine structure built into it. There is some evidence that this blast wave probably started to dissolve into background solar wind at a distance of about 1.5 A.U. from sun. (Contractor's abstract)

2561

San Andres U. Laboratório de Física Cósmica de Chacaltaya, La Paz (Bolivia).

CHARACTERISTIC EFFECTS OF THE DEFORMED MAGNETIC FIELD OF THE EARTH ON MEDIUM ENERGY COSMIC RAYS, by H. S. Ahluwalia and K. G. McCracken. 1965 [38]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-319 and National Aeronautics and Space Administration) Unclassified

Presented at Sixth Internat'l. Space Science Symposium, Mar del Plata (Argentina), May 11-19, 1965.

Published in Scientific Contributions of Space Physics Group, La Paz (Bolivia), Laboratório de Física Cosmica de Chacaltaya, 1965, p. 10-31.

A study is presented of the characteristic effects of the deformed magnetic field on the trajectories and asymptotic directions of arrival of medium energy cosmic rays at three representative stations: Chacaltaya, Deep River and London. For this purpose use has been made of the spherical harmonic description of the deformed magnetic field given by Mead (1964) and this has been superposed on Stormer Dipole and Finch and Leaton higher degree simulation field configurations. It is found that asymptotic directions of arrival for deformed fields are considerably different from those for undisturbed fields at lower rigidities and the mean deviation at each station is larger for night than for day hemisphere. There is also evidence of a strong modulation of penumbral bands by the deformed field. There is an indication that small semi-diurnal component, at equatorial stations, results from the deformation of the terrestrial field. The resulting

component is however, an order of magnitude smaller than that observed on many occasions at low latitude stations. (Contractor's abstract)

2562

San Andres U. Laboratório de Física Cósmica de Chacaltaya, La Paz (Bolivia).

SOLAR DAILY VARIATION RECORDED AT LOW LATITUDE STATION BY EAST AND WEST POINTING TELESCOPES DURING A PERIOD OF MAXIMUM AND MINIMUM IN SOLAR ACTIVITY, by H. S. Ahluwalia, V. I. Escobar and others. 1965 [11]p. incl. diagr. table. (AF AFOSR-64-319) Unclassified

Presented at Ninth Internat'l. Conf. on Cosmic Rays, London (Gt. Brit.) Sept. 6-17, 1965.

Published in Scientific Contributions of Space Physics Group, La Paz (Bolivia), Laboratorio de Física Cósmica de Chacaltaya, 1965, p. 1-9.

This report examines the characteristics of solar daily variation recorded by east and west pointing directional telescopes at Mt. Chacaltaya during the years of maximum (1958) and minimum (1964) in solar activity in the last solar cycle. It is found that the amplitude of the diurnal component, both in the east as well as in west directions, is reduced in 1964 compared to its value in 1958. The time of maximum of the diurnal component in the two directions has, however, the same value in the two years within errors of observations. The results of diurnal component are compared with those obtained with neutron monitors, at other equatorial mountain level stations of Huancayo and Mt. Norikura for the same period as well as with the parameters defining the diurnal component of solar daily variation is of 22 yr rather than of 11 yr. (Contractor's abstract)

2563

Sao Paulo U. [Dept. of Physics] (Brazil).

THE E_p = 2.66 MEV RESONANCE IN $O^{16}(p,p)O^{16}$, by V. Gomes, R. A. Douglas and others. [1965] [9]p. incl. diagrs. table. (AFOSR-65-2695) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-310 and National Science Foundation) AD 628698 Unclassified

Also published in Nuclear Phys., v. 68, 417-425, June 1965.

The absolute differential cross section has been measured over the E_p = 2.66 mev resonance [$E_x(F^{17})$ = 3.10 mev] in $O^{16}(p,p)O^{16}$ at the following angles in the center-of-mass system: 54.5°, 70.5°, 90.0°, 107.0°, 125.5° 140.5° and 151.3°. Also angular distributions (15 angles from $\theta_{c.m.}$ = 30.5° to 155.6°) were measured at the following energies, 1.473, 1.931, 2.481, 2.660, 2.668 and 2.978 mev. A partial wave analysis of the results was performed. The first analysis used only cross section data as the input to the computer programme. The results fail to predict the observed off resonance polarizations. A second analysis using both cross section and polarization data for the input gives a satisfactory fit to all experimental data. The parameters which give the best fit to the data are Γ = 20 ± 1 kev (lab), E_r = 2.663 ± 0.007 mev, J^π = 1/2-. (Contractor's abstract)

2564

Sao Paulo U. [Dept. of Physics] (Brazil).

ABSOLUTE CROSS SECTION MEASUREMENTS FOR THE REACTIONS $Ne^{20}(d,n)Na^{21}$ g.s. and $Ne^{20}(d,n)Na^{21}$ (0.34 MEV), by E. F. Pessoa, R. L. Dangle and others. [1965] [15]p. incl. diagrs. refs. (AFOSR-66-0445) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-310] and National Science Foundation) AD 630520 Unclassified

Also published in Nuclear Phys., v. 68, 337-351, June 1965.

Absolute cross sections for the reactions $Ne^{20}(d,n)Na^{21}$ g.s. and $Ne^{20}(d,n)Na^{21}$ (0.34 mev) have been measured in the range of incident particle energies from 1.3 to 2.3 mev. A phenomenological analysis has been applied to the total cross section for the $Ne^{20}(d,n)Na^{21}$(0.34 mev) reaction to separate the direct interaction contribution from the resonant state formation. The direct interaction contribution turns out to be very small indicating that the predominant reaction mechanism is a resonant type process.

2565

Sao Paulo U. School of Medicine, Dept. of Physiology (Brazil).

SPECIFIC CHANGES IN WATER INTAKE AND ADIPSIA FOR WATER AND SODIUM CHLORIDE AFTER HYPOTHALAMIC LESIONS, by J. Antunes Rodrigues and M. R. Covián. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-0988) (AF AFOSR-63-311) AD 635442 Unclassified

Also published in Acta Physiol. Latinoamer., v. 15, 251-259, 1965.

The effect of bilateral hypothalamic lesions on water and 2% NaCl intake was studied in 29 adult male rats using the self-selection method. Electrolytic bilateral lesions placed in the median hypothalamus reaching the anterior part of the posterior hypothalamus, laterally to the ventral medial nuclei, ventral to the fornix and partially destroying them resulted in a specific decrease in water intake. When lesions involved the median hypothalamus destroying its medial and lateral parts including the ventro-medial and lateral parts including the ventro-medial and dorsomedial nuclei and the fornix, the rats developed diabetes insipidus, sodium chloride ingestion was not increased. Lesions in the lateral hypothalamus in the frontal plane of the

ventro-medial nuclei and lateral to the fornix resulted in adipsia for both fluids and aphagia. Taking into account previous findings, the role of the hypothalamus in the regulation of hydro-mineral metabolism is discussed. (Contractor's abstract)

2566

Sao Paulo U. School of Medicine, Dept. of Physiology (Brazil).

ELECTROPHYSIOLOGICAL STUDY OF KANAMYCIN AND AMINOSIDINE OTOTOXICITY IN THE UNANESTHETIZED GUINEA PIG, by R. F. Marseillan. [1965] [8]p. incl. illus. diagrs. refs. (AFOSR-66-0990) (AF AFOSR-63-311) AD 634556 Unclassified

Also published in Acta Physiol. Latinoamer., v. 15: 300-307, 1965.

The chronic auditory ototoxicity of 2 oligosaccharide antibiotics was studied in guinea pigs with round window implanted electrodes. In the awake guinea pig auditory muscle activity is low and its effect on middle ear sound transmission negligible over 1 kc. Thus, the microphonic potentials have a very good stability making muscle section or recording under anesthesia unnecessary. Complete suppression of microphonic potentials was obtained after 15-21 days of kanamycin sulfate given in 400 mg/kg day. With 200 mg/kg day the maximum depression of the potentials was reached with a similar total quantity of drug, but a small response remained. The progression of the ototoxicity produced by aminosidine sulfate was more rapid and the general toxicity higher. The changes in the VIII nerve action potentials induced by the drugs were more irregular than those of the microphonics. (Contractor's abstract)

2567

Sao Paulo U. School of Medicine. Dept. of Physiology (Brazil).

[PHYSIOPATHOGENESIS OF PAIN] Fisiopatogenese da Dor, by M. R. Covian. [1965] [22]p. incl. illus. diagrs. refs. (AFOSR-66-0995) [AF AFOSR-63-311] AD 635441 Unclassified

Also published in Arquivos Neuro-Psiquiatria, v. 23: 143-164, Sept. 1965.

The study of the physiology of pain includes the study of the receptors, the stimuli, the pathways, the structures of the central nervous system, the perception of pain and the motor and automic reaction. The receptors and the pathways of pain, as well as their specificity, are analyzed. The transmission of the quick and slow pain through different nervous paths until the cerebral cortex is discussed. The influence of attention on the degree of the perception of pain is commented. Based on experimental researches, the reticulo-cortico-reticular circuit is considered as indispensable for the perception of pain. Regarding the pathology of pain, the congenital analgesia is analyzed, the author accepting the hypothesis that in some synapses the pattern of impulses which give rise to the sensation of pain is changed. Emphasis is given to the role played by the frontal lobe as part of a potentiating mechanism which conditions the general distress of the patient. Referred pain is explained by the theory of "convergence-projection" of visceral fibers and cutaneous fibers for pain on the same neuron in some point of the sensory path. The relief or ceasing of pain brought about by hypophysectomy in cases of breast cancer gives rise to discussions on the role played by the hormones on the perception of pain. (Contractor's abstract)

2568

Serendipity Associates, Los Angeles, Calif.

WIT, CREATIVITY, AND SARCASM, by E. E. Smith and H. L. White. [1965] [4]p. incl. refs. (AFOSR-65-1583) (AF 49(638)1216) AD 623294 Unclassified

Also published in Jour. Appl. Psychol., v. 49: 131-134, Apr. 1965.

A study was conducted using 156 airmen to test the hypotheses that wit and creativity are positively correlated; that defensiveness and creativity are negatively correlated, and that wits are effective leaders. The effects of sarcastic versus nonsarcastic wit were explored. The first 2 hypotheses were supported. Wits were not found to be effective leaders but were associated with less defensiveness and more effective group problem-solving. Most of the positive relationships with wit were found, more specifically, to be associated with sarcastic wit. (Contractor's abstract)

2569

Sheffield U. Dept. of Biochemistry (Gt. Brit.).

MICROBIAL GROWTH ON C_1 COMPOUNDS. SYNTHESIS OF CELL CONSTITUENTS BY METHANE- AND METHANOL-GROWN PSEUDOMONAS METHANICA, by P. A. Johnson and J. R. Quayle. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-2973) (Sponsored jointly by Air Force Office of Scientific Research under [AF EOAR-64-8], Public Health Service, and Rockefeller Foundation) AD 628391 Unclassified

Also published in Biochem. Jour., v. 95: 859-867, June 1965.

A study has been made of the incorporation of carbon from [^{14}C]methane, [^{14}C]methanol and [^{14}C]bicarbonate by cultures of Pseudomonas methanica growing on methane, and [^{14}C]methanol by cultures of the same organism growing on methanol. Over 90% of the radioactivity fixed from [^{14}C]methane or [^{14}C]methanol at the earliest times of sampling appeared in phosphorylated compounds. Glucose phosphate and fructose phosphate together constituted the largest part of the radioactive phosphates (70-90%). The first stable products of [^{14}C]bicarbonate fixation were malate and aspartate. The percentage of the total radioactivity fixed that was contained in each of the radioactive compounds has been plotted against time. The slopes of the curves obtained

show that hexose phosphates are primary stable products of [^{14}C]methane and [^{14}C]methanol incorporation and that aspartate and malate are primary stable products of [^{14}C]bicarbonate incorporation. No carboxydismutase activity has been found in cell-free extracts of the organism. This fact, together with the other findings, shows that an autotrophic metabolism involving the ribulose diphosphate cycle of carbon dioxide fixation cannot be operating. (Contractor's abstract)

2570

Sheffield U., Dept. of Biochemistry (Gt. Brit.).

INCORPORATION OF C_1 UNITS INTO ALLULOSE PHOSPHATE BY METHANE-GROWN PSEUDOMONAS METHANICA, by M. B. Kemp and J. R. Quayle. [1965] [3]p. incl. diagrs. table. (AFOSR-66-1882) (AF EOAR-64-8) AD 643915 Unclassified

Also published in Biochim. et Biophys. Acta, v. 107: 174-176, 1965.

Studies of the incorporation of [^{14}C]methane and [^{14}C] methanol into Pseudomonas methanica growing on methane, or [^{14}C]methanol into the same organism growing on methanol, have shown that over 90% of the radioactivity fixed at the earliest times of sampling appears in phosphorylated compounds. Glucose phosphate and fructose phosphate together constitute the largest part of the radioactive phosphates (70-90%); phosphoglycerate is a relatively minor component (2 - 17%). These results suggest that a direct incorporation of C_1 units into hexose phosphate occurs in P. methanica during growth on methane or methanol. This communication presents evidence that cell-free extracts of methane-grown P. methanica can catalyze the condensation of formaldehyde with ribose 5-phosphate to form allulose (psicose) phosphate.

2571

Sheffield U. Dept. of Fuel Tech., and Chemical Engineering (Gt. Brit.).

INTENTIONAL COMBUSTION OSCILLATIONS IN PROPULSION SYSTEMS, by D. Harris and J. Swithenbank. Final rept. Jan. 25, 1965 [21]p. incl. illus., diagrs. (Rept., no. H. I. C.-54) (AFOSR-65-1804) (AF EOAR-63-101) AD 625499 Unclassified

A review is presented of a study on the possible uses of combustion oscillations in a rocket combustion chamber. One such use is the extraction of magnetohydrodynamic electrical power. When the amplitude of oscillation is 50% or better, the mean conductivity is in theory increased by one and a half times. To test this analysis, experimental apparatus was constructed comprising a gaseous rocket motor where the air is introduced tangentially and the fuel is introduced either tangentially or longitudinally. Combustion oscillations have been produced during tangential entries of fuel but no experimental results have been obtained.

2572

Sheffield U., Dept. of Fuel Tech. and Chemical Engineering (Gt. Brit.).

METHODS OF ELECTROMAGNETIC INDUCTION APPLIED TO THE MEASUREMENT OF SUPERSONIC VELOCITIES IN SHOCK TUNNELS, by R. J. Parsons and M. A. Patrick. Feb. 1965 [9]p. incl. illus. diagrs. (Rept. no. H. I. C.-56) (AFOSR-65-1327) (AF EOAR-65-23) AD 622665 Unclassified

A technique based on electromagnetic induction is proposed to measure the velocity of the flow in a hypersonic shock tunnel. The expanded flow in the tunnel test section has a sufficiently high conductivity level to allow the generation of an MHD voltage in the presence of a magnetic field, which can then be used to indicate the flow velocity. To overcome charge effects on the electrodes, the magnetohydrodynamic voltage from such a device should be of the order of 100 v. For a true open circuit reading and input impedence of the external circuit should be very high. (Contractor's abstract, modified)

2573

Sheffield U. Dept. of Fuel Tech. and Chemical Engineering (Gt. Brit.).

AN INVESTIGATION OF SUPERSONIC COMBUSTION AND HETEROGENEOUS TURBULENT JET MIXING RELATED TO THE DESIGN/OPERATION OF SCRAMJETS, by I. T. Osgerby. Doctoral thesis Oct. 1965, [220]p. incl. illus. diagrs. tables, refs. (AFOSR-66-1855) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-23 and Ministry of Aviation) AD 638695 Unclassified

Chemical kinetic calculations of the combustion time in a constant area scramjet combustion (M_o 7) indicate reaction times 10^{-5} secs, and show that the combustion process is usually controlled by diffusion. The mixing process in concentric fuel/air jets is investigated by means of integral forms of the equations of motion and slow mixing requires about 50 diam. Initial contraction of the slow inner jet is predicted by the theory, and verified by experiment. The simulation of scramjet combustion conditions by a shock tunnel is considered feasible.

2574

Sheffield U. Dept. of Fuel Tech., and Chemical Engineering (Gt. Brit.).

REALLY HIGH SPEED PROPULSION BY SCRAMJETS, by E. T. Curran and J. Swithenbank. Oct. 1965. [32]p. incl. illus. refs. (Rept. no. H. I. C.-67) (AFOSR-66-1861) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-65-23 and Ministry of Aviation) AD 638520 Unclassified

The high overall efficiency of the scramjet engine is potentially maintained over the speed range from Mach 5 to 20. At higher speeds, Hydrogen fuel is essential

and a fixed geometry appears feasible. Optimization of the intake diffusion can be carried out most easily in terms of the intake process efficiency and velocity ratio. The optimum amount of diffusion is reduced when realistic nozzle losses are included. The development of a hypersonic flight test vehicle is recommended.

2575

Sheffield U., [Dept. of Physics] (Gt. Brit.).

THE MAGNETIC SUSCEPTIBILITY OF THE GADOLINIUM -LUTETIUM ALLOY SYSTEM, by J. Popplewell, A. M. Harris, and R. S. Tebble. [1965] [3]p. incl. diagrs. table. (AFOSR-65-0741) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-54 and Ministry of Aviation) AD 615070 Unclassified

Also published in Proc. Phys. Soc. (London), v. 85: 347-349, 1965.

The magnetic susceptibility χ has been measured for alloys containing 90.2%, 80.6%, 69.4%, 57.2%, 47.6%, 34.6%, 20.2%, 15% and 8.3% gadolinium in lutetium. These measurements have enabled the Curie temperature and magnetic moment P_{eff} of the alloys to be determined. Only the 20.2% Gd alloy shows any departure from the Curie-Weiss behavior, and this is attributed to the onset of antiferromagnetic ordering. (Contractor's abstract)

2576

Sheffield U Dept. of Physics (Gt. Brit.).

SOME ELECTRON SPIN RESONANCE OBSERVATIONS OF GADOLINIUM S STATE IONS IN METALS, by A M. Harris J. Popplewell, and R. S. Tebble. [1965] [10]p. incl. diagrs tables, refs. (AFOSR-65-1381) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-62-54 and Ministry of Aviation) AD 621348 Unclassified

Also published in Proc. Phys. Soc. (London), v. 85: 513-522, 1965.

Measurements of the paramagnetic g factors are made, using electron spin resonance at 8 mm wavelength, in solid solutions of gadolinium in yttrium, palladium and lutetium at temperatures between 60°K and 400°K. The measurements show that the g factor for the trivalent gadolinium ion in the metallic lattice varies significantly from the free ion value and is concentration dependent. For alloys containing more than 30% Gd in the Gd-Y alloy system, 80% Gd in the Gd-Lu alloy system, and for all concentrations in the Gd-Pd alloy system, the g factors are less than the free ion value. Lower concentrations of Gd in the Gd-Y and Gd-Lu alloy systems have g factors greater than the free ion value of 1.99. A qualitative attempt is made to explain this variation, using a model proposed by Kondo in which 2 interactions are considered. (Contractor's abstract)

2577

Sheffield U. Dept. of Physics (Gt. Brit.).

PARAMAGNETIC RESONANCE OF GADOLINIUM S - STATE IONS IN RARE EARTH METALS, by A. M. Harris and R. S. Tebble. Final rept. June 30, 1965. [52]p. incl. diagrs. table, refs. (AFOSR-65-1597) (AF EOAR-62-54) AD 623816 Unclassified

Electron spin resonance and magnetic susceptibility measurements were made on a series of gadolinium alloys, in the temperature ranges where ferromagnetism, antiferromagnetism, and paramagnetism occur. G factors for the alloys were estimated in the paramagnetic region at high temperatures. The concentration dependence of the g factor of Gd dissolved in several rare earth metals was determined The results cannot be explained on a simple indirect exchange Yosida model, and covalent mechanisms as suggested by Kondo appear to play an important role. (Contractor's abstract, modified)

2578

Siena U., Inst. of Medical Pathology (Italy).

MICROELECTRODE RECORDING OF SLOW WAVE AND UNIT RESPONSES TO AFFERENT STIMULI IN THE HYPOTHALAMUS OF THE CAT, by P. Rudomin, A. Malliani, and A. Zanchetti. [1965] [29]p. incl. illus. diagrs. refs. (AFOSR-65-1789) (Sponsored jointly by Aeronautical Systems Division, Air Force Office of Scientific Research under AF 61(052)253, and Consiglio Nazionale delle Ricerche) AD 626259 Unclassified

Also published in Arch. Ital. Biol., v. 103: 90-118, 1965.

Recording with 1-5 μ tungsten microelectrodes from different portions of the diencephalon was performed with the aim of correlating unit and wave responses to afferent stimuli, in order to validate the local origin of sensory evoked potentials in these parts of the brain. In unanesthetized immobilized cats evoked responses to single radial stimuli, to clicks and to light flashes could be recorded in all diencephalic regions explored. Rather long latencies were observed for purely negative potentials in the anterior and preoptic hypothalamus, and in the midline and intralaminar thalamus, while shorter latencies, sometimes less than 10 msec, were found for a short positive deflection with which most of posterior and lateral hypothalamic responses were initiated From the results obtained no conclusive evidence either pro or con the local origin of evoked waves in the anterior and preoptic hypothalamus could be obtained by micro electrode recordings, because of difficulties in isolating single unit discharges in these regions. (Contractor's abstract)

2579

Siena U., Inst. of Medical Pathology (Italy).

DISTRIBUTION OF ELECTRICAL RESPONSES TO SOMATIC STIMULI IN THE DIENCEPHALON OF THE

CAT, WITH SPECIAL REFERENCE TO THE HYPOTHALAMUS, by P. Rudomin, A. Malliani and others. [1965] [30]p. incl. illus. diagrs. refs. (AFOSR-65-1790) (Sponsored jointly by Aeronautical Systems Division, Air Force Office of Scientific Research under AF 61(052) 253, and Consiglio Nazionale delle Ricerche) AD 626245
Unclassified

Also published in Arch. Ital. Biol., v. 103: 60-89, 1965.

The basal diencephalon of intact immobilized cats under local anesthesia was systematically explored with stereotactically oriented electrodes, and the distribution of potentials evoked by single stimuli to somatic nerves was examined by alternatively employing a monopolar and bipolar leading arrangement. With the monopolar type of recording, almost the whole hypothalamus appeared responsive to somatic stimuli, and potentials picked up from adjacent structures were rather similar in shape, polarity and amplitude. Recordings with close coaxial bipolar electrodes gave a quite different, much more selective picture, some portions of the ventral diencephalon (lateral hypothalamus, subthalamus, etc.) being highly responsive to somatic stimuli, while other regions (preoptic and anterior hypothalamus, medial portions of the tuberal hypothalamus) did not show any consistent response. It is suggested that somatically evoked potentials in rostral parts of the hypothalamus, where responses are only detected monopolarly without evidence of local potential gradients in bipolar leads, are likely to represent activity originating at some distance and conveyed to the exploring electrode by electric spread. An alternative explanation is also discussed. (Contractor's abstract)

2580

Siena U. Inst. of Medical Pathology (Italy).

CONTRIBUTION OF LOCAL ACTIVITY AND ELECTRIC SPREAD TO SOMATICALLY EVOKED POTENTIALS IN DIFFERENT AREAS OF THE HYPOTHALAMUS, by A. Malliani, P. Rudomin, and A. Zanchetti. [1965] [17]p. incl. illus. diagrs. refs. (AFOSR-65-2241) (Sponsored jointly by Aeronautical Systems Division, Air Force Office of Scientific Research under AF 61(052) 253, and Consiglio Nazionale delle Ricerche) AD 629280
Unclassified

Also published in Arch. Ital. Biol., v. 103: 119-135, 1965.

The contribution of local activity and electric spread to somatically evoked potentials in different areas of the hypothalamus has been assessed by observing whether potentials monopolarly and bipolarly recorded therefrom were influenced by local lesions around the tip of the electrode, according to what could be expected for either local or remote activity in line with the volume conductor theory. Whenever the recording probe, either a macro- or a micro-electrode was in lateral and posterior regions of the hypothalamus and in the subthalamus, local lesions changed all monopolarly recorded responses into purely positive deflections, irrespective of the fact that, before the lesion, the evoked potentials were purely negative or positive-negative in configuration. The responses led bipolarly between the tips of a coaxial probe were completely abolished whenever the lesion involved both leads to the probe. When the recording electrode, either a macro- or a microelectrode, was in the anterior hypothalamus and in the preoptic region, even a large local lesion could never change polarity, shape or amplitude of the evoked potential. Careful control experiments showed that local electrolysis did not change recording conditions.

2581

Siena U. Inst. of Medical Pathology (Italy).

PRESSOCEPTIVE AND CHEMOCEPTIVE AORTIC REFLEXES IN DECORTICATE AND IN DECEREBRATE CATS, by G. Baccelli, M. Guazzi and others. [1965] [7]p. incl. diagrs. refs. (AFOSR-65-2242) (Sponsored jointly by Aeronautical Systems Division, Air Force Office of Scientific Research under AF 61(052)253, and Consiglio Nazionale delle Ricerche) AD 624832
Unclassified

Also published in Amer. Jour. Physiol., v. 208: 708-714, Apr. 1965.

Graded electrical stimulation of 3 different components of the aortic nerve has been performed in decorticate cats, and later repeated after intercollicular decerebration. Threshold stimuli, involving only the largest fibers probably originating from pressoceptors, slightly decrease blood pressure and respiration both in quiet decorticate and in decerebrate cats. However, in decorticate animals during spontaneous fits of sham rage, inhibition of all somatic and visceral components of rage behavior is observed. When aortic nerve stimuli also involve intermediate-threshold fibers presumably of chemoceptive origin, excitation of rage behavior accompanied by strong hypertension and hyperventilation is seen in decorticate preparations, while after decerebration reflex hyperpnea is accompanied by hypotension or by no consistent pressor change. Stronger stimuli activating smaller fibers of probable pressoceptive origin still have conspicuous excitatory effects in decorticate animals, as shown by appearance of rage activity and pressor reactions, whereas after decerebration prominent hypotension with hyperpnea is observed. The predominance of excitatory cardiovascular responses to aortic nerve stimuli in decorticate animals, and of inhibitory reactions after decerebration is discussed. (Contractor's abstract)

2582

Siena U. Inst. of Medical Pathology (Italy).

LOCAL TISSUE LESIONS AS A MEANS OF ASSESSING THE LOCAL OR REMOTE ORIGIN OF EVOKED POTENTIALS WITHIN THE BRAIN, by A. Malliani and A. Zanchetti. [1965] [3]p. incl. diagrs. (Sponsored jointly by Aeronautical Systems Division, Air Force Office of Scientific Research under AF 61(052)253, and Consiglio Nazionale delle Ricerche) Unclassified

Published in Nature, v. 206: 627-629, May 8, 1965.

Recent investigations have been carried out on the distribution of somatically evoked potentials throughout the non-specific sensory system in the core of the brain using bipolar and monopolar probes. The absence of local potential gradients, as detected by bipolar leads, strongly suggests that in some regions the monopolar electrodes were not picking up locally evoked activity. This paper has attempted to devise a more crucial technique for supporting this conclusion. This method consists of observing the eventual changes in amplitude and shape of monopolarly and bipolarly recorded potentials after local lesions have been formed round the tip of the recording electrode. This experimental approach is based on the commonly accepted volume conductor theory. The data so far amassed indicate that caution should be applied before a committal is made to mere monopolar recording with relatively low-impedance electrodes, especially from those numerous regions deep in the brain.

2583

Siena U. Inst. of Medical Pathology (Italy).

BRAIN STEM SYSTEMS AND BEHAVIOR, by C. Bartorelli and A. Zanchetti. Final rept. June 1, 1964-May 31, 1965, 58p. incl. illus. diagrs. tables, refs. (AFOSR-65-1579) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-41 and Consiglio Nazionale delle Ricerche) AD 623798 Unclassified

The results of research conducted in the cat on the brain stem systems and behavior are presented. Research includes: (1) Comparison of the afferent regulation of waking and emotional behavior in the intact and decorticate cat; (2) Study of ascending and descending pathways involved in the regulation of deep sleep, and of the pontine centers responsible for sleep induction; and, (3) Study of the circulatory changes occurring during the wakefulness-sleep cycle, and the influence thereon of carotid sinus and aortic reflexes.

2584

Siena U. Inst. of Medical Pathology (Italy).

CAROTID SINUS AND AORTIC REFLEXES IN THE REGULATION OF CIRCULATION DURING SLEEP, by M. Guazzi and A. Zanchetti. [1965] [3]p. incl. illus. table, refs. (AFOSR-65-2524) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-41 and Consiglio Nazionale delle Ricerche) AD 628340 Unclassified

Also published in Science, v. 148: 397-399, Apr. 16, 1965

In the cat with intact sino-aortic reflexes, episodes of deep sleep are accompanied by marked falls in both systolic and diastolic blood pressure. The falls are much larger after bilateral sino-aortic deafferentiation: to such low pressures during sleep that episodes of transient cerebral ischemia (electroencephalographic flattening and seizures) sometimes occur. (Contractor's abstract)

2585

Siena U. Inst. of Medical Pathology (Italy).

A STUDY OF PONTINE LESIONS SUPPRESSING DEEP SLEEP IN THE CAT, by G. Carli and A. Zanchetti. [1965] [38]p. incl. illus. diagrs. tables, refs. (AFOSR-66-0846) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-41 and Consiglio Nazionale delle Ricerche) AD 639813 Unclassified

Also published in Arch. Ital. Biol., v. 103: 751-788, 1965.

Experiments were performed on cats carrying implanted recording electrodes in the skull and neck, whose sleeping behavior was long studied both before and after lesions in the caudal midbrain and in the pons. Complete destruction of various structures in the caudal midbrain and in the pons did not prevent deep sleep from repeatedly occurring. Among these structures, which are clearly not essential for induction of deep sleep, one should recall several nuclei participating in the ascending limb of the midbrain-limbic circuit, several raphe nuclei, nucleus reticularis tegmenti pontis, the locus coeruleus as well as the associated nucleus subcoeruleus. None of these structures has also been found to play an essential role in mediating any of the ascending or descending phenomena of deep sleep. In none of the cats with loss of deep sleep was nucleus reticularis pontis caudalis markedly injured. Loss of deep sleep for at least four consecutive days, and often for longer periods, was constantly associated with lesions in nucleus reticularis pontis oralis. However, only when the largest extent of the brain stem lesion involved the mediolateral portions of the middle and perhaps the posterior pontis oralis has been devided, was deep sleep long suppressed in all its various manifestations. Lesions limited to either the medial or the lateral portions of nucleus reticularis pontis oralis at any rostrocaudal level, or even severely involving the anterior third but affecting to a lesser degree the middle one, were always compatible with maintenance of deep sleep. (Contractor's abstract).

2586

Siena U. Inst. of Medical Pathology (Italy).

BRAIN STEM-LIMBIC CONNECTIONS, AND THE ELECTROGRAPHIC ASPECTS OF DEEP SLEEP IN THE CAT, by G. Carli, V. Armengol, and A. Zanchetti. [1965] [26]p. incl. illus. diagrs. refs. (AFOSR-66-0847) (Sponsored jointly by Aeronautical Systems Division, Air Force Office of Scientific Research under AF EOAR-64-41, and Consiglio Nazionale delle Ricerche) AD 634487 Unclassified

Also published in Arch. Ital. Biol., v. 103: 725-750, 1965.

Lesions which interrupt the ascending limb of the midbrainlimbic circuit in the cat at different levels, or which even destroy it completely, do not prevent electroencephalographic desynchronization at the beginning of periods of deep sleep, nor do they affect the maintenance

of desynchronization throughout the deep sleep episodes. Likewise, none of the lesions to ascending limbic pathways abolishes or impairs the appearance of a hippocampal theta rhythm at the beginning of each deep sleep episode, and its regular maintenance throughout its duration. Lesions involving the course or termination of various descending components of the limbic-midbrain circuit do not prevent or modify any of the classical signs of deep sleep, including the appearance of spiky waves in the pontine tegmentum shortly before and throughout each deep sleep period. It is concluded that neither the ascending nor the descending component of the limbic-midbrain circuit exert any essential role in deep sleep behavior. (Contractor's abstract)

2587

Siena U. Inst. of Medical Pathology (Italy).

BLOOD PRESSURE AND HEART RATE DURING NATURAL SLEEP OF THE CAT AND THEIR REGULATION BY CAROTID SINUS AND AORTIC REFLEXES, by M. Guazzi and A. Zanchetti. [1965] [29]p. incl. illus. diagrs. tables, refs. (AFOSR-66-0868) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-41 and Consiglio Nazionale delle Ricerche) AD 632814 Unclassified

Also published in Arch. Ital. Biol., v. 103: 789-817, 1965.

Blood pressure and heart rate changes during the wakefulness-sleep cycle were studied in 24 unanesthetized free-moving cats, carring an implanted cannula in a femoral artery as well as electrodes for electroencephalographic, electromyographic and eye movement recording. In 14 animals sino-aortic deafferentiation was performed. Quantitative evaluation of all data was carried out by analysis of variance. Both in intact and in deafferented animals, light sleep was accompanied by a slight but definite decrease in systolic and diastolic pressures, and in heart rate. While both arterial pressure and heart rate showed a consistent trend to increase toward the end of light sleep and at the very beginning of deep sleep, a large fall in arterial pressure and heart rate were always observed during deep sleep. Blood pressure and heart rate were also more variable during deep than during light sleep. Systolic and diastolic pressures, as well as heart rate, were significantly higher in deafferented than in intact animals both during quiet wakefulness and throughout light sleep. However, such surprisingly large falls in pressure were recorded during the course of deep sleep episodes that arterial pressure finally attained much lower absolute values in deafferented than in intact animals. In several incidents of the lowest values of blood pressure, episodes of transient cerebral ischemia (electroencephalographic flattening and seizures) occurred.

2588

Siena U. Inst. of Medical Pathology (Italy).

ROLE OF PRESSOCEPTIVE AND CHEMOCEPTIVE REFLEXES IN THE REGULATION OF CIRCULATION DURING SLEEP (Abstract), by M. Guazzi, G. Baccelli, and A. Zanchetti. [1965] [1]p. (AFOSR-66-1114) (Sponsored jointly by Air Force Office of Scientific Research under [AF EOAR-65-6] and Consiglio Nazionale delle Ricerche) AD 639843 Unclassified

Also published in Abstracts of Papers presented at Twenty-third Internat'l. Cong. Physiological Sciences, Tokyo (Japan), Sept. 1-9, 1965.

In order to study the role of sino-aortic reflexes in circulatory control during such a usual daily phenomenon as sleep, we have compared the effects of deep sleep on arterial pressure in cats with intact sino-aortic reflexes and in cats with sino-aortic deafferentation. In all animals blood pressure was continuously recorded through a polyethylene cannula in a femoral artery, while EEG, neck EMG and eye movements were simultaneously monitored to assess depth of sleep. Selective destruction of either carotid body chemoceptors or carotid sinus pressoceptive afferents has provided a means of assessing the respective role of each type of afferent input in regulating circulation during deep sleep. (Contractor's abstract, modified)

2589

[Societe Francaise de Physique, Paris (France)]

SEVENTH INTERNATIONAL CONFERENCE ON THE PHYSICS OF SEMICONDUCTORS. VOL. 2. PLASMA EFFECTS IN SOLIDS (7e Congrès international de physique des semiconducteurs. Vol. 2. Effets de plasmas dans les solides), Paris (France) (July 16-17, 1964). Paris, Dunod, 1965. 221p. incl. illus. diagrs. table, refs. (AFOSR-65-0723) (In cooperation with French Ministry of Scientific Research and Atomic and Spatial Problems, International Union of Pure and Applied Physics, and United Nations Educational, Scientific and Cultural Organization) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-26, International Atomic Energy Agency, National Science Foundation, Office of Naval Research and others) AD 626132 Unclassified

The symposium on plasma effects in solids was the first of its kind. It was an attempt to bring together 2 rather distinct groups of people: plasma and solid-state physicists; their common interest being the study of the gas of free charged carriers in solids. One hundred and fifty physicists from about 20 countries attended the conference. Twenty five papers were presented and appreciable time was allotted to the following discussions. wave propagation in solid state plasmas, wave interactions, quantum effects, hot plasmas, and instabilities.

2590

[Societe Francaise de Physique, Paris (France)]

SEVENTH INTERNATIONAL CONFERENCE ON THE PHYSICS OF SEMICONDUCTORS. VOL. 3. RADIATION DAMAGE IN SEMICONDUCTORS (7e Congrès international de physique des semiconducteurs. Vol. 3 Effets des rayonnements sur les semiconducteurs),

Paris, (France) (July 16-18, 1964). Paris, Dunod, 1965, 426p. incl. illus. diagrs. tables, refs. (AFOSR-65-0724) (In cooperation with French Ministry of Scientific Research and Atomic and Spatial Problems, International Union of Pure and Applied Physics, and United Nations Educational, Scientific and Cultural Organization) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-26, International Atomic Energy Agency, National Science Foundation, Office of Naval Research and others) AD 626133 Unclassified

Approximately 110 scientists were present at the 3 day symposium on Radiation damage in semiconductors. The reviews, discussions and contributions presented at the meetings are classified under the following headings: primary structure of defects, defect-impurity interactions, mobility and annealing, theory of point defects, semiconducting compounds, and thresholds and cross sections. The present volume gives a measure of the progress made since the last prior meeting on the subject of radiation effects in semiconductors. (1959).

2591

[Societe Francaise de Physique, Paris (France)]

SEVENTH INTERNATIONAL CONFERENCE ON THE PHYSICS OF SEMICONDUCTORS. VOL. 4. RADIATIVE RECOMBINATION IN SEMICONDUCTORS (7e Congres international de physique des semiconducteurs. Vol. 4. Recombinaison radiative dans les semiconducteurs), Paris (France) (July 27-28, 1964). Paris, Dunod, 1965, 296p. incl. illus, diagrs. tables, refs. (AFOSR-65-0725) (In cooperation with French Ministry of Scientific Research and Atomic and Spatial Problems, International Union of Pure and Applied Physics, and United Nations Educational, Scientific and Cultural Organization) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-26, International Atomic Energy Agency, National Science Foundation, Office of Naval Research and others) AD 626134 Unclassified

The symposium on radiative recombination in semiconductors brought together about 250 specialized physicists from some 20 countries. The proceedings give an up-to-date account of the physical processes which are fundamental in semiconductor lasers. The subjects treated include intrinsic radiative recombination, impurity and exciton effects, junction lasers, new excitation processes, in particular those involving an electron beam, and new materials which enlarge the field of semiconductor lasers toward the visible spectrum.

2592

Society for Industrial and Applied Mathematics, Philadelphia, Pa.

JOURNAL OF THE SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS, SERIES A: CONTROL VOLUME 3, NUMBER 2, ed. by L. W. Neustadt, A. V. Balakrishnan and others. Philadelphia, SIAM Publications, 1965 [175]p. incl. refs. (AFOSR-66-0013) (AF AFOSR-64-527) AD 641628 Unclassified

This journal contains research articles on the mathematical theory of control and its applications, as well as topics in applied probability, stochastic processes, and mathematical programming which are related to control theory. It also includes English translations of important foreign papers on control.

2593

Society for Industrial and Applied Mathematics, Philadelphia, Pa.

JOURNAL OF THE SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS, SERIES A: CONTROL, VOLUME 3, NUMBER 3, ed. by L. W. Neustadt, A. V. Balakrishnan and others. Philadelphia, SIAM Publications, 1965 [151]p. incl. diagrs. refs. (AFOSR-66-0556) (AF AFOSR-64-527) AD 637993 Unclassified

For abstract see item no. 2592.

2594

Socony Mobil Oil Corp. Dept. of Research, Princeton, N. J.

PLASMA-DENSITY MEASUREMENTS USING A DEUTERON BEAM, (Abstract), by R. L. Hickok, F. C. Jobes, and J. F. Marshall. [1965] [1]p. [AF 49(638)1500] Unclassified

Published in Amer. Phys. Soc., Series II, v. 10: 508, Apr. 26, 1965.

A 1.8 mev deuteron beam has been used to investigate the deuterium density distribution in a high-current deuterium-arc plasma. The beam lies in a plane perpendicular to the arc axis and is swept through the arc at 60 cps. Protons from the $D(d,p)H^3$ reactions, detected by solid-state counters, are used to sample the sweep voltage and thereby determine the beam path at the time of reaction. It is necessary to calculate the proton paths in the nonuniform confining magnetic field of the arc to determine the counting efficiency as a function of position along the deuteron beam. The proton counting rate can then be related to the average deuterium density along the beam path. If the arc is assumed to have cylindrical symmetry, then the data can be inverted to a radial density profile. Density profiles obtained this way are compared with the profiles of spectral lines emitted by the arc.

2595

Socony Mobil Oil Corp. [Dept. of Research] Princeton, N. J.

PLASMA DENSITY MEASUREMENTS USING A DEUTERON BEAM (Abstract), by R. L. Hickok, F. C. Jobes, and J. F. Marshall [1965] [1]p.

(Bound with AFOSR 65-1266; AD 622527) (AF 49(638) 1500) Unclassified

Presented at Eighth AFOSR Contractor's meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

The deuterium density distribution in a magnetically confined vacuum arc plasma has been investigated by using a 1.8 mev deuteron beam. The arc is a gas fed dc electrical discharge running between electrodes and confined by an axial magnetic field of approx 4000 gauss. In normal operation, the gas feed is of the order of 3 atm-cc/sec and the dc power dissipation is 30 kw. This produces a plasma with an estimated electron temperature of 40 ev, an estimated ion temperature of 5 ev, and an ion density of the order of 10^{14} per cc. The 1.8 mev deuteron beam lies in a plane perpendicular to the arc axis and is swept through the arc at 60 cps. Protons from the $D(\alpha, p)H^3$ reaction, detected by a surface barrier semiconductor counter, are correlated with beam position by using the detector pulses to sample the sweep voltage. The sweep voltage is then used to select the address in a multichannel pulse height analyzer. Since the amplitude of the sweep voltage is a measure of the deuteron beam position, the pulse height analyzer presents a display of the number of protons detected versus beam position. After adjustment for the relative time spent in each beam path, the number of counts in each channel is a measure of the deuterium density integrated over the beam path that corresponds to that channel. The data are then inverted to yield a radial density profile of the form $\rho = f(r) + g(r) \cos \theta$, using detector efficiencies computed as functions of position along the beam paths. The computed efficiencies must take into account the particle trajectories in the nonuniform magnetic field. Density profiles obtained this way are quite similar to the profiles of spectral lines emitted by both ions and neutral atoms in a He doped arc.

2596

Southern California U. Dept. of Chemistry, Los Angeles.

A STUDY OF DOUBLE LAYER REPULSION AND VAN DER WAALS ATTRACTION IN SOAP FILMS, by J. Lyklema and K. J. Mysels. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-1633) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49 (638)309] and National Science Foundation) AD 624280 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 2539-2546, June 20, 1965.

Measurements of equilibrium thicknesses of soap films over a range of ionic strengths are presented for mobile and rigid films of sodium lauryl sulfate in the presence of lithium chloride. The forces determining this thickness are discussed in terms of existing theories of van der Waals attractions and of electric double layer repulsion. Some of the problems involved in the experimental testing of these theories are brought out. While there is good qualitative agreement between theory and experiment, definite quantitative discrepancies appear also. It is suggested that some of these could stem from limitations of the double layer theory.

2597

Southern California U. Dept. of Chemistry, Los Angeles.

NITROGEN ANALOGS OF SESQUIFULVALENCE. I. SYNTHESIS AND PROPERTIES, by J. A. Berson, E. M. Evleth, Jr. and Z. Hamlet. [1965] 15p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)828, Army Research Office (Durham) and Camille and Henry Drefus Foundation) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 2887-2900, July 5, 1965.

The syntheses of a series of pyridine anhydro bases isoelectronic with sesquifulvalence are described. These substances are protonated on carbon rather than on nitrogen. The corresponding conjugate acids are strong enough to be titratable, the pK_a values being in the range 8.5 to 12. The acidity of a C-H function attached to C-2 or C-4 of a pyridinium nucleus is enhanced by a factor of 10^6 to 10^7 by incorporation of the C-H group in a cyclopentadienyl ring. (Contractor's abstract)

2598

Southern California U. Dept. of Chemistry, Los Angeles.

NITROGEN ANALOGS OF SESQUIFULVALENE. II. THEORETICAL CORRELATION OF GROUND-STATE PROPERTIES, by J. A. Berson, E. M. Evleth, Jr., and S. L. Manatt. [1965] 8p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)828, [Army Research Office (Durham)] and Camille and Henry Dreyfus Foundation) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 2901-2908, July 5, 1965.

The dipole moments of a series of nitrogen anhydro bases and pyridones can be calculated by a modified Huckel technique. The agreement with experimental values is quite good. Despite pronounced bond alternation, the confugated systems of the anhydro bases have substantial charge separation as evidenced by experimental dipole moments, a result that is not predicted by considerations of n.m.r. chemical shifts. The relative acidities of the conjugate acids of these substances are not properly predicted by Hückel theory, probably because of the undue emphasis the calculation places on formal conjugation. The large spread in acidities in the series cyclopentadiene, indene, and fluorene is drastically compressed by attachment of a pyridinium nucleus. Much of the effect of annelation of the five-membered ring on the acidities of the anhydro bases of the 2-series seems to be attributable to intramolecular overcrowding in the annelated derivatives, which produces noncoplanarity of the conjugated system. (Contractor's abstract)

2599

Southern California U. Dept. of Chemistry, Los Angeles.

NITROGEN ANALOGS OF SESQUIFULVALENE. III. THEORETICAL CORRELATION OF EXCITED-STATE PROPERTIES, by E. M. Evleth, Jr., J. A. Berson, and S. L. Manatt. [1965] 6p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)828, [Army Research Office (Durham)]and Camille and Henry Dreyfus Foundation) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 2908-2913, July 5, 1965.

The experimental energies and intensities of the electronic absorption bands of a series of nitrogen analogs of sesquifulvalene are compared with the results of three kinds of theoretical treatment. Although the Huckel theory and its variant, the π-method, are satisfactory in correlating much of the data, they fail to account for the major observed difference in behavior between the members of the 2- and 4-series, namely, the occurrence of strong, long wave length bands in the 2-series but of only one in the 4-series. Treatment of the data by first order perturbation theory, using the series of anions phenylcyclopentadienide, phenylindenide, and phenylfluorenide, gives better results. The transition energies are correlated with the values calculated from perturbation theory with a correlation coefficient of 0.953 the value of the resonance integral β, obtained from the slope of the correlation, is -47.6 kcal. mol. (Contractor's abstract)

2600

Southern California U. Dept. of Chemistry, Los Angeles.

KRAMERS-KRONIG DISPERSION ANALYSIS OF INFRARED REFLECTANCE BANDS, by G. Andermann, A. Caron, and D. A. Dows. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2398) (AF 49(638)1308) AD 625772 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 55: 1210-1216, Oct. 1965.

A procedure is presented for the use of the Kramers-Kronig dispersion relations in treatment of normal-incidence infrared reflection spectra to yield optical constants of crystals. The crux of the practical problem, treatment of unobserved wing regions in the integrations, is discussed in detail. Definitive methods of picking optimum upper and lower limits for integration over actual data and for fitting artificial wings are discussed. The method is tested on a reflection spectrum generated by a model involving several damped harmonic oscillators. It is shown how a region involving a single band (but flanked by "unobserved" bands) can be treated, and how accurately the method reproduces the theoretically known optical indices. It appears feasible to obtain the indices of absorption and of refraction to ± 0.005 and ± 0.002, respectively, given accurate data on reflectance. Integrated band intensities are reproduced to within a few percent. (Contractor's abstract)

2601

Southern California U. [Dept. of Electrical Engineering] Los Angeles.

CATHODOLUMINESCENCE AT p-n JUNCTIONS IN GaAs, by D. B. Wittry and D. F. Kyser. [1965] [3]p. incl. illus. diagr. (AFOSR-65-1898) (AF AFOSR-63-76) AD 625875 Unclassified

Also published in Jour. Appl. Phys., v. 36: 1387-1389, Apr. 1965.

A decrease in the cathodoluminescence produced in GaAs by a scanning electron probe has been observed when the probe is close to a p-n junction. The decreased intensity is shown to result from the drift of excess carriers across the junction. Measurements of the short-circuit current of the diode confirm this interpretation and provide a means of estimating minority carrier diffusion lengths.

2602

Southern California U. Dept. of Electrical Engineering, Los Angeles.

ON THE THEORY OF CONTINUOUS ARRAY PROCESSING, by D. G. Childers and I. S. Reed. [1965] [7]p. incl. refs. (AFOSR-66-1060) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-188 and Air Force Systems Command) AD 638503 Unclassified

Also published in IEEE Trans. Aerospace and Navigational Electron., v. ANE-12: 103-109, June 1965.

The theory of continuous and discrete array signal processing is considered for tracking and navigational radar (sonar) systems. The purpose of the active array (and the associated filtering) is to detect an echo of a transmitted pulse reflected from a target in the presence of correlated reverberation or clutter and uncorrelated noise, both of which may vary from antenna-array element to antenna-array element, i.e., both of which are space-time varying functions. The array configuration and signal processor can also be used to determine the target location and direction. For the continuous array the receiving 'elements' are distributed continuously in the spatial medium, and the linear processor has a frequency response that is a function of the spatial variables. The discrete array is one where each individual point-receiving element in the spatial medium has a linear signal processor. (Contractor's abstract, modified)

2603

Southern California U. Dept. of Electrical Engineering, Los Angeles.

SPACE-TIME CROSS-CORRELATION FUNCTIONS FOR ANTENNA ARRAY ELEMENTS IN A NOISE FIELD, by D. G. Childers and I. S. Reed. [1965] [9]p. incl. diagrs. refs. (AFOSR-67-0464) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-188

and Air Force Systems Command) AD 648269 Unclassified

Also published in IEEE Trans. Inform. Theory, v. IT-11: 182-190, Apr. 1965.

The importance of designing a radar (or communications) receiver to operate effectively in the presence of spatial noise creates the necessity for determining the space-time cross-correlation functions between antenna array elements. A representation of a general, polarized, nonisotropic noise process is used to determine the cross-spectral densities and cross-correlation functions between arbitrarily oriented dipole antenna array elements in the presence of a noise field only. Several examples have been worked out for isotropic noise to show the variation of the cross-correlated noise function vs the spatial separation of the dipoles. One important result is that the noise cross correlation is shown to be a function of the receiver element spatial orientation when the elements are dipoles. For certain spatial orientations between dipoles it is possible to reduce the noise cross correlation between these antenna array elements to zero. (Contractor's abstract)

2604

Southern California U. Dept. of Electrical Engineering, Los Angeles.

PAIRING ENERGY OF LITHIUM AND BORON IN SILICON, by W. G. Spitzer and M. Waldner. [1965] [3]p. incl. diagr. (AFOSR-65-0915) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office Durham, and Office of Naval Research under AF AFOSR-64-496]) AD 618355 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 223-224, Feb. 15, 1965.

Recent studies have shown that isolated substitutional boron impurities in silicon give rise to an infrared active, local mode of vibration. Several samples of B-doped Si compensated with Li were measured as a function of temperature between room temperature and approx 200°C. At 25°C the weak B^{10} absorption band near 644 cm^{-1} is seen with 3 other bands, 681, 584, and 522 cm^{-1}. It is further observed that the 644-cm^{-1} band increases in strength with increasing temperature; the other bands show a related decrease. These results are interpreted as additional evidence for Li-B ion pairing.

2605

Southern California U. Dept. of Electrical Engineering, Los Angeles.

REALIZATION OF IRRATIONAL IMPEDANCES BY INFINITE LENGTH CASCADED NETWORKS, by R. M. Gagliardi and A. Beihaghi. [1965] [3]p. (AFOSR-65-2103) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-496) AD 627965 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 290-292, June 1965.

An attempt is made to develop some sufficiency conditions and formal design procedures for a class of irrational impedance functions of the form $Z(s) = (+) \sqrt{P(s)}$, where P(s) is rational meromorphic and the (+) indicates the root having a positive real part. The problem is restricted to networks that are 1-dimensional semi-infinite and can therefore be viewed as an infinite length of cascaded substructures. The necessary conditions are first considered for the impedance function in the equation above to be realizable as a passive network. It is concluded that Z(s) will be a PR irrational function if P(s) is real and positive for s real and positive. The sufficiency of these conditions for realization of Z(s) as a semi-infinite passive one-port is more difficult to determine.

2606

Southern California U. Dept. of Electrical Engineering, Los Angeles.

WAVE PROPAGATION IN HOT PLASMA WAVE-GUIDES WITH INFINITE MAGNETOSTATIC FIELDS, by H. H. Kuehl, G. E. Stewart, and C. Yeh. [1965] [7]p. incl. diagrs. (AFOSR-65-2116) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-496) AD 630209 Unclassified

Also published in Phys. Fluids, v. 8: 723-729, Apr. 1965.

Solutions of the dispersion relation for an unbounded Maxwellian electron plasma, are given. Solutions of the corresponding relation for a circular waveguide filled with a hot plasma with an infinite magnetostatic field are also presented. It is shown that these solutions are of importance in evaluating the fields in such waveguides since they determine the poles of the integrands which arise in the integral formulation of the problem. The integral solution for the field in the waveguide due to a general symmetric excitation at the wall of the waveguide is given.

2607

Southern California U. Dept. of Electrical Engineering, Los Angeles.

DOUBLE EXCHANGE FOR POLARONS, by J. Smit. [1965] [2]p. incl. diagr. refs. (AFOSR-65-2117) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-496) AD 629062 Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 18-19, 1964.

Also published in Jour. Appl. Phys., v. 36: 1143-1144, Mar. 1965.

The transition of a metallic type of electronic conductivity to a semi-conducting one, observed at the Curie point in several ferromagnetic compounds with mixed valency, is explained in the limit of heavy ions. It is shown that above the Curie point the susceptibility should obey the Curie-Weiss law.

2608

Southern California U. [Dept. of Electrical Engineering] Los Angeles.

THEORY OF PHONON-ASSISTED TUNNELING IN SEMICONDUCTORS, by L. Kleinman. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR-65-2734) (Sponsored jointly by Advanced Research Projects Agency and AIR Force[Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-496) AD 626445 Unclassified

The phonon-assisted tunneling current is calculated for a model p-n junction (as opposed to the homogeneous-electric-field model) due to 2 mechanisms. A first-order mechanism in which an electron on, say the p side scatters to a state on the n side with the emission of a phonon yields results similar to those calculated by other workers for the homogeneous-electric-field model and is about three orders of magnitude too small to account for the experimentally observed current. A second-order process in which an electron on the p side tunnels to an intermediate state in a higher band on the n side via the interband term in the Hamiltonian and then scatters with the emission of a phonon to a final state on the n side yields a current equal in magnitude to the experimentally observed current. This mechanism also succeeds, where the first one fails, in accounting for the magnitude of an differences between the experimentally measured pressure coefficients $^{\pi}LA^{+}$, $^{\pi}LA^{-}$, $^{\pi}TA^{+}$, $^{\pi}TA^{-}$, where $^{\pi} = J^{-1}dJ\ dP$, the superscripts identify the direction of current flow, and the subscripts, the branch of the phonon involved in the tunneling process (LA = longitudinal acoustic, TA = transverse acoustic).

2609

Southern California U. Dept. of Electrical Engineering, Los Angeles.

TRANSVERSE MAGNETIC WAVE PROPAGATION IN SINUSOIDALLY STRATIFIED DIELECTRIC MEDIA, by C. Yeh, K. F. Casey, and Z. A. Kaprielian. [1965] [6]p. incl. diagrs. (AFOSR-66-0538) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-496]) AD 641734 Unclassified

Also published in IEEE Trans. Microwave Theory and Techniques, v. MTT-13: 297-302, May 1965.

The problem of the propagation of TM waves in a sinusoidally stratified dielectric medium is considered. The propagation characteristics are determined from the stability diagram of the resultant Hill's equation. Numerical results show that the stability diagrams for Hill's equation and those for Mathein's equation are quite different. Consequently, the dispersion properties of TM waves and TE waves in this stratified medium are also different. Detailed dispersion characteristics of TM waves in an infinite stratified medium and in waveguides filled longitudinally with this stratified material are obtained.

2610

Southern California U. Dept. of Electrical Engineering, Los Angeles.

INTERACTION OF MICROWAVES WITH AN INHOMOGENEOUS AND ANISOTROPIC PLASMA COLUMN, by C. Yeh and W. V. T. Rusch. [1965] [5]p. incl. diagrs. (AFOSR-66-0539) (Sponsored jointly by Air Force Cambridge Research Lab; and [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-496]) AD 641726 Unclassified

Also published in Jour. Appl. Phys., v. 36: 2302-2306, July 1965.

The problem of the interaction of microwaves with a radially inhomogeneous plasma column confined by an impressed axial static magnetic field is treated analytically. Extensive numerical results for the back-scattering cross sections are presented for various interesting ranges of the parameters involved. It is found that the often-used homogeneous model for interpretation of experimental data can sometimes lead to ambiguous results. This ambiguity arises because of the interdependence of the average plasma frequency, the gyrofrequency, and the inhomogeneity of the plasma density distribution. Further measurements are suggested to distinguish these effects.

2611

Southern California U. Dept. of Electrical Engineering, Los Angeles.

EXACT SOLUTION TO A LENS PROBLEM, by C. Yeh. [1965] [8]p. incl. diagr. refs. (AFOSR-66-0540) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-64-496) AD 641729 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 55, 860-867, July 1965.

An exact solution is obtained for the diffraction of plane electromagnetic waves by an elliptic cylindrical lens surrounding an infinitely long parallel slit in a perfectly conducting plane. Results are expressed in terms of Mathieu functions. Approximate expressions for the expansion coefficients for the diffracted waves, the scattered intensity at infinity, and the transmission coefficients are also obtained in the long-wavelength (Rayleigh scattering) limit. Possible numerical investigations are discussed. (Contractor's abstract)

2612

Southern California U. Dept. of Electrical Engineering, Los Angeles.

REFLECTION AND TRANSMISSION OF ELECTROMAGNETIC WAVES BY A MOVING DIELECTRIC MEDIUM, by C. Yeh. [1965] [5]p. incl. diagrs. (AFOSR-66-0541) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-64-496] and Naval Ordnance Test Station) AD 641733 Unclassified

Also published in Jour. Appl. Phys., v. 36: 3513-3517, Nov. 1965.

The reflection and transmission of electromagnetic waves by a moving dielectric medium are investigated theoretically, and the reflection and transmission coefficients are determined. Two cases of the movement are considered: (a) The dielectric medium moves parallel to the interface. (b) The dielectric medium moves perpendicular to the interface. Various interesting features concerning the variation of the reflection and transmission coefficients, angles of reflection and transmission, and the frequencies of the reflected and transmitted wave, as a function of the velocity of the moving medium, are discussed.

2613

Southern California U. Dept. of Electrical Engineering, Los Angeles.

RESEARCH IN OPTICAL COHERENCE, by R. S. Macmillan, G. O. Young and others. Final rept. Dec. 1965, 15p. incl. diagrs. (USCEE rept. no. 168) (AFOSR-66-0917) (AF AFOSR-65-188) AD 634013 Unclassified

This report summarizes the research in optical coherence and related subjects performed during the past calendar year. It consists of a brief summary of the research performed during 1965 and a list of papers which have been submitted for publication or which are in the process of being prepared for publication. At present, one paper has been published, two papers have been submitted for publication, and two papers are in the process of being prepared for publication. In addition to the papers, there was a presentation at the 1965 Fall URSI-IEEE Meeting. The topics discussed include coherence studies, functional transformations optical polarization modulation, a test for ergodicity for a certain class of random processes, and lens system optimization.

2614

Southern California U. [Dept. of Electrical Engineering] Los Angeles.

POLARIZATION EFFECTS IN TWO-PHONON RAMAN SCATTERING IN CUBIC CRYSTALS, by L. Kleinman. [1965] [7]p. incl. diagr. tables, refs. (AFOSR-65-1224) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research] under AF AFOSR-65-496, and National Aeronautics and Space Administration) AD 622845 Unclassified

Also published in Solid State Commun., v. 3: 47-53, 1965.

It is shown how to calculate which Raman active irreducible representations are present in any 2-phonon state even when the individual phonons are degenerate. It is also shown how, using polarization effects, to determine experimentally which irreducible representations are present in the 2-photon state responsible for any Van Hove singularity in the 2-phonon Raman dispersion curve. (Contractor's abstract)

2615

Southern California U. Dept. of Electrical Engineering, Los Angeles.

THE THERMODYNAMICS OF IMPERFECTIONS IN AgBr, by F. A. Kroger. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-1461) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-496) AD 622851 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 26: 901-909, 1965.

Analysis of experimental data available in the literature leads to an evaluation of the enthalpies and entropies of formation of native atomic and electronic imperfections. Estimates are made for the free enthalpy of formation of neutral and charged Schottky defects, which show that bromine vacancies are always a minority species. (Contractor's abstract)

2616

Southern California U. Dept. of Electrical Engineering, Los Angeles.

THE IONICITY OF GaAs, by F. A. Kröger. [1965] [1]p. (AFOSR-65-2062) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-496) AD 627719 Unclassified

Also published in Phys. Ltrs., v. 15: 218, Apr. 1, 1965.

From recent (200) x-ray reflection intensity measurements of GaAs, it may be deduced that Ga has a positive charge and As a corresponding negative charge of (0.51 ± 0.13) unit charges. This polarity is not surprising in view of the difference in electro-negativity of Ga and As. The observed value for the static charge is close to the dynamic charge determined to be about 0.46 q from infrared reflection and dielectric and refractivity measurements. However, it is cautioned that this correspondence may be fortuitous.

2617

Southern California U. Dept. of Electrical Engineering, Los Angeles.

INFRARED REFRACTIVE INDEX AND ABSORPTION OF InAs AND CdTe, by O. G. Lorimor and W. G. Spitzer. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-2063) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-496) AD 627720 Unclassified

Also published in Jour. Appl. Phys., v. 36: 1841-1844, June 1965.

Transmission interference fringes from 2690 to 320 cm^{-1} for InAs and from 1330 to 320 cm^{-1} for CdTe are analyzed with classical dispersion theory to obtain the room-temperature dielectric constants. For InAs the dielectric constant ϵ_∞ between the band edge and the reststrahl, and the static dielectric constant ϵ_0 are: $\epsilon_\infty = 11.8 \pm 0.1$, $\epsilon_0 = 14.55 \pm 0.3$; and for CdTe: $\epsilon_\infty = 7.05 \pm 0.05$ ϵ_0 10.60 ± 0.15. These values agree favorably with previously reported values. The absorption of InAs is measured from 2500 cm^{-1}, near the fundamental absorption edge, to 260 cm^{-1}. Eight absorption peaks are observed between 444 and 269 cm^{-1} which are attributed to multiphonon combinations with the following characteristic phonon frequencies: TO_1 = 222 cm^{-1}, TO_2 214 cm^{-1}, LO = 196 cm^{-1}, and LA = 143 cm^{-1}. The transmission of CdTe is observed from 10,000 to 220 cm^{-1}. From 10,000 to 450 cm^{-1} the transmission is essentially constant at ~60%. Below 400 cm^{-1} only two previously reported transmission minima are observed.

2618

Southern California U. Dept. of Electrical Engineering, Los Angeles.

THE P-T-x PHASE DIAGRAM OF THE SYSTEM ZINC-TELLURIUM, by F. A. Kroger. [1965] [3]p. incl. diagrs. refs. (AFOSR-65-2399) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research] under AF AFOSR-65-496) AD 625876 Unclassified

Also published in Jour. Phys. Chem., v. 69: 3367-3369, Oct. 1965.

Combination of the results of thermodynamic and phase diagram studies with those of a physicochemical investigation of the semiconductor properties of ZnTe makes it possible to construct the pressure-temperature-composition (P-T-x) phase diagram of the system Zn-Te. (Contractor's abstract)

2619

Southern California U. Dept. of Electrical Engineering, Los Angeles.

INVARIANCE, UNCONTROLLABILITY, AND UNOBSERVABILITY IN DYNAMICAL SYSTEMS, by P. K. C. Wang. [1965] [2]p. (AFOSR-65-2449) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research] under AF AFOSR-65-496) AD 628697 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10: 366-367, July 1965.

The purpose of this paper is to indicate that the notions of controllability and observability also can be interpreted in the variational frame-work, and one may classify uncontrollability and unobservability under the general category of invariance properties. In the sequel, the notions of uncontrollability and unobservability for linear ordinary differential systems will be established first. Then, the extension of these notions to nonlinear ordinary differential systems will be discussed. (Contractor's abstract)

2620

Southern California U. [Dept. of Electrical Engineering] Los Angeles.

JOINT SERVICES ELECTRONICS PROGRAM. Final rept. Sept. 1, 1964-Aug. 31, 1965, 106p. incl. illus. diagrs. tables, refs. (AFOSR-65-2648) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research] under AF AFOSR-65-496) AD 628025 Unclassified

Research activity carried out during this period is summarized under the following categories: Solid state (semiconductors, magnetism, imperfection in crystals, superconductivity); Applied electromagnetics and plasmas (plasmas, applied electromagnetics); Information sciences (control systems, computers, coding theory); and Projects funded by joint services.

2621

Southern California U. Dept. of Electrical Engineering, Los Angeles.

INFRARED COMBINATION MODE ABSORPTION IN LITHIUM-BORON-DOPED SILICON, by M. Waldner, M. A. Hiller, and W. G. Spitzer. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-66-0080) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research] under AF AFOSR-65-496) AD 641047 Unclassified

Also published in Phys. Rev. v. 140 A172-A176, Oct. 4, 1965.

Infrared absorption bands due to double-quantum transitions of local lattice-mode vibrations is boron-lithium-doped silicon have been observed. The transistions are found near twice the frequency of all local modes and at the sum frequency of the two strongest local-mode vibrations, which are those associated with boron-lithium pairs. The relative strengths of the pair modes, the displacement of the modes from the mode due to isolated substitutional boron, and the relative strengths of the overtone absorption bands are consistent with the assumption of a predominantly Coulomb interaction between the boron and lithium ions. Five additional absorption bands, with frequency depending upon boron isotope, are found at frequencies not corresponding to sums of local-mode frequencies. Four of these bands occur at sum frequencies of the two strongest local-mode frequencies. Four of these bands occur at sum frequencies of the two strongest local-mode frequencies and of silicon critical-point phonon frequencies. The dependence of the frequency of all absorption peaks on lithium and boron isotopes is used to assist in the assignment of the absorption bands.

2622

Southern California U. Dept. of Electrical Engineering, Los Angeles.

THE EFFECT OF DOUBLY IONIZABLE VACANCY ACCEPTORS ON THE CONDUCTIVITY OF DONOR DOPED SEMICONDUCTING COMPOUNDS WITH SPECIAL REFERENCE TO CdTe AND ZnTe, by F. A. Kroger. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-66-0527) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research under AF AFOSR-65-496) AD 641045 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26: 1717-1726, Dec. 1965.

A discussion is given for the effect of doubly ionizable vacancy acceptors on the semiconducting properties of donor doped compound semiconductors. The state during preparation as well as that reached after rapid cooling is discussed. The considerations are applied to CdTe and ZnTe. It is shown that a model proposed for CdTe by de Nobel is consistent with the experimental data available at present. ZnTe is seen to have a strong preference for p-type conduction, but on the basis of the model accepted so far conversion to low resistivity n-type material should be possible at large doping concentrations. High resistivity material, as observed, requires extension of the model. Different conclusions reached by Mandel et al. are traced back to the assignment of an erroneous value to an essential entropy term. (Contractor's abstract)

2623

Southern California U. [Dept. of Electrical Engineering] Los Angeles.

CONSOLIDATED SEMIANNUAL PROGRESS REPORT NO. 2. Apr. 1, 1965-Sept. 30, 1965, 135p. incl. illus. diagrs. tables, refs. (AFOSR-66-0535) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research] under AF AFOSR-65-496) AD 625471 Unclassified

For abstract see item no. 2620.

2624

Southern California U. Dept. of Electrical Engineering, Los Angeles.

CERENKOV RADIATION IN INHOMOGENEOUS PERIODIC MEDIA, by K. F. Casey, C. Yeh, and Z. A. Kaprielian [1965] [8]p. incl. diagrs. refs. (AFOSR-66-0537) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research] under AF AFOSR-65-496) AD 641046 Unclassified

Also published in Phys. Rev., v. 140: B768-B775, Nov. 8, 1965.

The formal exact solution to the problem of the radiation of a charge particle traveling with a constant velocity in a periodically inhomogeneous medium is obtained. As a specific example, the case with a sinusoidally varying dielectric profile is treated in detail. Results of the computation are summarized in 2 graphs from which information concerning threshold velocity for a particular mode, the emission angles for various radiating modes, and the cutoff frequency for a certain mode can be found. Unlike the case of Cerenkov radiation in a homogeneous medium, there exist radiating modes in this inhomogeneous-dielectric case even when the velocity of the charged particle is below the threshold Cerenkov velocity. A formal expression for the radiation spectrum is also given. Approximate expressions for the radiated fields and for the radiation spectrum are obtained when the variation of the permittivity is small. Results are discussed and interpreted. (Contractor's abstract)

2625

Southern California U. Dept. of Electrical Engineering, Los Angeles.

THE ROLE OF THE IONIZATION OF DEFECTS IN CAUSING SYSTEMATIC DIFFERENCES IN THE SEMICONDUCTOR PROPERTIES OF UNDOPED COMPOUNDS, by F. A. Kroger. [1965] [9]p. incl. diagr. tables, refs. (AFOSR-66-1067) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-496) AD 641049 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 26, 1707-1715, Dec. 1965.

Undoped compounds often show either n- or p-type conduction, a variation of the activity of the lattice constituents causing a variation in the concentration of donor or acceptors, but not a change of the conductivity

type. Only in a few cases can a transition from n- to p-type be achieved. It is shown that the degree of ionization of the imperfections acting as donors or acceptors is an important factor in deciding the type of atomic imperfection that is predominately formed. The insight gained is used to explain some observed trends in the semiconductor properties of the II-VI and IV-VI compounds.

2626

Southern California U. Dept. of Electrical Engineering, Los Angeles.

ON THE ALMOST SURE STABILITY OF LINEAR TIME-LAG SYSTEMS WITH STOCHASTIC PARAMETERS, by P. K. C. Wang. [1965] [8]p. (AFOSR-66-2338) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research] under AF AFOSR-65-496) AD 643364 Unclassified

Also published in Internat'l. Jour. Control, v. 2 433-440, Nov. 1965.

The stability problem associated with linear time-lag systems with stochastic parameters is considered. A sufficient condition for ensuring almost sure asymptotic stability in the large is derived. Its application is illustrated by examples.

2627

Southern California U. Dept. of Electrical Engineering, Los Angeles.

OPTIMAL CONTROL PROBLEMS AS EXTERNAL PROBLEMS IN A BANACH SPACE, by L. W Neustadt [1965] [10]p. (AFOSR-67-0377) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research] under AF AFOSR-65-496) AD 647456 Unclassified

Also published in Proc. Symposium on System Theory, New York (Apr. 20-22, 1965), ed by J. Fox, M. Crowell, and R. Krieger. Brooklyn, Polytechnic Press, 1965, p. 215-224.

This paper presents the formulation of an extremely general variational problem in a Banach space setting. This formulation includes, a special cases, the conventional optimal control problems both with an without restricted phase coordinates. Using the concept of quasiconvexity, it is possible to derive necessary conditions for extremality in terms of the separability of two convex sets in a Banach space The Pontryagin maximum principle, together with its extension to the problem with restricted phase corrdinates, is derived from the general necessary conditions presented herein. (Contractor's abstract)

2628

[Southern California U. Engineering Center, Los Angeles]

HIGH-SPEED LOW-DENSITY WAKE AS A STUDY IN TRANSITIONAL GASDYNAMICS (Abstract), by R. L. Chuan. [1965] [1]p. [AF AFOSR-63-55] Unclassified

Presented at meeting of the Amer. Phys. Soc., Calif. Inst. of Tech., Pasadena, Nov. 23-25, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 273, Feb. 25, 1965.

In the immediate neighborhood of a rapidly moving body whose dimension is small as compared to the free-stream mean-free path, molecule-body collisions dominate (and the local flow field is free molecular); but far enough away from the body, molecule-molecule collisions dominate. Thus, in the wake configuration, one finds the development of a flow field from free molecular to continuum uncomplicated by the presence of walls. The low-density "wake" really represents a "region of influence" of a scatterer placed in an unbounded high-speed low-density gas stream. Experimental description of such a complete gasdynamic spectrum has been obtained in the forms of flow field photographs and impact-pressure profiles with spheres and cylinders at Knudsen numbers from 0.02 to 30 and Mach numbers from 6 to 8. It is found, in the case of the cylinder, that at a distance of about 2 free-stream mean free paths downstream, the flow field exhibits free molecular behavior; and that from a distance of about 10 mean free paths on, the wake departs appreciably from a free molecular description.

2629

[Southern Methodist U., Dallas, Tex.]

ULTRASONICS IN GEOLOGY, by G. Simmons. [1965] [9]p. incl. diagrs. refs. (AF AFOSR-65-418) AD 467148 Unclassified

Also published in Proc. IEEE, v. 53: 1337-1345, Oct. 1965.

Ultrasonics is used in geology for the determination of elastic properties of rocks and minerals. For measurements on rocks, techniques with precisions of a few percent have come into use; these measure delay times of elastic waves propagating through specimens several inches long. For single crystals, the techniques are the same as those used in solid state physics and are basically interferometric methods. Techniques of measurement are reviewed. An extensive bibliography is included. (Contractor's abstract)

2630

Southwest Center for Advanced Studies, Dallas, Tex.

QUASI-STELLAR SOURCES AND GRAVITATIONAL COLLAPSE; PROCEEDINGS OF THE FIRST TEXAS SYMPOSIUM ON RELATIVISTIC ASTROPHYSICS, Dallas, Tex., Dec. 16-18, 1963, ed. by I. Robinson,

A. Schild, and E. L. Schucking. Chicago U. Press, 1965, 475p. incl. illus. diagrs. tables, refs. (AFOSR-65-1494) (In cooperation with Texas U., Dallas and Yeshiva U., New York) (Sponsored jointly by Aeronautical Research Laboratory; Air Force Office of Scientific Research under AF AFOSR-64-539, National Aeronautics and Space Administration, National Science Foundation, and Office of Naval Research) Unclassified

Papers presented at the first Texas Symposium on Relativistic Astrophysics and related papers are reported. Theories of the quasi-stellars that were first identified in 1963 and theories on the strong radio sources that led to their discovery are discussed. The theory of gravitational collapse is given special consideration. Though the gravitational field is the weakest field in nature, it is the only one that can theoretically account for the enormous energy output of the quasi-stellars. It was established at the conference that the quasi-stellars are superstars, emitting enormous amounts of energy and located far beyond what had been thought to be the edge of space; still their interior structure and physical mechanism of energy production are not understood.

2631

Southwest Center for Advanced Studies, Dallas, Tex.

ALL HOMOGENEOUS SOLUTIONS OF EINSTEIN'S FIELD EQUATIONS WITH INCOHERENT MATTER AND ELECTROMAGNETIC RADIATION, by I. Ozsvath. [1965] [4]p. (AFOSR-66-0379) (AF AFOSR-64-709) AD 630236 Unclassified

Also published in Jour. Math. Phys., v. 6: 1265-1268, Aug. 1965.

The theorem is proven that the Einstein field equations with dust and electromagnetic null field have only two homogeneous solutions. Discussions of these two solutions appear in another paper.

2632

Southwest Center for Advanced Studies, Dallas, Tex

NEW HOMOGENEOUS SOLUTIONS OF EINSTEIN'S FIELD EQUATIONS WITH INCOHERENT MATTER OBTAINED BY A SPINOR TECHNIQUE, by I. Ozsvath. [1965] [21]p. (AFOSR-66-0061) (AF AFOSR-65-903) AD 630310 Unclassified

Also published in Jour. Math. Phys., v. 6: 590-610, Apr. 1965.

Einstein's field equations with incoherent matter are solved for the case of homogeneous spacetime, i.e., for metrics allowing a 4 parametric simply transitive group of motions. Two families of new solutions are obtained by use of a spinor technique. As a special result a proof emerges for Godel's theorem, which states that there exist only 2 homogeneous solutions of Einstein's field equations with incoherent matter and rigid rotation, namely the Godel cosmos and the Einstein static universe.

2633

Southwest Center for Advanced Studies, Dallas, Tex.

UNITARY SYMMETRY VIEWED AS A BROKEN ROTATIONAL INVARIANCE, by Y. Ne'eman and I. Ozsvath. [1965] [14]p. incl. tables, refs. (AFOSR-66-0062) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-903, Atomic Energy Commission, and National Aeronautics and Space Administration) AD 630321 Unclassified

Also published in Phys. Rev., v. 138: B1474-B1487, June 1965.

The incorporation of Q = - S currents into SU(3) theory implies its extension into an R(8) symmetry. Universality requires that these "skew" currents have a much weaker coupling than the ΔS = - ΔQ transitions. The R(8) currents may cause the breakdown of CP invariance as suggested by Wolfenstein. An R(8) model would not allow the existence of SU(3) triplets. (Contractor's abstract)

2634

Southwest Center for Advanced Studies, Dallas, Tex.

ENERGY CONSERVATION AS THE BASIS OF RELATIVISTIC MECHANICS. II, by J. Ehlers and W. Rindler [1965] [3]p. (AFOSR-66-0468) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR 65-903 and National Aeronautics and Space Administration) Unclassified

Also published in Amer. Jour. Phys., v. 33: 995-997, Dec. 1965.

From the relativity principle and the conservation of energy in particle collisions the form of the energy function is deduced, as is, the conservation of inertial mass and three-momentum. It is shown that the arguments are parallel under Einsteinian and Galilean kinematics.

2635

Southwest Center for Advanced Studies, Dallas, Tex.

HOMOGENEOUS SOLUTIONS OF THE EINSTEIN-MAXWELL EQUATIONS, by I. Ozsvath, [1965] [11]p. (AFOSR 66-0471) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-903 and National Aeronautics and Space Administration) AD 630384 Unclassified

Also published in Jour. Math. Phys. v. 6: 1255-1265, Aug. 1965.

In this paper the solutions of the Einstein-Maxwell equations are investigated under the assumption that

the metric of the space-time and the electromagnetic field are invariant under the transformations of a four-parametric, simply transitive group. The results can be summarized as follows: In the case of null electromagnetic fields there are two different possibilities; if the cosmological constant = 0, all the solutions are Robinson waves; if the cosmological constant does not = 0, there exists only one solution. There exist no other solutions for null electromagnetic fields. In the case of non-null electromagnetic fields two solutions are found. One metric is known having been first given by Robinson; A new solution is given. The question as to whether there are solutions different from these remains open.

2636

Southwest Center for Advanced Studies, Dallas, Tex.

NEW HOMOGENEOUS SOLUTIONS OF EINSTEIN'S FIELD EQUATIONS WITH INCOHERENT MATTER, by I. Ozsvath [1965] [30]p. (AFOSR 66-0479) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-903 and National Aeronautics and Space Administration) AD 631375 Unclassified

Also published in Abhandl. Math. Naturwissench. Kl., No. 1: 3-31, Jan. 1965.

Some properties of a new 2-parametric family of homogeneous solutions of Einstein's field equations with incoherent matter and with a nonvanishing cosmological constant are discussed. The 4-parametric simple transitive group of the solutions are given by the commutator relations.

2637

Southwest Center for Advanced Studies, Dallas, Tex.

[GRAVITATIONAL WAVES IN THE PRESENCE OF AN ELECTROMAGNETIC FIELD, II] Ondes gravitationneles en presence d'un champ electromagnetique, II. by M. Cahen and J. Leroy. [1965] [15]p. incl. refs. (AFOSR-66-1403) (AF AFOSR-65-903) AD 640935 Unclassified

Also published in Bull. Acad. Roy. Belg. Cl. Sci., Ser. 5, v. 51: 996-1016, 1965.

All solutions of Einstein Maxwell equations of Petrov type N in the case of a null electromagnetic field are found. Certain limiting cases are studied.

2638

Southwest Research Inst. Dept. of Electronics and Electrical Engineering, San Antonio, Tex.

NONDESTRUCTIVE EVALUATION OF METAL FATIGUE, by F. N. Kusenberger, B. E. Leonard and others. Final rept. Mar. 1965, 85p. incl. illus. diagrs. tables, refs. (AFOSR-65-0981) (AF 49(638)1352) AD 619685 Unclassified

Work under this program has included studies of the usefulness of ultrasonic and magnetic techniques as nondestructive observational methods for determining the extent of fatigue development in both ferromagnetic and nonferromagnetic metals. Investigations were conducted on rod-type specimens cycled in direct tension. The magnetic techniques were carried out on steel specimens and the ultrasonic techniques on both steel and aluminum. Methods were investigated for generating and focusing Rayleigh waves, and transducer design and fabrication were examined. X-ray diffraction measurements, using a 0.004 in. diam collimator, were also made in the vicinity of the tip of a small fatigue crack.

2639

Southwest Research Inst. Dept. of Mechanical Sciences, San Antonio, Tex.

TRANSIENT HEAT CONDUCTION AT HIGH THERMAL FLUX, by U. S. Lindholm, E. J. Baker, and R. C. Kirkpatrick. [1965] [4]p. incl. illus. diagrs. (AFOSR-65-1158) (AF 49(638)1119) AD 618002 Unclassified

Presented at Winter annual meeting of the Amer. Soc. Mech. Engineers, Philadelphia, Pa., Nov. 17-22, 1963.

Also published in Jour. Heat Transfer, v. 87: 49-52, Feb 1965.

Transient heat conduction in a copper rod was studied using an arc-imaging furnace to supply pure radiant thermal energy at flux levels up to 1000 cal/cm^2-sec. No significant effects were observed attributable to the rate of heating up to and through melting at the surface. Transient temperature profiles agree well with theory and melting was initiated at its equilibrium temperature. The dynamics of the vaporization process are more uncertain. (Contractor's abstract)

2640

Southwest Research Inst. Dept. of Mechanical Sciences, San Antonio, Tex.

WAVE PROPAGATION IN AN ELASTIC NONHOMOGENEOUS BAR OF FINITE LENGTH, by U. S. Lindholm and K. D. Doshi. [1965] [8]p. incl. diagrs. (AFOSR-65-1159) (AF 49(638)1119) AD 618980 Unclassified

Presented at Winter annual meeting of the Amer. Soc., Mech. Engineers, New York, Nov. 29-Dec. 3, 1964.

Also published in Jour. Appl. Mech. v. 32: 135-142, Mar. 1965.

The case of an elastic disturbance propagating in a nonhomogeneous bar of finite length is solved by using the principle of virtual work. The nonhomogeneity is prescribed as a continuously varying modulus of elasticity with position in the bar. The density is assumed constant. Numerical results are presented for a finite-length pressure pulse in a free-free bar

giving a comparison between the homogeneous and non-homogeneous solutions. (Contractor's abstract)

2641

Southwest Research Inst. [Dept. of Mechanical Sciences] San Antonio, Tex.

TRANSIENT STRESSES IN SOLIDS INDUCED BY RADIANT SURFACE HEATING, by U. S. Lindholm. [1965] [3]p. incl. diagrs. (AFOSR-65-1740) (AF 49(638)1119) AD 625990 Unclassified

Also published in AIAA Jour., v. 3: 1203-1205, June 1965.

If the surface of a solid is exposed to a very high rate of radiant heating, transient stresses may be induced either by thermoelastic coupling at low surface temperatures or by rapid vaporization at high surface temperatures. Some preliminary considerations of this phenomena are discussed. An experiment is described for detecting transient stresses in a rod-type lead specimen resulting from a high thermal flux at one end. The specimen is heated in an arc-imaging facility. The transient pressures measured appear in qualitative agreement with predictions based on rapid vaporization from the surface. More quantitative agreement will require accurate knowledge of the surface emissivity, surface temperature, and internal energy distribution in the solid or melt.

2642

Space Sciences, Inc., Waltham, Mass.

ASYMPTOTIC SOLUTIONS OF THE BHATNAGAR-GROSS-KROOK EQUATION, by L.-K. Chi. [1965] [2]p. (AF 49(638)1228) AD 625965 Unclassified

Also published in Phys. Fluids, v. 8: 991-992, May 1965.

The relationship between the Boltzmann equation and the boundary-layer equations is investigated. It is shown that the boundary-layer equations can be derived directly from the Bhatnagar-Gross-Krook model of the Boltzmann equation by coupling the Chapman-Enskog procedure with the boundary analysis. For illustration, the 2-dimensional monatomic gas flow past a semi-infinite flat plate is considered. The boundary-layer equations and the Navier-Stokes equations are found to be different asymptotic forms of the Bhatnagar-Gross-Krook equation in different limiting processes.

2643

Space Sciences Inc., Waltham, Mass.

KINETIC THEORY OF THE LEADING EDGE, by S. Ziering, L.-K. Chi, and R. Fante. [1965] [12]p. incl. diagrs. refs. (AF 49(638)1228) Unclassified

Also published in Rarefied Gas Dynamics, Proc. Fourth Internat'l. Symposium, Toronto U. (Canada) (July 14-17, 1964), ed. by J. H. de Leeuw. New York Academic Press, v. 1: 394-415, 1965.

The interaction of a finite plate with a streaming gas is considered by using the Bhatnagar, Gross, and Krook equation of statistical mechanics. In order to describe the near free molecule domain accurately, the distribution function is separated into various domains. The collisionless forms of the distribution functions are constructed and briefly discussed. When collisions are retained, integral solutions are constructed for the various parts of the distribution function. These have to be solved either by numerical methods or by approximation schemes. Various limiting cases are treated and discussed. Specific numerical results for a linearized iterative treatment in the near free molecule domain are presented. (Contractor's abstract)

2644

Sperry Rand Corp. [Univac Div.] Blue Bell, Pa.

SOME NOTES ON THE USE AND DATA PROCESSING ASPECTS OF ASSOCIATION FACTORS IN IS&R SYSTEMS, by E. G. Fossum and G. Kaskey. Mar. 30, 1965, 28p. incl. tables, refs. (Technical status rept. no. 5) (AFOSR-65-1702) (AF 49(638)1194) AD 624241 Unclassified

A number of methods have been proposed to utilize the statistical properties of pair-occurrences of index terms used to describe documents in a library. The common objective is to increase the number of terms in an original search request by the addition of others "highly associated" with them. For the study being conducted by UNIVAC a large sample of DDC (formerly ASTIA) documents were used for testing and evaluating some of the several measures of association which have been proposed, and for determining the implications of their use upon the configurations of a data processing system used in an information storage and retrieval application. The formulation of the exact purpose and nature of such tests requires incorporating the use of association factors into the total specifications of an operating IS&R system. A number of the problems connected with attempts to accomplish this are discussed.

2645

Sperry Rand Research Center, Sudbury, Mass.

SIMULATION OF THERMONUCLEAR PLASMA BY THERMALLY IONIZED PLASMAS (Abstract), by W. D. McBee. [1965] [1]p. (Bound with AFOSR 65-1266; AD 622527) (AF 49(638)1541) Unclassified

Presented at Eighth AFOSR Contractor's meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

A parallel can be drawn between hot, dense, thermonuclear plasmas and cold, thin, thermally generated plasmas in terms of certain dimensionless parameters

which relate to configurational stability. Experiments are being planned to use this parallel in a study of proposed thermonuclear plasma stabilizing field configurations and microinstabilities, using a thermally generated alkali plasma laboratory facility. The advantage of this approach lies in the ease with which parameter values and field configurations can be changed in the relatively low magnetic field, small size, low temperature simulant plasma. The thermally generated plasma system which will be the facility used in this study has been in operation for some time.

2646

Stanford Research Inst., Menlo Park, Calif.

WORK ACTIVITIES AND ATTITUDES OF SCIENTISTS AND RESEARCH MANAGERS: DATA FROM A NATIONAL SURVEY, by H. M. Vollmer. May 1965, 218p. incl. tables. (AFOSR-65-0781) (AF 49(638)1028) AD 620376 Unclassified

This report constitutes a basic data source on the organizational relations, activities, and attitudes of scientists and research managers in a variety of contexts throughout the United States. The data were obtained from a national survey of scientists and research managers in 4 disciplines-biology, chemistry, mathematics, and physics--using random samples of members of professional associations, and are broken down by 5 major variables: professional affiliation, type of employer, geographic region, educational level, and age. This is a descriptive report and largely consists of a tubular presentation of data accompanied by brief textual summaries of outstanding findings. As presented, the data are susceptible to further analysis and interpretation according to specific interests of the reader.

2647

Stanford Research Inst., Menlo Park, Calif.

LIQUID-PHASE OXIDATIONS OF CYCLIC ALKENES, by D. E. Van Sickle, F. R. Mayo, and R. M. Arluck. [1965] [9]p. incl. tables, refs. (AFOSR-66-0686) (AF 49(638)1102) AD 632255 Unclassified

Presented at meeting of the Org Chem. Div. of the Amer. Chem. Soc., Sept. 10, 1963.

Abstract published in 145th meeting of the Amer Chem. Soc. Abstracts of Papers, 1963, p. 26O.

Also published in Jour. Amer. Chem. Soc., v. 87: 4824-4832, Nov. 5, 1965.

This work was undertaken to relate the initial products of liquid-phase oxidations of unsaturated hydrocarbons under mild conditions (and thus their mechanisms of oxidation) to the structures of the hydrocarbons. Results with cyclopentene, cyclohexene, cycloheptene, cyclooctene, cyclododecene, methylenecyclohexane, and vinylcyclohexane at 50-70 are discussed in terms of the addition and hydrogen-abstraction mechanisms. Indicated rates of addition of alkylperoxy radicals to the corresponding cyclic alkenes are similar. Indicated rates of abstraction (per hydrogen atom) differ by a factor of 22 and depend partly on the degree of reorganization required to give a planar allyl radical. While the other alkenes give mostly allylic hydroperoxides, 70% of the cyloctene reacts by the addition mechanism, producing epoxide, suberic aldehyde, and polymer. These results are compared with the work of others. The "dimeric" peroxides from cyclopentene and cyclohexene are shown to be 2-(3-cycloalkenylperoxy)cycloalkanyl hydroperoxides. (Contractor's abstract)

2648

Stanford Research Inst., Menlo Park, Calif.

THE LIQUID-PHASE OXIDATION OF CYCLOPENTENE, by D. E. Van Sickle, F. R. Mayo, and R. M. Arluck. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-66-0698) (AF 49(638)1102) AD 632256 Unclassified

Presented at meeting of the Org. Chem. Div. of the Amer. Chem. Soc., Chicago, Ill., Sept. 4, 1964.

Abstract published in 148th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1964, p. 92s.

Also published in Jour. Amer. Chem. Soc., v. 87: 4832-4837, Nov. 5, 1965.

The axo-initiated oxidation of cyclopentene was studied at 50° in the presence and absence of benzene as solvent. In the absence of benzene, the oxidation is autocatalytic. The rate of initiation by hydroperoxide corresponds closely to its second-order rate of decomposition. The hydroperoxide is more stable in benzene solution and no autocatalysis of the oxidation of cyclopentene is observed in benzene at 50°. A retarder is formed during the autoxidation of cyclopentene. An intermediate steady rate of oxidation therefore may only represent a transition from initial autocatalysis to later autoretardation.

2649

Stanford Research Inst., Menlo Park, Calif.

SHOCK INITIATION OF LOW-DENSITY PRESSINGS OF AMMONIUM PERCHLORATE, by M. W. Evans, B. O. Reese and others. Oct. 1965, 26p. incl. illus. diagrs. tables, refs. (AFOSR-65-2261) (AF 49(638) 1124) AD 624537 Unclassified

Presented at Fourth Symposium on Detonation, Naval Ordnance Lab., White Oak, Silver Spring, Md., Oct. 1965.

Initiation and detonation behavior of 13 μ ammonium perchlorate was studied at loading density 1.00 g cm^3. Steady detonation velocities were determined experimentally at three diameters and extrapolated to 3.75 $\pm$ 0.15 mm μsec at infinite diameter. Calculations with the BKW equation of state give 4 25 mm μsec-- as good agreement as could be expected for a low-energy

chlorine-containing explosive. By introducing 24-kbar flat-topped plane shocks into pellets of various lengths, it was determined that steady full-strength detonation was reached after about 15 mm travel. The growth of pressure in the accelerating wave was followed approximately be means of free-surface measurements on thin Plexiglas at the top surfaces of the pellets, and these measurements indicated the pressure to be 55 ± 10 kbar in the full-strength wave. Reducing the air pressure in the pressings to 5 microns left the build-up to detonation unaffected. The position of the shock Hugoniot for the pressings relative to the Hugoniot of the solid crystal is discussed in terms of heat production during collapse and possible reaction processes. (Contractor's abstract)

2650

Stanford Research Inst., Menlo Park, Calif.

AN ANALYSIS OF THE SHOCK INITIATION OF GRANULAR EXPLOSIVES BY THE GAS COMPRESSION-CONDUCTION MECHANISM, by C. M. Ablow, Y. D. S. Rajapakse, and M. W. Evans. Oct. 1, 1965 [30]p. incl. diagrs. tables, refs. (Rept. no. WSCI 65-30) (AFOSR-65-2308) (AF 49(638)1124) AD 628033 Unclassified

The role of the gas compression-conduction mechanism in shock initiation of granular materials was studied by analyzing the dependence of grain surface temperature on the magnitude of the shock and the relative sizes of grain and surrounding volume of interstitial gas. It is shown that at one atmosphere initial ambient pressure the mechanism can be a contributing factor to initiation if particle size distribution or particle irregularity leads to the existence of small particles surrounded by large, gas-filled spaces; the required sizes are possible for real materials. At low pressures (approximately 10μ hg) on the other hand, it is unlikely that the mechanism is a contributing factor. Since in practice these granular masses can be shock-initiated independent of initial ambient pressure, the conclusion is that at least one primary initiation mechanism other than gas compression-conduction plays a role. (Contractor's abstract, modified)

2651

Stanford Research Inst., Menlo Park, Calif.

SHOCK WAVE COMPRESSION OF 'PLEXIGLAS' IN THE 2.5 TO 20 KILOBAR REGION, by D. N. Schmidt and M. W. Evans. [1965] [4]p. incl. illus. diagrs. table. (AFOSR-65-2492) (AF 49(638)1124) AD 628715 Unclassified

Also published in Nature, v. 206: 1348-1349, June 26, 1965.

The dynamic compressibility of 'plexiglas' in the range from 2.5 to 20 kbar was studied using the wedge and optimal lever technique described by Fowles. Cast 'plexiglas', determined by photoelastic examination to be freer of structure and residual strain than extruded or moulded material, was used. The results imply the existence of a maximum shear stress of 1.5 times the observed stress difference, that is 1.5 x 3 kbar = 4.5 kbar. The reduction of critical shear stress to 1.5 x 2 kbar = 3 kbar at the higher shock amplitude may be due to the associated temperature increase, which is estimated to be 60°C. The absence of a precursor wave is reflected in the pressure-volume curve as a positive monotonic second derivative. This implies that yielding occurs over a range of stresses and cannot be assigned a definite value.

2652

Stanford Research Inst., Menlo Park, Calif.

RESEARCH ON UNSTABLE COMBUSTION IN SOLID PROPELLANT ROCKETS, by L. A. Dickinson, E. L. Capener, and R. J. Kier. Annual rept. Jan. 1, 1964-Dec. 31, 1964. Jan. 13, 1965 [58]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1418) (AF 49(638)1367) AD 612178 Unclassified

Initiation of axial combustion instability in an experimental combustor 40 in. long by 50 in. inside diam containing a radial burning grain is studied utilizing a wide variety of composite propellants. Where instability occurs a correlation is found between the threshold pressure at which instability is first observed and propellant ballistic parameters notably the linear burning rate. Fast burning propellants containing either a catalyst or potassium perchlorate, do not sustain axial mode combustion instability. Transverse instability is observed for most non-aluminized propellants in pressure regimes where they are stable to axial combustion instability. A granular diffusion flame model is shown as a promising explanation of combustion stability criteria. (Contractor's abstract)

2653

[Stanford Research Inst. Poulter Labs., Menlo Park, Calif.]

CONTACT POTENTIAL OF A SHOCKED METAL, by G. E. Duvall and R. M. Thomson. [1965] [17]p. incl. diagrs. tables. (In cooperation with Washington State U., Pullman) [AF 49(638)1086] Unclassified

Published in Physics of Solids at High Pressures, Proc. First Internat'l. Conf., Tucson, Arizona (Apr. 20-23, 1965), ed. by C. T. Tomizuka and R. M. Emrick, New York, Academic Press, 1965, p. 196-212.

The motion of electrons in a mechanically shocked solid is examined theoretically, using as a basis the assumptions that the electrons have a fermi distribution of velocities, that they accelerate classically under the influence of internal electric fields, and that their interactions with the solid lattice are adequately described by a relaxation process. In an acoustic approximation the potential difference between two pressure-free surfaces of a shocked slab is found to be zero. (Contractor's abstract)

2654

Stanford U., Calif.

NONLINEAR MAGNETOELASTIC INTERACTIONS, by B. A. Auld. [1965] [17]p. incl. illus. diagrs. refs. [AF 49(638)1429] Unclassified

Published in Proc. IEEE, v. 53: 1517-1533, Oct. 1965.

The physical basis for magnetoelastic coupling is presented in terms of simple models. These models are used to illustrate the magnetoelastic nonlinearities present in real crystals, and an enumeration is made of the instabilities which can be excited by means of these nonlinearities. Published material on instability theory and experiments is reviewed, and current possibilities for device applications are briefly evaluated. (Contractor's abstract)

2655

Stanford U. [Applied Mathematics and Statistics Lab.] Calif.

ON HYPERBOLIC MIXED PROBLEMS, by L. Sarason. [1965] [25]p. (AFOSR-65-1397) (AF 49(638)1345) AD 622651 Unclassified

Also published in Arch. Rational Mech. and Anal., v. 18: 310-334, 1965.

The mixed problem for first order strictly hyperbolic systems with principal parts having constant coefficients is considered. An explicit representation is given for the solution of the mixed problem with inhomogeneous righthand side, initial, and boundary data when the lower-order term is absent. In the case that the boundary condition is dissipative and there are just two space-like variables, an estimate is given which is similar to Agmon's, but extends it in that there is no restriction on the characteristic roots of the operator beyond those imposed by strict hyperbolicity and in that the boundary value of the solution is also estimated. The estimate permits the addition to the differential operator of a lower order term with variable coefficients.

2656

Stanford U. [Applied Mathematics and Statistics Lab.] Calif.

THE SPAN AND PRINCIPAL FUNCTIONS IN RIEMANNIAN SPACES, by L. Sario, M. Schiffer, and M. Glasner. [1965] [20]p. (Sponsored jointly by Air Force Office Office of Scientific Research under AF 49(638)1345 and National Science Foundation) (In cooperation with California U., Los Angeles) AD 624114 Unclassified

Also published in Jour. D'Anal. Math., v. 15: 115-134, 1965.

The first step in building up a theory of harmonic functions of finite norm in a Riemannian space is to characterize the spaces in which such functions exist. Let HD be the class of harmonic functions with finite norm D, and denote by O_{HD} the class of Riemannian spaces that do not carry nonconstant functions in HD. We shall associate with every Riemannian space R a number S such that $R \in O_{HD}$ if and only if $S = 0$. The number S shall be called the span of R. This result together with other properties of the span was a consequence of a general extremum theorem in the theory of principal functions, which was developed for Riemannian spaces. The approach employed was a generalization of a method previously used for the Laplacian and for elliptic operators in Euclidean space. At the crucial step of establishing convergence, earlier proofs do not, however, generalize. This difficulty was overcome by the fact that the main existence theorems for principal functions can also be used in continuity and convergence arguments.

2657

Stanford U. [Applied Mathematics and Statistics Lab.] Calif.

THE DECOMPOSITION OF CERTAIN GROUP REPRESENTATIONS, by K. de Leeuw and I. Glicksberg. [1965] 57p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-62-381] and National Science Foundation) Unclassified

Also published in Jour. D'Anal. Math., v. 15: 135-192, 1965.

Let G^d be the discrete version of a locally compact group G. If U is a unitary representation of G^d on a Hilbert space H, which is also weakly measurable on G, von Neumann and Segal have shown that $H = H_c \oplus H_0$, where H_c, H_0 are invariant orthogonal subspaces consisting, respectively, of all χ in H with $g \to U_g \chi$ continuous on G, and those χ in H for which $g \to (U_g \chi, \chi)$ is a null (L^1) function on G. Correspondingly, if p is any positive definite function on G^d, locally measurable as a function on G, then $p = p_c + p_0$ where p_c is positive definite and continuous, while p_0 is positive on G^d and a null function on G. This paper was devoted to some extensions of this result to a much broader context, in which local compactness and measurability need not play a fundamental role.

2658

Stanford U. Dept. of Aeronautics and Astronautics, Calif.

HYPERSONIC FLOW OVER AN OSCILLATING WEDGE, by S. C. McIntosh, Jr. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-1744) [AF 49(638)1274] AD 625974 Unclassified

Presented at Amer. Inst. Aeronaut. Astronaut. Fifth Annual Structures and Materials Conf., Palm Springs, Calif. Apr. 1-3, 1964.

Also published in AIAA Jour., v. 3: 433-440, Mar. 1965.

The equations of hypersonic small-disturbance theory are perturbed for small oscillations of a thin, semi-infinite, flexible wedge. A solution for arbitrary smooth mode shapes is found in terms of infinite series. It is shown that the results from more approximate methods, such as piston theory and others that attempt to account for a strong bow shock, can be reproduced by successively neglecting terms in the complete solution. It appears that the most significant contribution of the complete solution is to change the phase shift of the unsteady pressure. It is shown that the complete solution is the only one that will produce an adequate representation in the double limit of very large Mach number and adiabatic exponent near unity. (Contractor's abstract)

2659

Stanford U. Dept. of Aeronautics and Astronautics, Calif.

A METHOD OF SERIES TRUNCATION APPLIED TO SOME PROBLEMS IN FLUID MECHANICS, by M. Van Dyke. Oct. 1965, 20p. incl. diagrs. refs. (SUDAER rept. no. 247) (AFOSR-65-2014) (AF 49(638)1274) AD 627655 Unclassified

Presented at Seventh Symposium on Advanced Problems and Methods in Fluid Dynamics, Jurata (Poland), Sept. 1965.

During the last few years a method of series truncation has been applied to some of the problems in fluid mechanics. In this paper significant features of this method are discussed. Illustrative examples are drawn partly from published work and a number of new results, some still in the process of completion, are included. Topics covered are: (1) thin layer: the blunt-body problem; (2) changes of variable: an accurate blunt-body solution; (3) thick layer: viscous flow past circle and parabola.

2660

Stanford U. Dept. of Aeronautics and Astronautics, Calif.

HYPERSONIC FLOW BEHIND A PARABOLOIDAL SHOCK WAVE, by M. Van Dyke. [1965] [17]p. incl. diagrs. tables, refs. (AFOSR-66-2242) (AF 49(638) 1274) AD 645409 Unclassified

Also published in Jour. Mecanique, v. 4: 477-493, Dec. 1965.

A standard blunt-body problem is studied: the axis-symmetric flow of diatomic gas at infinite Mach number past the semi-infinite body that produces a paraboloidal bow wave. The method of series truncation is modified to provide an accurate semi-analytical solution. The fourth truncation yields four-figure accuracy throughout the subsonic region. Comparison is made with other methods, 3 of which closely check the present results. (Contractor's abstract)

2661

Stanford U. [Dept. of Aeronautics and Astronautics] Calif.

A COMPARISON OF THREE PERTURBATION METHODS FOR EARTH-MOON-SPACESHIP PROBLEM, by A. H. Nayfeh. [1965] [6]p. incl. diagrs. refs. (AF 49(638) 1274) Unclassified

Published in AIAA Jour., v. 3: 1682-1687, Sept. 1965.

The limiting case of the restricted 3 body problem, in which the mass of one of the finite bodies is much smaller than the mass of the other, is of the singular perturbation type. The first-order perturbation solution has a logarithmic singularity at the position of the smaller body, and higher approximations are increasingly more singular. Three methods of treating singular perturbation problems are compared as applied to this problem. Uniformly valid first-order solutions are obtained for the problem of a two-fixed force-center by using the generalized method. It is shown that the generalized method gives better approximations than the method of inner and outer expansions and thus can be used for wider ranges of the small parameter. Furthermore, the Poincare-Lighthill-Kuo (PLK) method is shown to give incorrect results for the trajectory. (Contractor's abstract)

2662

[Stanford U. Dept. of Aeronautics and Astronautics, Calif.]

AN EXPANSION METHOD FOR TREATING SINGULAR PERTURBATION PROBLEMS, by A. H. Nayfeh. [1965] [6]p. (AF 49(638)1274) Unclassified

Published in Jour. Math. Phys., v. 6: 1946-1951, Dec. 1965.

Cochran's method for treating singular perturbation problems is shown to give, in some cases, expansions which are not uniformly valid. This method is modified and extended to give uniformly valid expansions. The new method is applied to the problem of heat transfer in a duct to give a solution in agreement with that obtained by the WKBJ method. (Contractor's abstract)

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Stanford U. Dept. of Aeronautics and Astronautics, Calif.

THE BUCKLING BEHAVIOR OF UNIFORMLY HEATED THIN CIRCULAR CYLINDRICAL SHELLS, by B. Ross, N. J. Hoff, and W. H. Horton. Apr. 1965 [58]p. incl. illus. diagrs. tables, refs. (SUDAER rept. no. 225)

(AFOSR-65-0982) (AF 49(638)1276) AD 618092
Unclassified

The results of buckling tests on uniformly heated, clamped, thin circular cylindrical shells are presented and discussed. Particular attention is paid to both the actual buckling process and the ensuing postbuckling behavior. Load versus end shortening curves are included and it is remarked that, in the thermal buckling problem, such curves are nonlinear. The possibility of snap-through buckling, which occurs at a value of end shortening greater than that corresponding to the maximum supported load, is experimentally verified. A comparison of the present experimental results with available theory is made. It is observed that the experimental values of the buckling temperature can be substantially greater than the temperatures calculated by linear theory from the experimental buckling loads. (Contractor's abstract)

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Stanford U. Dept. of Aeronautics and Astronautics, Calif.

BUCKLING OF CIRCULAR CYLINDRICAL SHELLS UNDER EXTERNAL PRESSURE, by T.-C. Soong. Apr. 1965, 34p. incl. diagrs. tables, refs. (SUDAER rept. no. 228) (AFOSR-65-0986) (AF 49(638)1276) AD 619684 Unclassified

A set of uncoupled differential equations of equilibrium based on Sanders' assumptions has been developed which includes the effects of the prestresses. Both the Sanders-type equations and Donnell's equations are solved for the buckling pressure of shells under lateral and hydrostatic pressure. It is found that restriction of the axial displacement has considerable influence upon the buckling pressure. Moreover, the more rigorous Sanders-type equations yield lower buckling pressures than Donnell's equations (Contractor's abstract)

2665

Stanford U. Dept. of Aeronautics and Astronautics, Calif.

ELASTIC PLASTIC ANALYSIS OF THE COLLAPSE OF UNIFORMLY COMPRESSED CIRCULAR CYLINDRICAL SHELLS, by T.-C. Soong and N. J. Hoff. Apr. 1965, 50p. incl. illus. diagrs. tables, refs. (SUDAER rept. no. 231) (AFOSR-65-1587) (AF 49(638)1276) AD 625276 Unclassified

A new geometric form is proposed as a large-displacement buckling pattern of a circular cylindrical shell of finite length simply supported at the ends and subjected to axial compressive load. Exact expressions are derived for displacements and membrane strains. They show that the new pattern is almost entirely free of membrane strain. During buckling plastic yield hinges are assumed to develop which form ridges separating the mostly flat buckled surfaces. The buckling load and the postbuckling load are calculated from the energy balance and from a compatibility condition of the displacements of test specimen and elastic testing machine. (Contractor's abstract)

2666

Stanford U. Dept. of Aeronautics and Astronautics, Calif.

THE SNAP-THROUGH AND POSTBUCKLING EQUILIBRIUM BEHAVIOR OF CIRCULAR CYLINDRICAL SHELLS UNDER AXIAL LOAD, by W. A. Madsen and N. J. Hoff. Apr. 1965, 68p. incl. diagrs. tables, refs. (SUDAER rept. no. 227) (AFOSR-65-1588) (AF 49(638)1276) AD 625275 Unclassified

The present analysis was begun with an investigation of the effect that a more accurate displacement assumption, in conjunction with the exact strain-displacement relations, has on the postbuckling equilibrium behavior. It was hoped that the limiting behavior of wall thickness and wave number parameter would be altered, and that the stress coefficient would not tend to zero. Particular attention was given to an exact representation of membrane strains because it was known that in the limit as the radius-to-thickness ratio of the shell approaches infinity, the displacements approach the inextensional polyhedral surface. While all the strains in the middle surface of this limiting polyhedral shell are zero, the Donnell strain-displacement relations yield strains amounting to 0.1% if the number of waves around the circumference is 10. The results obtained did not differ significantly from the Donnell strain-displacement relations. (Contractor's abstract)

2667

Stanford U. Dept. of Aeronautics and Astronautics, Calif.

AN ANALOG STUDY OF THE THERMAL BUCKLING BEHAVIOR OF THIN CYLINDRICAL SHELLS, by B. Ross. Apr. 1965 [29]p. incl. diagrs. (SUDAER rept. no. 226) (AFOSR-65-1875) (AF 49(638)1276) AD 629580 Unclassified

A simple beam-column model is utilized to study the thermal buckling behavior of similar shells. Closed-form solutions of the governing differential equation are presented for the cases of simply-supported ends and clamped ends. Numerical calculations are performed and the data obtained used to construct equilibrium curves relating the axial load to the axial end shortening and to the midlength lateral deflection. The theoretical curves obtained for the clamped beam-column are in good qualitative agreement with the experimental curves recorded in an equipment problem of a previous investigation. (Contractor's abstract)

2668

Stanford U. Dept. of Aeronautics and Astronautics, Calif.

A NEW SOLUTION OF THE BUCKLING PROBLEM OF THIN CIRCULAR CYLINDRICAL SHELLS HEATED ALONG AN AXIAL STRIP, by N. J. Hoff and B. Ross. May 1965, 25p. incl. diagrs. refs. (SUDAER rept. no. 234) (AFOSR-66-0005) (AF 49(638)1276)
AD 629579 Unclassified

With the aid of a set of orthonormal functions the critical temperatures are calculated for thin-walled circular cylindrical shells rapidly heated along a narrow axial strip. The results obtained are compared with experimental data of an earlier investigation. (Contractor's abstract)

2669

Stanford U. Dept. of Aeronautics and Astronautics, Calif.

[SOME NEW RESULTS FROM RESEARCH ON THE BUCKLING OF CYLINDRICAL SHELLS] Quelques nouveaux resultats de recherches sur le flambage des coques cylindriques, by N. J. Hoff. May 1965 [49]p. incl. illus. diagrs. tables, refs. (SUDAER rept. no. 240) (AFOSR-66-0065) (AF 49(638)1276) AD 628925 Unclassified

Recent results for cylindrical shell buckling under uniformly distributed axial compression are reviewed. Based on the results an analysis was performed of a semi-infinite shell with nonrigid support. In addition, the theory of large displacements is discussed, along with the significance of an equilibrium state with large displacements A bibliography of recent publications on shell theory is included.

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Stanford U. Dept. of Biological Sciences, Calif.

THE MECHANISM OF DISCHARGE PATTERN FORMATION IN CRAYFISH INTERNEURONS, by K. Takeda and D. Kennedy. [1965] [19]p. incl. diagrs. refs. (AFOSR-66-1131) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-147 and Public Health Service) AD 640183 Unclassified

Also published in Jour. Gen. Physiol., v. 48: 435-453, Jan. 1965.

Excitatory and inhibitory processes which result in the generation of output impulses were analyzed in single crayfish interneurons by using intracellular recording and membrane polarizing technique. Individual spikes which are initiated orthodromically in axon branches summate temporally and spatially to generate a main axon spike; temporally dispersed branch spikes often pace repetitive discharge of the main axon. Hyperpolarizing IPSP's sometimes suppress anonal discharge to most of these inputs, but in other cases may interact selectively with some of them. The IPSP's reverse their polarity at a hyperpolarized level of membrane potential; they sometimes exhibit 2 discrete time courses indicating 2 different input source. Outward direct current at the main axon near branches causes repetitive discharges which may last, with optimal current intensities, for 1 to 15 sec. The relation of discharge frequency to current intensity is linear for an early spike interval, but above 100 to 200 impulses/sec it begins to show saturation. In one unit the current-frequency curve exhibited two linear portions, suggesting the presence of 2 spike-generating sites in the axon. Current threshold measurements, using test stimuli of different durations, showed that both accommodation and "early" or "residual" refractoriness contribute to the determination of discharge rate at different frequencies. (Contractor's abstract)

2671

Stanford U. Dept. of Biological Sciences, Calif.

FUNCTIONAL ROLE OF MUSCLE RECEPTOR ORGANS IN CRAYFISH, by H. L. Fields and D. Kennedy. [1965] [6]p. incl. illus. diagrs. refs. (AFOSR-66-1132) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-334, Epilepsy Foundation, and Public Health Service) AD 641487 Unclassified

Also published in Nature, v. 206: 1232-1237, June 19, 1965.

The abdominal stretch receptors of decapod crustaceans have been extensively analyzed as to mechanisms of transduction and of excitatory and inhibitory control. Despite the thoroughness with which this organ has been examined as a receptor, little is known of its reflex function or of its central connections. Two types of experiments have been performed to elucidate the function of this proprioceptor in the reflex control of abdominal muscles in the crayfish. The first approach was to determine the innervation pattern of the extensor musculature. Glass microelectrodes were used to record junctional events in muscle fibers while the nerve trunk to the extensors was electrically stimulated with brief pulses of graded intensity. A more directly functional approach involved analysis of the central effects of stretch receptor output with all neural connections intact. In these experiments, receptor discharge was monitored with a fine platinum wire hooked under the dorsal nerve. Motoneurone discharge was simultaneously followed by monitoring junctional potentials in other extensor muscle fibers with an intracellular microelectrode.

2672

Stanford U. Dept. of Biological Sciences, Calif.

REFLEX CONTROL OF ABDOMINAL FLEXOR MUSCLE IN THE CRAYFISH. II. THE TONIC SYSTEM, by D. Kennedy and K. Takeda. [1965] [18]p. incl. diagrs. tables, refs. (AFOSR-66-1133) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-334 and Public Health Service)
AD 641488 Unclassified

2668

Stanford U. Dept. of Aeronautics and Astronautics, Calif.

A NEW SOLUTION OF THE BUCKLING PROBLEM OF THIN CIRCULAR CYLINDRICAL SHELLS HEATED ALONG AN AXIAL STRIP, by N. J. Hoff and B. Ross. May 1965, 25p. incl. diagrs. refs. (SUDAER rept. no. 234) (AFOSR-66-0005) (AF 49(638)1276) AD 629579 Unclassified

With the aid of a set of orthonormal functions the critical temperatures are calculated for thin-walled circular cylindrical shells rapidly heated along a narrow axial strip. The results obtained are compared with experimental data of an earlier investigation. (Contractor's abstract)

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Stanford U. Dept. of Aeronautics and Astronautics, Calif.

[SOME NEW RESULTS FROM RESEARCH ON THE BUCKLING OF CYLINDRICAL SHELLS] Quelques nouveaux resultats de recherches sur le flambage des coques cylindriques, by N. J. Hoff. May 1965 [49]p. incl. illus. diagrs. tables, refs. (SUDAER rept. no. 240) (AFOSR-66-0065) (AF 49(638)1276) AD 626925 Unclassified

Recent results for cylindrical shell buckling under uniformly distributed axial compression are reviewed. Based on the results an analysis was performed of a semi-infinite shell with nonrigid support. In addition, the theory of large displacements is discussed, along with the significance of an equilibrium state with large displacements A bibliography of recent publications on shell theory is included.

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Stanford U. Dept. of Biological Sciences, Calif.

THE MECHANISM OF DISCHARGE PATTERN FORMATION IN CRAYFISH INTERNEURONS, by K. Takeda and D. Kennedy. [1965] [19]p. incl. diagrs. refs. (AFOSR-66-1131) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-147 and Public Health Service) AD 640183 Unclassified

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2671

Stanford U. Dept. of Biological Sciences, Calif.

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2672

Stanford U. Dept. of Biological Sciences, Calif.

REFLEX CONTROL OF ABDOMINAL FLEXOR MUSCLE IN THE CRAYFISH. II. THE TONIC SYSTEM, by D. Kennedy and K. Takeda. [1965] [18]p. incl. diagrs. tables, refs. (AFOSR-66-1133) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-334 and Public Health Service) AD 641488 Unclassified

Also published in Jour. Exper. Biol., v. 43: 229-246, 1965.

The flexor musculature of the crayfish abdomen is divided into 2 systems: a set of tonic superficial muscles, and a complex series of massive flexor muscles that produce powerful twitches but never exhibit tonic contractions. The muscle types are histologically differentiated, and also separately inervated: the main flexors receive 10 large motor axons, and the slow superficial muscles six smaller ones. Impulses in the inhibitor axon, even at the optimal interval, reduce the amplitude of excitatory post-functional potentials by only a small amount: their effect in shortening duration is more notable. It is postulated that the peripheral inhibitor functions to cut short excitatory depolarizations and hence to terminate lingering tension that might oppose subsequent reflex actions. (Contractor's abstract)

2673

Stanford U. Dept. of Biological Sciences, Calif.

REFLEX CONTROL OF ABDOMINAL FLEXOR MUSCLES IN THE CRAYFISH. I. THE TWITCH SYSTEM, by D. Kennedy and K. Takeda. [1965] [18]p. incl. illus. diagrs. refs. (AFOSR-66-2370) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-334 and Public Health Service) AD 646557 Unclassified

The flexor musculature of the crayfish abdomen is divided into 2 systems: a set of tonic superficial muscles, and a complex series of massive flexor muscles that produce powerful twitches but never exhibit tonic contractions. The muscle types are histologically differentiated, and also separately innervated: the main flexors receive ten large motor axons, and the slow superficial muscles six small ones. Fibres of the main flexor muscles studied are almost all triply innervated; each receives endings from (a) the "motor giant axon, (b) one of several specific nongiant motor axons, and (c) a common inhibitor. Excitatory junctional potentials due to motor giant and non-giant anons are similar and large; each may trigger secondary, active "spikes", thus often producing post-junctional responses of 100 m V. or more. Activity in the central giant fibres drives both motor axons. The response to both when the motor giant system is fully rested, is slightly larger than that to either alone; when activated by stimulation of the central giant fibre the junctional potentials are evoked asynchronously due to differences in central reflex time, and double spiking in the muscle fibres sometimes results. (Contractor's abstract modified)

2674

Stanford U. Dept. of Chemistry, Calif.

INDUCTIVE EFFECTS ON THE POSITION OF A RING-CHAIN EQUILIBRIUM, by R. H. Eastman and K. Tamaribuchi. [1965] [3]p. incl. diagrs. table. (AFOSR-65-1635) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1272 and National Science Foundation) AD 624006 Unclassified

Also published in Jour. Org. Chem., v. 30: 1671-1673, May 1965.

A Hammett study is made of the succinic acid-succinic anhydride equilibrium in order to quantitatively evaluate the relative importance of bulk versus electronic influences in ring-chain equilibria. In the compounds studied, only an inductive effect is possible. Results show that the effect of the substituents cannot be purely electronically inductive and that electron-injecting groups favor the anhydride form. The data suggest focusing attention on effects of electron donation on the stability of the anhydride form, assuming that the substituent has little effect on that of the diacid.

2675

Stanford U. [Dept. of Chemistry] Calif.

FACTORS INVOLVED IN THE STABILITY OF CYCLOPROPANES. Final technical rept. Oct. 1, 1961-Sept. 15, 1965, 13p. incl. diagrs. (AFOSR-65-1793) (AF 49(638)1272) AD 625080 Unclassified

Brief summaries are presented of research accomplishments on the following topics: (1) thermally-induced valence bond isomerization in the bicyclo[3.1.0]-hexene system; (2) the steric relationship between the cyclopropane ring and the benzene ring in a series of phenylcyclopropanes; (3) the thermal isomerization of trans-2-thujene and the stereochemistry of the reduction of dihydroumbellulone; (4) the synthesis of cyclic ketones which undergo facile photodecarbonylation in solution; and (5) ring-chain, anhydride-diacid equilibrium which is found only slightly sensitive to inductive electronic effects.

2676

Stanford U. Dept. of Genetics, Palo Alto, Calif.

OPTICAL RESOLUTION OF D, L AMINO ACIDS BY GAS CHROMATOGRAPHY AND MASS SPECTROMETRY, by B. Halpern, J. W. Westley and others. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-2031) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-886, National Aeronautics and Space Administration, and National Institutes of Health) AD 629825 Unclassified

Also published in Biochem. and Biophys. Research Commun., v. 20: 710-714, 1965.

Experiments were conducted on DL-amino acids with the L-form labeled with two ^{2}H atoms. They were coupled with trifluoroacetylthiazolidine-4-carboxylic acid chloride into which, in position 2, ^{2}H can be introduced by radioactive formaldehyde. The solution was injected into the gas chromatograph and the emerging components collected for introduction into the mass spectrometer. By monitoring the ratios of fraction a (a : a + 2) at m/e 184:186, and the ratio of (b : b + 1) at the base peak M-156, the identity of the optically active amino acids could be determined. By improving

the method with a direct coupling of the mass spectrometer to the gas chromatograph, it was expected to increase the sensitivity to the nanogram range.

2677

Stanford U. Dept. of Chemistry, Calif.

THE ROLE OF DIPOLE INTERACTIONS IN DETERMINING POLYPEPTIDE CONFIGURATIONS, by D. A. Brant and P. J. Flory. [1965] [2]p. incl. diagr. refs. (AFOSR 65-0876) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1341 and National Institutes of Health) AD 619126
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 663-664, Feb. 1965.

A characteristic measure of the unperturbed dimensions of the random polypeptide chain is given by $\langle r^2 \rangle_0 / n l^2$, the ratio of the actual mean square end-to-end distance, $\langle r^2 \rangle_0$, to the mean square end-to-end distance for the randomflight chain of virtual bonds, $n_p l_p^2$. Experiments were conducted to determine $\langle r^2 \rangle_0$ for 3 polypeptides: poly-β-benzyl-L-asparate in m-cresol at 100°, poly-L-glutamic acid in aqueous 0.3 M sodium phosphate at pH 7.95 and 37°, and poly-L-lysine hydrobromide in aqueous 1.0 M sodium bromide at pH 4.54 and 37°. A characteristic ratio of 9 ± 1 was found for all 3 polymers. Previously published results for poly-γ-benzyl-L-glutamate yield a value in the same range. The experimental result is much larger than the value of 1.93 calculated assuming free rotation about the single bonds adjoining the α-carbons. Thus, the same value of $\langle r^2 \rangle_0 / n_p l_p^2$ holds within experimental error for the systems studied, marked differences in solvents and in amino acid side chains notwithstanding. Investigation of the influence of dipolar interactions on peptide configurations is also reported.

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Stanford U. Dept. of Chemistry, Calif.

THE CONFIGURATION OF THE POLYOXYETHYLENE CHAIN, by J. E. Mark and P. J. Flory. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-65-1214) (AF 49 (638)1341) AD 621306
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 1415-1423, Apr. 5, 1965.

In this study, experimental stress-temperature coefficients for polyoxyethylene networks were presented from which the coefficient $d \ln \langle r^2 \rangle_0 / dT$ is deduced. An estimate is given of the characteristic ratio $\langle r^2 \rangle_0 / nl^2$ based on the intrinsic viscosity-molecular weight studies of Bailey and co-workers. A theoretical treatment of the polyoxyethylene chain is also given in terms of the rotational isomeric state scheme successfully applied to other polymers.

2679

Stanford U. Dept. of Chemistry, Calif.

THE CONFIGURATION OF VINYL POLYMERS. EXPERIMENTAL RESULTS, by J. E. Mark and P. J. Flory. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-1215) (AF 49(638)1341) AD 621305
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 1423-1429, Apr. 5, 1965.

The characteristic ratio $\langle r^2 \rangle_0 / nl^2$ for isotactic poly(n-pentene-1) deduced from intrinsic viscosities of fractions in 2-pentanol at the θ-point of 62.4° is 9.2 ± 0.5. This result, though larger than the characteristic ratios for polyethylene, polyisobutylene, and poly(dimenthysiloxane), is less than would be expected on the basis of steric interactions within the isotactic chain structure. The temperature coefficients determined for several isotactic and atactic vinyl polymers from stress-temperature measurements on crosslinked networks in the amorphous state, are found to be positive but small. The temperature coefficient for isotactic poly(n-pentene-1) from the temperature dependence of its intrinsic viscosity in n-hexadecane is in satisfactory agreement with the stress-temperature value. The significance of these results is discussed in relation to those for other vinyl polymers and also with reference to predictions from analysis of the chain structure and the interactions of its substituents. (Contractor's abstract)

2680

Stanford U. Dept. of Chemistry, Calif.

STATISTICAL THERMODYNAMICS OF LIQUID MIXTURES, by P. J. Flory. [1965] [6]p. incl. refs. (AFOSR-65-1449) (AF 49(C38)1341) AD 621398
Unclassified

Also published in Jour. Amer. Chem., Soc., v. 87: 1833-1838, May 5, 1965.

Liquid mixtures of nonpolar molecules are treated on the basis of a simple partition function affording an approximate, but satisfactory, representation of liquid state properties. Parameters characterizing the pure components, i.e., the density, thermal expansion coefficient, and thermal pressure coefficient, are thus brought to bear on the analysis of properties of mixtures. Theoretical expressions for the equations of state contributions to the free energy, enthalpy, entropy, chemical potential, and excess volume are derived. The theoretical entropy of mixing in excess of the combinatorial or ideal entropy depends on the reduced volumes of the 2 components and of the mixtures: it does not vanish, in general, when the excess volume is reduced to zero, contrary to a tenet of regular solution theory. The treatment is applicable to mixtures of molecules differing in size.

2681

Stanford U. Dept. of Chemistry, Calif.

THE THERMODYNAMIC PROPERTIES OF MIXTURES OF SMALL, NONPOLAR MOLECULES, by A. Abe and P. J. Flory. [1965] [9]p. incl. tables, refs. (AFOSR-65-1450) (AF 49(638)1341) AD 622625 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 1838-1846, May 5, 1965.

The excess enthalpies, volumes, and entropies of 23 equimolar binary liquid mixtures for which necessary data are available in the literature are interpreted according to the relationships presented in P. J. Flory, Jour. Amer. Chem. Soc., v. 87: 1833, 1965. Most of the mixtures comprise pairs of small globular molecules from the group c-C_6H_{12}, C_6H_6, $C(CH_3)_4$, CCl_4, $SiCl_4$, $TiCl_4$, and $SnCl_4$ or from the condensed gases CH_4, Ar, O_2, and N_2. Also included are mixtures of C_6H_6 and of c-C_6H_{12} with n-hexane and n-heptane, the benzene-diphenyl system, and 2 hydrocarbon-fluorocarbon mixtures. Previously unaccounted equation of state terms, which depend on properties of the pure components, make important contributions to each of the excess quantities. Through use of pair interaction parameters chosen to achieve agreement with the observed excess enthalpies, excess volumes are calculated which agree in nearly all cases with those observed within limits set by experimental errors. Although excess entropies calculated on the same basis tend to be somewhat lower than those observed, the agreement is favorable for most systems.

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Stanford U. Dept. of Chemistry, Calif.

THERMODYNAMIC PROPERTIES OF SOLUTIONS OF HELICAL POLYPEPTIDES, by P. J. Flory and W. J. Leonard, Jr. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-65-1641) (AF 49(638)1341 AD 624274 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 2102-2108, May 20, 1965.

Partial pressures of mixtures of pyridine and of 1, 2-dichloroethane with poly-γ-benzyl-L-glutamate have been determined at 25° for volume fractions of solvent from ω_1 = 0 to ca 0.4. Similar experiments have been carried out on mixtures of chloroform with poly-β-benzyl-L-asparate. In all cases the solvent activities increase gradually and smoothly with solvent concentrations; they are insensitive to the molecular weight of the polymer. The Henry's law slope at $\varphi_1 = 0$ is very much less than would be required by ideal solution theory, which should apply to a system of impenetrable rod-like particles at high concentration. The observed behavior is readily explicable in terms of solvent mixing with side chains of α-helical solute particles. The solvent activities are devoid of evidence of phase transitions. The occurrence of conformational changes with dilution is rendered extremely unlikely by the results presented. The side chains of the undiluted polypeptide evidently are disordered.

2683

Stanford U. Dept. of Chemistry, Calif.

SECOND AND FOURTH MOMENTS OF CHAIN MOLECULES, by P. J. Flory and R. L. Jernigan. [1965] [11]p. incl. diagr. refs. (AFOSR-65-1642) (AF 49(638) 1341) AD 624273 Unclassified

Also published in Jour. Chem. Phys., v. 42: 3509-3519, May 15, 1965.

Exact methods are developed for calculating second and fourth moments $\langle M^2 \rangle$ and $\langle M^4 \rangle$ of chain molecules, where $M = \sum_{i=1}^{n} m_i$ and m_i is a vector associated with Bond i but not necessarily colinear with it. The rotational isomeric-state approximation is adopted to represent the effects of hindrance potentials affecting bond rotations. No other approximations are invoked in deriving the statistical-mechanical averages denoted by $\langle\ \rangle$. Account is taken of neighbor correlations, and the treatment is applicable alike to finite and infinite chains. Illustrative calculations of $\langle r^2 \rangle / nl^2$ and of $\langle r^4 \rangle / n^2 l^4$, where r is the end-to-end length of the chain, l the bond length, and n the number of bonds, are presented for normal alkane homologs H-$(CH_2)_n$-H, throughout the range of n from $1 < n < \infty$. The methods are applicable also to chains having any variety of bonds in linear succession.

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Stanford U. Dept. of Chemistry, Calif.

THE CONFIGURATION OF RANDOM POLYPEPTIDE CHAINS. I. EXPERIMENTAL RESULTS, by D. A. Brant and P. J. Flory. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-2376) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1341 and National Institutes of Health) AD 629282 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 2788-2791, July 5, 1965.

A dimensionless characteristic ratio $(r^2)_o / n_p l_p^2$ of the measured mean square unperturbed end-to-end distance $(r^2)_o$ to the number n_p of planar, trans peptide units multiplied by the square of the length l_p between successive α-carbons has been evaluated for 4 polypeptides. Measurements reported on poly-β-benzyl-L-asparate in m-cresol at 100°, on poly-L-glutamic acid in aqueous 0.3 M sodium phosphate at pH 7.85 and 37°, and on poly-L-lysine in aqueous 1.0 M sodium bromide at pH 4.54 and 37° yielded values of the characteristic ratio of 9.6, 8.8, and 8.6, respectively. From the data of Doty, Bradbury, and Holtzer for

poly-γ-benzyl-L-glutamate in dichloroacetic acid at 25, (J. Am. Chem. Soc. 78:947, (1956), a value of 6.8 was calculated. No dependence of the unperturbed dimensions upon the solvents or amino acid side chains represented is discernible within the estimated experimental uncertainty of ≈ 10%. (Contractor's abstract)

2685

Stanford U. Dept. of Chemistry, Calif.

THE CONFIGURATION OF RANDOM POLYPEPTIDE CHAINS. II. THEORY, by D. A. Brant and P. J. Flory. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-2397) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1341 and National Institutes of Health) AD 628283 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 2791-3000, July 5, 1965.

The experimentally measured dimensions of polypeptide chains in the unperturbed, random coil form were successfully correlated with the chain structure using the rotational isomeric state model and statistical mechanical methods applicable to linear systems of interacting subunits. The poly-peptide chain with all its amide groups in the transformation may be treated as a sequence of virtual bonds of fixed length connecting successive α-carbons; the mutual orientation of a pair of adjoining virtual bonds is determined by the angles of rotation about the single bonds at the intervening α-carbon atom. Contributions to the configuration energy from bond rotation (torsional) potentials and interactions between nonbonded atoms and groups have been assessed and subsequently evaluated using approximate analytical expressions. From the chain geometry and the character of these interactions, it is shown that the mutual orientation of a given pair of adjoining virtual bonds is sensibly independent of the orientations of all other virtual bonds in the chain. Electrostatic interactions between amide groups, heretofore ignored, markedly affect the configuration. Satisfactory agreement between theoretical calculations and experimental results is achieved only by taking account of these dipolar interactions, in addition to the relevant torsional and van der Waals energies. The dependence of the polypeptide unperturbed dimensions on chain length was also investigated. (Contractor's abstract)

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Stanford U. Dept. of Chemistry, Calif.

DIPOLE MOMENTS IN RELATION TO CONFIGURATION OF n-ALKANE CHAINS BEARING α, ω-DIPOLAR SUBSTITUENTS by W. J. Leonard, Jr., R. L. Jernigan, and P. J. Flory. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-2768) (AF 49(638)1341) AD 627956 Unclassified

Presented at meeting of the Phys. Chem. Div. of the Amer. Chem. Soc., Detroit, Mich., Apr. 5, 1965.

Also published in Jour. Chem. Phys., v. 43: 2256-2261, Oct. 1, 1965.

The dipole moments of α, ω-dibromo-n-alkanes Br-$(CH_2)_{n-1}$-Br have been treated by exact methods applicable to a linear sequence of bonds each constrained to choice among several discrete rotational states, due account being taken of neighbor dependence in assignment of statistical weights to the various configurations. Computations have been carried out on the basis of threefold potentials with one trans and two gauche states (±120°) for each bond. Successive gauche states of opposite sign are excluded by steric overlaps. An energy of 500 mol^{-1} has been assigned to gauche relative to trans, in keeping with spectroscopic evidence for n-alkanes and the scheme successfully applied to the mean-square dimensions of polymethylene chains. Nonbonded interactions in which a Br atom is involved have been assigned statistical weights consistent with van der Waals radii and with evidence from Raman and infrared studies on n-alkyl bromides. The mean-square dipole moments averaged over all configurations are appreciably affected by the dipole-dipole interaction energy for n - 1 ≤ 6, but not for longer chains. Calculated values are in good accord with experimental results for n - 1=3 to 10, inclusive. The applicability of the rotational-isomeric state-approximation to chains of comparatively short length is thus demonstrated. (Contractor's abstract)

2687

Stanford U. Dept. of Chemistry, Calif.

STEREOREGULARITY AND UNPERTURBED DIMENSIONS OF ISOTACTIC POLY-α-OLEFINS, by P. J. Flory, J. E. Mark, and A. Abe. [1965] [4]p. incl. diagrs. (AFOSR-66-0316) (AF 49(638)1341) AD 629281 Unclassified

Also published in Polymer Ltrs., v. 3: 973-976, 1965.

The occurrence of some of the units of the chain in non-isotactic structural arrangements offers the only plausible explanation for the striking discordance between theory and experiments on allegedly stereoregular vinyl polymers having the hydrocarbon substituents R = CH_3, C_2H_5, n-C_3H_7, and C_6H_5. The atypical structures probably are syndiotactic units; A further possibility is occurrence of an occasional head-to-head pair of units. Typical isotactic vinyl polymers appear to possess a small fraction of atactic units, and these are regarded as responsible for depressing the dimensions of the random coil. The facts that various isotactic polymers including polypropylene, poly-n-butene-1, and poly-n-pentene-1 are highly crystalline and spherulitic, and that they exhibit fairly sharp melting points, show unequivocally that their crystalline domains greatly exceed the average length (ca. 10-15 monomer units) of an isotactic sequence. The syndiotactic units, and/or other stereo-irregular units, must therefore be incorporated in crystallites.

2688

Stanford U. Dept. of Electrical Engineering, Calif.

THE DETECTION OF KNOWN SIGNALS IN COLORED GAUSSIAN NOISE, by T. Kailath. [1965] [6]p. incl.

refs. (AFOSR-65-2356) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1517, Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-22583) AD 629369 Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill. Oct. 25-27, 1965.

Also published in Proc. Nat'l. Electronics Conf., v. 21: 650-655, 1965.

The use of the Karhunen-Loeve method provides an elegant solution for the problems of the detection of known signals in colored Gaussian noise. Nevertheless it introduces certain complications because the expansion is an infinite-series expansion: questions of convergence and interchange of order of integration. The resolution of these problems is difficult and has led (when the K-L expansion is used) to the introduction of subsidiary conditions whose physical meaning is often unclear. A method of reducing the detection problem to a finite-dimensional form is presented where many of the difficulties with the infinite-series K-L expansion do not arise. The resulting simplicity provides more physical insights into the earlier results. It has also suggested some new results.

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Stanford U., Dept. of Genetics, Palo Alto, Calif.

AN OPERATING SYSTEM FOR THE LINC COMPUTER, by R. K. Moore. Nov. 1, 1965, 157p. (Technical rept. no. IRL-1038) (AFOSR-66-0325) (Sponsored jointly by Air Force Office of Scientific Research under AF 49 (638)1599, National Aeronautics and Space Administration and National Institutes of Health) AD 628780 Unclassified

This report describes an extensive software system for the LINC computer. The system includes a symbolic program assembler, an Algol-58 compiler (which runs on an IBM 7090), a data-filing system, and various displaying and typing programs, including a general text editor. Utilization of all system features is described, with the aid of many examples, and annotated program listings of the system are included. The system is of interest both as an example of LINC utilization and as a study in the programming of small computers with aid of large computers.

2690

[Stanford U. Dept. of Genetics, Palo Alto, Calif.]

BIOLOGICAL APPLICATIONS OF MASS SPECTROMETRY, by J. Lederberg. Final rept. Mar. 1-June 30, 1965. Aug. 1, 1965 [13]p. incl. diagrs. table, refs. (Technical rept. no. IRL 1030) (AFOSR-65-1632) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-886, National Aeronautics and Space Administration, and National Institutes of Health) AD 624074 Unclassified

A review is presented of an investigation on the applications of the mass spectrometer to biological research. The mass spectra of the amino acids is examined as well as the spontaneous cyclization of oligopeptides, the optical activity of amino acids, logarithmic recording of the mass spectral data, computer methods and other techniques of analysis, and the heavy particle bombardment of biochemical materials. Included is an article on the optical resolution of D, L amino acids by gas chromatography and mass spectrometry. The use of mass spectrometry is shown for the radio detection of D and L input reagents, as well as to identify the optically active species.

2691

Stanford U. Dept. of Materials Science, Calif.

DISLOCATION REACTIONS IN SILICON WEB-DENDRITE CRYSTALS, by S. O'Hara and G. H. Schwuttke. [1965] [5]p. incl. illus. diagr. refs. (AFOSR-66-0235) (In cooperation with Westinghouse Electric Corp., Pittsburgh, Pa. under AF 49(638) 1029) (AF AFOSR-65-731) AD 629840 Unclassified

Also published in Jour. Appl. Phys., v. 36: 2475-2479, Aug. 1965.

The origin and reactions of dislocations in silicon web-dendrite crystals are discussed. In particular, x-ray topographs are compared with etching results. Dislocations having [2$\bar{1}$1] axes or < 110 > type axes have been characterized. In the former case, normal edge and 20° dislocations are seen; however, an apparently new dislocation with a [2$\bar{1}$1] axis and [101] type or [110] type of Burgers vector has also been observed. Dislocations having a [$\bar{1}$10] axis and [110] Burgers vector have been identified and associated with the Cottrell-Lomer reaction. The presence of multiple twin planes parallel to the growth direction of the web, accompanied by regions of very high dislocation density near the dendrites, increases the probability of certain dislocation reactions.

2692

Stanford U. [Dept. of Materials Science] Calif.

DISLOCATIONS IN SILICON WEB AS SEEN IN LARGE-AREA X-RAY TOPOGRAPHS (Abstract), by G. H. Schwuttke and S. O'Hara. [1965] [1]p. [AF AFOSR-65-731] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Nov. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 310, Mar. 24, 1965.

The crystal perfection of silicon web is discussed. Dislocation sources, dislocations, and dislocation reactions in such crystals are described. Dislocations with [211] axis are shown to have 90° or 30° Burgers vectors; dislocations with [110] axis and [101] Burgers

vector are associated with the Lomer-Cottrell reaction. Also, a new dislocation with [211] axis and Burgers-vector direction in [101] or [110] is identified. Finally, the unique role played by multiple twin planes present along the length of the web in increasing certain dislocation reactions is pointed out.

2693

Stanford U. Dept. of Mechanical Engineering, Calif.

DIRECT ENERGY CONVERSION SYSTEMS, by R. H. Eustis. Final technical rept. Nov. 1, 1961-Sept. 30, 1965, Oct. 29, 1965, 19p. incl. refs. (AFOSR-65-2013) (AF 49(638)1123) AD 627658 Unclassified

A brief summary is presented of the research conducted. Details of the work are reported in earlier reports. The scope of this program has included magnetogasdynamic, electrochemical, and thermoelectric studies. In addition to a summary of the research work, 22 technical papers and 10 theses, generating from this work, are listed. (Contractor's abstract, modified)

2694

Stanford U. Dept. of Mechanical Engineering, Calif.

DIRECT ENERGY CONVERSION SYSTEMS. PART I. ELECTRICAL CONDUCTIVITY OF PARTIALLY IONIZED GASES, by S. Schweitzer and M. Mitchner. Quarterly technical rept. Mar. 1-May 31, 1965, Sept. 30, 1965, 52p. incl. diagrs. tables, refs. (Rept. no. SU-IPR-18) (AFOSR-66-0225) (AF 49(638)1123) AD 628528 Unclassified

A simplification of the Chapman-Enskog method for the calculation of the electrical conductivity of a multicomponent partially ionized gas in a magnetic field is presented. The calculation requires the inversion of a matrix which is of the order of the approximation, and is independent of the number of species. The third approximation to the electrical conductivity is examined for an electron-ion-neutral plasma and the results are compared with those obtained from the mixture rules of Lin, Resler, and Kantrowitz, and of Frost. It is shown that within the uncertainties in the experimental electron-neutral cross-section values, Frost's formula offers a satisfactory method of calculation for most engineering applications. (Contractor's abstract)

2695

Stanford U. Dept. of Mechanical Engineering, Calif.

DIRECT ENERGY CONVERSION SYSTEMS. PART II. ELECTROCATALYTIC ACTIVITY OF HYDRAZINE IN FUEL CELL APPLICATIONS, by P. D. Stonehart. Quarterly technical rept. Sept. 30, 1965 [63]p. incl. illus. diagrs. tables, refs. (AFOSR-66-0226) (AF 49(638)1123) AD 626529 Unclassified

The electrode reactions of hydrazine in acid and basic solutions on smooth and platinised platinum have been examined. From analysis of the rest potentials and concentration relationships a rapid one electron exchange with a stable surface species has been postulated. The mechanism of oxidation occurs via a sequential system whereby hydrazinium radicals are the products of the initial oxidation. The electrode reactions of carbon monoxide in acid solutions on smooth platinum electrodes have also been examined. The carbon monoxide is strongly bound to the metal surface and probably exists as a compound. Suppression of the reversible hydrogen reaction was observed in the presence of CO. Removal of the carbon monoxide film was performed as soon as oxide formation occurred indicating that the carbon monoxide is essentially electro-inactive and that the reaction is purely chemical with the metal oxide to form carbon dioxide. Electrochemical regeneration of the metal oxide forms the regenerative cycle. $MO + CO \rightarrow M + CO_2$ $M + H_2O \rightarrow MO + 2H^+ + 2e^-$. The oxidation of methanol in acid does not proceed via carbon monoxide as an intermediate. (Contractor's abstract)

2696

Stanford U. Dept. of Mechanical Engineering, Calif.

USE OF HYDROGEN BUBBLES FOR QUANTITATIVE DETERMINATION OF TIME DEPENDENT VELOCITY FIELDS IN LOW SPEED WATER FLOWS, by F. A. Schraub, S. J. Kline and others. Feb. 1964, 55p. (Rept. no. MD-10) (AFOSR-64-1278) (AF 49(638)1278) AD 602 795 Unclassified

Presented at Winter Annual Meeting of the Amer. Soc. of Mechanical Engineers, Nov. 29-Dec. 3, 1964, New York.

Also published in Jour., Basic Engineering, v. 87: 429-444, June 1965.

Improved flow visualization methods based on the hydrogen bubble technique are described. Use of "combined-streak markers" allows quantitative measurement of the instantaneous velocity field in a plane as a function of time in low speed water flows. Adaptation to a great variety of situations using different probe techniques is possible. Disturbance to the flow is very small. Adequate accuracy is obtainable. The method offers the advantage of simultaneous visual images of the flow structure and quantitative measurement of velocity over a finite region. It also allows some types of measurements not previously possible. Limitations of the method include its restriction to low speed water flows and the observation of fluctuations only at low frequencies. Practical difficulties occur due to probe frangibility and problems of uniform bubble production. Part I describes the underlying concepts, summarizes the history of the method and describes operating experience to data at Educational Services, Inc., and Stanford U. Part II is a detailed analysis of the uncertainties in velocity measurements using combined-time-streak markers formed by hydrogen bubbles. (Contractor's abstract)

2697

Stanford U. Dept. of Mechanical Engineering, Calif.

A STUDY OF THE STRUCTURE OF THE TURBULENT BOUNDARY LAYER WITH AND WITHOUT LONGITUDINAL PRESSURE GRADIENTS, by F. A. Schraub and S. J. Kline. Mar. 1965, 157p. incl. illus. diagrs. tables, refs. (Rept. no. MD-12) (AFOSR-67-0605) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1278 and National Science Foundation) AD 646989 Unclassified

The existence of 3 regions of the turbulent boundary layer, each correlating with a distinct part of the nondimensional mean velocity profile, was confirmed; these are (a) wake or intermittent region (b) fully turbulent region (c) wall layer region. Details of the flow structure of these regions were further verified using a new hot-wire anemometer and an improved combined-time-streak marker hydrogen-bubble technique. Instananeous spanwise velocity profiles over a large extent of the flow at many fixed y-positions across the layer were obtained. The study of the flow structure was extended to include both positive and negative pressure gradient flows, including a relaminarization flow. The hot-wire anemometer provided a means of obtaining detailed mean velocity profiles well within the sublayer region. The hydrogen-bubble combined-time streak marker visualization technique was shown to be a useful tool for quantitative measurement of time-dependent velocity fields. (Contractor's abstract, modified)

2698

Stanford U. Dept. of Mechanical Engineering, Calif.

A UNIFIED METHOD FOR PREDICTING THE PERFORMANCE OF SUBSONIC DIFFUSERS OF SEVERAL GEOMETRIES, by A. B. Cocanower, S. J. Kline, and J. P. Johnston. May 1965, 94p. incl. diagrs. tables, refs. (Rept. no. PD-10) (AFOSR-66-2702) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1278 and General Electric Company) AD 642497 Unclassified

A unified performance prediction method has been developed for Class A diffusers. The prediction method uses the momentum equation, continuity equation, and two empirical correlation equations. In addition to the prediction method, two parameters have been developed to characterize inlet conditions and separation respectively: B_1 is defined as the ratio of the inlet boundary layer blockage area to the total inlet area; B_1 0.05 indicates those flows which can be divided into an effective core flow plus turbulent boundary layers, B^* is a correlation of first appreciable stall in a diffuser; it provides a means to terminate analytical calculations. The predicted results include: (1) performance charts; (2) predicted effects of Reynolds number, Mach number, wall counter, corners, and diffuser geometry on pressure recovery for Class A diffusers.

2699

Stanford U. Dept. of Mechanical Engineering, Calif.

AN ANALYTICAL AND EXPERIMENTAL STUDY OF THE PLANE, INCOMPRESSIBLE, TURBULENT FREE SHEAR LAYER WITH ARBITRARY VELOCITY RATIO AND PRESSURE GRADIENT, by C. M. Szbin. Oct. 1963, 113p. (Rept. no. MD-9) (AFOSR-5443) (AF AFOSR-63-136) AD 430120 Unclassified

Presented at Winter Annual Meeting of the Amer. Soc. of Mech. Engineers, Nov. 29-Dec. 3, 1964, New York

Also published in Jour. Basic Eng., v. 87: 421-428, June 1965.

A first order approximation is derived in similarity coordinates for the velocity variation across a mixing zone between two streams of different velocities in an arbitrary pressure gradient. The velocity profiles obtained are functions of a single parameter, the ratio of the velocity of the slow stream to that of the fast stream. The first order velocity profiles are compared to those obtained from the complete solution to the zero pressure gradient case by Gortler and good agreement is found when the velocity ratio is greater than 0.5. The form of the eddy diffusivity appropriate to the first order theory is determined from analysis and experimental data. This form leads to an explicit transformation for the similarity coordinate requiring only a single empirical constant for all cases. This similarity coordinate is shown to reduce to Gortler's variable in the constant pressure case. Expressions for the shear and the mixing layer width for the general case are presented, and shown to check the data from several cases. A hot wire anemometer which was specially designed and constructed for taking the experimental data in a water channel is described. (Contractor's abstract)

2700

Stanford U. [Dept. of Physics] Calif.

OBSERVATIONS OF THE SIX MOST INTENSE RATIO SOURCES WITH A 1.0 FAN BEAM, by A. R. Thompson and T. Krishnan. [1965] [15]p. incl. diagrs. tables, refs. (AFOSR-65-2952) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1375 and National Science Foundation) AD 629366 Unclassified

Observations of the radio sources Cassiopeia A, Taurus A, the Orion Nebula, the Omega Nebula, Sagitarius A, and Cygnus A have been made with a beam width of 1.0 in the east-west direction using the Stanford compound interferometer. The adjustment of the phase lengths of the lines and amplifiers was carried out with the aid of modulated reflections from gas-discharge tubes and diodes. The right ascensions and widths of the sources are in good agreement with values from 3 other fan-beam surveys. (Contractor's abstract)

2701

Stanford U. Dept. of Physics, Calif

UNCOUPLED-PHASE METHOD IN THE MULTI-CHANNEL N/D FORMALISM, by P. Nath and G. L. Shaw. [1965] [6]p. incl. tables, refs. (AFOSR-65-0845) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389 and National Science Foundation) AD 617040 Unclassified

Also published in Phys. Rev., v. 137: B711-B716, Feb. 8, 1965.

The uncoupled-phase method is a nonperturbative formalism relating the scattering amplitudes describing n strongly coupled 2-body channels to the uncoupled amplitudes describing n-1 channels alone. The uncoupled scattering amplitudes are defined to be those that would exist if the couplings to the nth channel were switched off while the interactions among the n-1 channels remain unchanged. The uncoupled-phase method, previously based on the potential model, is extended to the relativistic problem by considering a set of n coupled N/D partial-wave dispersion relations. For the situation in which the left-hand cut is approximated by the forms g (s + m) where g is an n x n matrix of constants and s is square of the total energy in the center-of-mass system, the uncoupled-phase method is exact. The quantitative validity of the uncoupled-phase method for more complicated left-hand singularities is tested by performing a 2-channel computer experiment. A full numerical solution of the coupled integral equations for the N functions is obtained by the matrix-inversion technique

2702

Stanford U. Dept. of Physics, Calif.

THRESHOLD AND ASYMPTOTIC BEHAVIOR OF THE N/D EQUATIONS, by M. Bander and G. L. Shaw. [1965] [19]p. incl. diagrs. refs. (AFOSR-65-0846) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389, Atomic Energy Commission, and National Science Foundation) AD 617042 Unclassified

Also published in Ann. Phys., v. 31. 506-524, Feb. 1965.

Two important problems involved in obtaining solutions of partial wave dispersion relations by the N/D method are having (1) the correct threshold behavior, and (2) an acceptable high energy behavior. Various physical and numerical approximations have been made to insure this. The sensitivity of the solutions of the N/D equations to these approximations are numerically investigated. For this purpose, J = 1 π-π scattering is considered, employing elastic unitarity and assuming that the left hand cut is dominated by the exchange of the resonance. Two significant features are: (a) The values of the cutoffs needed to produce a resonance are quite sensitive to the input strength of the left hand cut, e.g., a change of the input width of the by a factor of 2 changed the value for a straight cutoff to produce a resonance at a given energy by a factor of 10 Due to the results of (a) the danger in employing a single cut-off in the calculations of SU_3 multiplets is emphasized. (b) If a pole is introduced on the left hand cut in order to insure the threshold behavior (1), then the ranges in values for the cutoffs to insure (2) for which any resonance occurs are extremely narrow. A solution in which the phase shift does not become large is insensitive to the position of this pole. (Contractor's abstract)

2703

Stanford U. Dept. of Physics, Calif.

EFFECT OF CLOSED INELASTIC CHANNELS ON THE WIDTH OF RESONANCES, by J. R. Fulco, G. L. Shaw, and D. Y. Wong. [1965] [8]p. incl. diagrs. refs. (AFOSR-65-0847) (AF 49(638)1389) AD 617038 Unclassified

Also published in Phys. Rev., v. 137: B1242-B1249, Mar. 8, 1965.

It is proposed that including nearby inelastic channels would greatly reduce the discrepancy between predicted and observed widths of resonances This statement is examined in a quantitative manner. Three separate examples of -wave resonances, (760 mev), K* (885), and N* (1238), are considered for a 3-channel π-π, $\pi\omega$, KK system, a 2-channel πK, ηK system, and a 2-channel πN, KΣ system, respectively. It is found that, all the calculated widths are 2 to 5 times larger than the observed values, indicating that the lowest mass channels coupled via the longest range forces do not constitute a realistic model.

2704

Stanford U. Dept. of Physics, Calif.

DECAY $K_L^0 \to 2\pi$ AND SPONTANEOUS BREAKDOWN OF THE CP SYMMETRY, by G. Marx. [1965] [3]p. (AFOSR-65-0848) [AF 49(638)1389) AD 617043 Unclassified

Also published in Phys. Rev. Ltrs., v. 14. 334-336, Mar. 1, 1965.

An attempt has been made to explain the decay $K_L^0 \to 2\pi$ by spontaneous breakdown of the CP symmetry. The asymmetric vacuum was characterized by the minimum condition $\langle 0 | H | 0 \rangle_{min}$ with $a_k \neq 0$, using a CP-symmetric Hamiltonian The principle of relativity and of equivalence is maintained in this model.

2705

Stanford U. Dept. of Physics, Calif.

HYPERON PRODUCTION BY NEUTRINOS IN AN SU_3 MODEL, by N. Cabibbo and F. Chilton [1965] [7]p.

incl. diagrs. refs. (AFOSR-65-1065) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389 and Atomic Energy Commission)
AD 618288 Unclassified

Also published in Phys. Rev., v. 137: B1626-B1634, Mar. 22, 1965.

An SU_3 model of weak interactions is used to discuss amplitudes and cross sections for hyperon production by neutrinos. Numerical results for the cross sections are given. The notion of first- and second-class currents is extended to currents transforming like multiplets under SU_3. (Contractor's abstract)

2706

Stanford U. Dept. of Physics, Calif.

LEPTON SCATTERING AMPLITUDES IN TWO MODEL FIELD THEORIES, by G. W. Erickson and H. M. Fried. [1965] [10]p. incl. refs. (AFOSR-65-1347) (AF 49(638) 1389) AD 622618 Unclassified

Also published in Jour. Math. phys., v. 6: 414-423, Mar. 1965

Two lepton-lepton scattering amplitudes are considered within the context of a no-recoil Bloch-Nordsieck model, with emphasis on the singularities in that configuration-space variable conjugate to momentum transfer. For the interaction $\mathcal{L}_I = g\bar{\psi}A\psi$, renormalizable in 4 dimensions, and in the approximation of including only the exchange of all possible bosons between a pair of leptons, a light cone singularity no worse than that of the one-boson-exchange graph is found. Similar statements may be made for the same interaction, nonrenormalizable in 6 dimensions, provided certain continuations in the center-of-mass energy variable are employed; otherwise, an essential singularity appears. A remark illustrating the formation of bound states is made for the renormalizable interaction. No argument is given to establish the relevance of these models to the actual field-theoretic situations. (Contractor's abstract)

2707

Stanford U Dept. of Physics, Calif.

P-AND D-STATE CONTRIBUTIONS TO THE CHARGE FORM FACTORS OF H^3 AND He^3, by B. F. Gibson and L. I. Schiff. [1965] [7]p. incl refs. (AFOSR-65-1348) (AF 49(638)1389) AD 622619 Unclassified

Also published in Phys. Rev., v 138: B26-B32, Apr. 12, 1965.

The method of Sachs is used to obtain explicit expressions for the P- and D-state components of the ground-state wave functions of H^3 and He^3, under the assumption that they have $T = 1/2$ and $J^P = 1/2^+$. The effect of a reasonable admixture of these components on the electric charge form factors of the two nuclei is calculated, and it is found that the striking difference between the observed charge form factors cannot be accounted for in this way. It seems most likely that a combination of S'-state and T = 3/2-state admixture might provide an explanation of this effect without leading to disagreement with other experimental observations. (Contractor's abstract)

2708

Stanford U. Dept. of Physics, Calif.

NONEQUIVALENCE OF THE ONE-CHANNEL N/D EQUATIONS WITH INELASTIC UNITARITY AND THE MULTICHANNEL ND^{-1} EQUATIONS, by M. Bander, P. W. Coulter, and G. L. Shaw. [1965] [3]p. (AFOSR-65-1755) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389) and Atomic Energy Commission) AD 626299 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 270-272, Feb. 22, 1965.

An example is presented demonstrating the nonequivalence of the one-channel N/D equations with inelastic unitarity and the multichannel ND^{-1} equations. A partial-wave elastic-scattering amplitude A = N/D determined by the Frye-Warnock equations is shown in general not equal to the amplitude A_{11} determined by the multichannel ND^{-1} formalism for a set of coupled two-body channels with potentials B_{ij}. It is found that a sufficient condition for the two calculations to agree is that the diagonal forces in the channels not explicitly considered should not be strong enough to produce bound states in the absence of coupling to channel 1. It is speculated that this condition holds in general

2709

Stanford U Dept. of Physics, Calif.

CLASSICAL EXAMPLES OF SPACE INVERSION AND TIME REVERSAL, by L. I. Schiff. [1965] [5]p. incl. diagrs. (AFOSR-65-1758) (AF 49(638)1389)
AD 626297 Unclassified

Also published in Physics, v. 1: 209-213, 1965.

The motions of 4 different classical systems under space inversion (P) and time reversal (T) are discussed. It is imagined that each system is photographed with a motion picture camera, and that the film is developed and positively printed. The film may then be inverted front for back and run through the projector in normal time sequence (P), or run through the projector in the correct orientation but backward in time (T). If the projected image represents a possible motion of the system, it is said to be P or T invariant, as the case may be. Classical models of a moving charge, a precessing magnetic dipole, a moving magnetic monopole, and a precessing electric dipole, are considered. The first 2 systems are separately P and T invariant, and the last 2 are neither P nor T invariant. A brief comment is made on charge conjugation (C) invariance and the classical validity of CPT invariance. (Contractor's abstract, modified)

2710

Stanford U. Dept. of Physics, Calif.

STRUCTURE OF THE PROTON AND THE HYPERFINE SHIFT IN HYDROGEN, by C. K. Iddings. [1965] [13]p. incl. diagrs. tables, refs. (AFOSR-65-1775) (AF 49(638) 1389) AD 625937 Unclassified

Also published in Phys. Rev., v. 138: B446-B458, Apr. 26, 1965.

The proton-size correction to the hyperfine structure in the ground state of atomic hydrogen is re-examined. It is shown by means of dispersion relations that this correction can be expressed as an integral over experimentally measurable cross sections for electron-proton scattering. This clarifies the physical nature of the correction, puts it on a rigorous basis and lends support to previous analyses. In the absence of experimental data, some theoretical estimates for the correction are given. They agree with previous estimates, and therefore the present experimental value for the hyperfine splitting cannot be explained. Some possible implications of this disagreement are discussed and some experiments are suggested which would clarify the situation. (Contractor's abstract)

2711

Stanford U. Dept. of Physics, Calif.

ROTATION AND GRAVITATIONAL COLLAPSE, by R. V. Wagoner. [1965] [6]p. (AFOSR-65-1831) AF 49(638)1389) AD 625933 Unclassified

Also published in Phys. Rev., v. 138: B1583-B1588, June 21, 1965.

A new method of solution of the Einstein field equations is used to investigate the gravitational collapse of a rotating massive body. The equations are studied on a timelike hyperplane of reflection symmetry within an axially symmetric distribution of perfect fluid. An explicit family of solution is obtained for the evolution in time of the metric at a fixed radius in a comoving coordinate system. These solutions contain as limiting cases, valid throughout the hyperplane, the nonrotating collapse of a uniform-density sphere and the Newtonian equation of motion for a class of finite rotating bodies. The general solution reveals that rotation is unable to halt gravitational collapse at a given comoving radius if the ratio of interior rest mass to angular momentum per unit mass is sufficiently large. In that case the contribution of the rotational kinetic energy to the effective gravitational mass becomes more important than the opposing effect of centrifugal force. This leads to a dynamical singularity, in which the proper-time derivatives of both radial and circumferential distances become negatively infinite, while the distances themselves remain finite. (Contractor's abstract)

2712

Stanford U. Dept. of Physics, Calif.

GIANT MAGNETIC QUADRUPOLE OSCILLATIONS IN NUCLEI, by T. DeForest, Jr., J. D. Walecka and others. [1965] [4]p. incl. diagrs. table, refs. (AFOSR-65-1832) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389 and Office of Naval Research) AD 463453 Unclassified

Also published in Phys. Ltrs., v. 16. 311-314, June 1, 1965.

Calculations are carried out for the $J^- 2^-$, T 1 states in O^{16} and C^{12}, using the particle, hole approximation and the random phase approximation. Two elements of spin dependence are included-- that of the free force and the spin-orbit splitting of the configurations. In the calculations, a giant magnetic quadrupole state occurs at 20.76 mev in C^{12} and 21.34 mev in O^{16}. High resolution experiments on the giant dipole region in C^{12} and O^{16} at 180° are reported. The cross section for inelastic scattering at 180° from carbon of 65 mev primary electrons is plotted as a function of the excitation energy. A strong energy peak occurs at the 19.2 mev level in C^{12}. Similar results have been reported at the 20.2 mev level in O^{16}. These rapidly rising peaks in C^{12} and O^{16} suggest that they are the giant magnetic quadrupole oscillations.

2713

Stanford U. Dept. of Physics, Calif.

ELASTIC MAGNETIC ELECTRON SCATTERING, by R. H. Pratt, J. D. Walecka, and T. A. Griffy. [1965] [8]p. incl. table, refs. (AFOSR-65-1833) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389 and Office of Naval Research) AD 625925 Unclassified

Also published in Nuclear Phys., v. 64: 677-684, 1965.

The 180° elastic scattering of electrons from nuclei is discussed in Born approximation. In the derivation of the differential cross section given, only the static magnetic moment is seen in the backward direction as the momentum transfer $q \to 0$. The derivation has the advantage that it holds for an extended target with arbitrary charge and current distribution and with any spin. It also demonstrates how the experimental results can deviate from this limit. The ml form factor for F^{19} is calculated as experimental results for this nucleus have not been in agreement with the theory using the static magnetic moment. The analysis brings the theoretical cross section into agreement with experiment. (Contractor's abstract, modified)

2714

Stanford U. Dept. of Physics, Calif.

DOUBLE-CHARGE-EXCHANGE SCATTERING OF

PIONS FROM NUCLEI, by R. G. Parsons, J. S. Trefil, S. D. Drell. [1965] [4]p. incl. tables, refs. (AFOSR-65-1834) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389, and Atomic Energy Commission) AD 625921 Unclassified

Also published in Phys. Rev., v. 138: B847-B850, May 24, 1965

Pions offer a unique possibility as probes of nuclear structure since they can exchange two units of electrical charge unaccompanied by other quantum numbers. The double-charge-exchange cross section is calculated for the reaction $\pi^- + He^3 \rightarrow \pi^+ + 3n$ in the impulse approximation using the Chew-Low model for the pion-nucleon interaction. Only the dominant 3-3 channel is retained. For incident pions in the energy region of several hundred mev, values of the differential cross section of $d^2\sigma / d\Omega dE \approx 1.10$ μb mev are obtained for forward angles. Triple-scattering terms are also calculated and found to introduce corrections of 10^{-7} in $d^2\sigma / d\Omega dE$. Similar results are obtained when the work is extended to the reaction $\pi^+ + O^{18} \rightarrow \pi^- + Ne^{18}$ using shell-model wave functions.

2715

Stanford U. Dept. of Physics, Calif.

STRUCTURE OF He^3 AND H^3 FROM HIGH-ENERGY ELECTRON SCATTERING, by T. A. Griffy and R. J. Oakes. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-1835) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389 and Office of Naval Research) AD 625939 Unclassified

Presented at meeting of the Amer. Phys. Soc., Gatlinburg, Tenn., Oct. 15-17, 1964.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10, 624, June 23, 1965

Also published in Rev. Modern Phys., v. 37: 402-405, July 1965.

The structure of the 3-nucleon systems He^3 and H^3 is investigated by analysis of their electron-proton coincidence cross sections. The cross section is computed using 2 approximations: (1) The nonrelativistic approximation in which the 3-body nucleus is described by a wave function, and (2) the nucleon-pole approximation. In the former case, calculations using the Irving-Gunn wave function are found to best agree with recent experimental results. In the latter case the shape of the cross section is given by the nucleon propagator and is also found in agreement with experimental data. The relation between the 2 approximations is presented

2716

Stanford U., Dept. of Physics, Calif.

SINGLE-CHANNEL CALCULATION OF THE ρ RESONANCE WITH INELASTIC UNITARITY, by P. W. Coulter and G. L. Shaw [1965] [6]p. incl. diagrs. refs. (AFOSR-65-1836) (AF 49(638)1389) AD 625936 Unclassified

Also published in Phys. Rev., v. 138: B1273-B1278 June 7, 1965.

The width and shape of the ρ resonance are computed from a single-channel N/D formalism with inelastic unitarity. The input force is assumed to be furnished primarily by the exchange of the σ in the crossed channels. The input mass, 760 mev, and width, ~100 mev, are taken from experiment. The inelastic factor η is assumed to be determined by the $\pi\pi \rightarrow \pi\omega$ reaction at low energy and fitted to various arbitrary forms at higher energies. A cutoff is adjusted to produce the ρ resonance at the observed energy. The smallest output width obtained is 250 mev, as compared with 600 mev for the pure-elastic-scattering ($\eta = 1$) calculation. A more nearly symmetric shape for the resonance is obtained when inelastic effects are considered. (Contractor's abstract)

2717

Stanford U. Dept. of Physics, Calif.

MULTICHANNEL EFFECTIVE-RANGE THEORY FROM THE N/D FORMALISM, by P. Nath and G. L. Shaw. [1965] [5]p. incl. diagrs. refs. (AFOSR-65-1837) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389 and Atomic Energy Commission) AD 625932 Unclassified

Also published in Phys. Rev., v. 138: B701-B706, May 10, 1965.

An effective-range theory for systems of many coupled 2-body channels is given using the N/D formalism. The effective-range expansion is carried out in the amplitudes M_{ij}, where M is essentially the matrix T^{-1} with the right-hand cut removed. Quite in analogy with the single-channel effective-range theory, the diagonal elements M_{ij} are given by an expression quadratic in k_i, the relative momentum in channel i. The effective ranges R_{ii} are given by certain principal-value integrals which depend on the position of the left-hand singularities in the corresponding channels and can be taken to be energy-independent to the same extent as in the one-channel theory. The nondiagonal elements M_{ij}, in general, have a weak energy dependence and can approximately be treated as constants. A 2-channel computer experiment is performed to test these proposals in detail. Three different situations for the left-hand cut are considered: (1) a set of monopoles, (2) a set of dipoles, and (3) the left-hand cut produced by the exchange of scalar particles in the crossed t reactions. For a larger number of situations considered, the simple features proposed for the multichannel effective range theory are found to exist.

2718

Stanford U. Dept. of Physics, Calif.

VALIDITY OF THE PHASE-SHIFT REPRESENTATIONS,

by Y. Fujii. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-1838) (AF 49(638)1389) AD 625940 Unclassified

Also published in Phys. Rev., v. 139: B472-B475, July 26, 1965.

A previous discussion on the validity of the phase-shift representation is further developed. An example treated in a previous work based on a separable-potential model is given in an improved method to show that such a representation fails in more general cases than those considered recently by Bander, Coulter, and Shaw, based on a simplified N/D model. It is also shown that $\delta_I(S)$, the imaginary part of the elastic phase shift, is a boundary value of a function which connects the elastic S-matrix element in the physical sheet to that in other Riemann sheets. Consequently, $\delta_I(S)$ should be so chosen as to satisfy certain mathematical conditions as well as to fit experiments. The simplest example of such a function is given. (Contractor's abstract)

2719

Stanford U. Dept. of Physics, Calif.

MESON DECAYS AS POSSIBLE TESTS FOR A STRONG C VIOLATION, by Y. Fujii and G. Marx. [1965] [3]p. (AFOSR-65-1839) (AF 49(638)1389) AD 625927 Unclassified

Also published in Phys. Ltrs., v. 17: 75-77, June 15, 1965.

Meson decays with simple transition matrix elements are investigated as possible tests for strong C violation. Three decays are considered: (1) the transition $\cdot \eta$ (2) the transition $\ldots \nu$, and (3) the transition $\varphi \rightarrow \gamma$. For (1) the observation of a decay $^0 \rightarrow \cdot^0 \gamma\gamma$ would prove the existence of a C violation. If the matrix element for (2) would not vanish, it would result in a decay mode $\omega \rightarrow (\cdot^+ \cdot^-)_{I=1}, \gamma$ in which the 2π system would be in a p state and characterized by I = 1. This would mean a C violation, though difficulties occur because of the low Q value of (2). The observation of the analogous case (3) would establish a C violation. It is noted that it would be worthwhile to search after the $\cdot \pi\pi\gamma$ decay as it seems to be favorable for the measurement of the ratio of the C violating and C conserving matrix elements.

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Stanford U. Dept. of Physics, Calif.

DEUTERON ELECTROMAGNETIC FORM FACTORS - II, by M. Gourdin. [1965] [9]p. incl. refs. (AFOSR-65-1867) (AF 49(638)1389) AD 626811 Unclassified

Also published in Nuovo Cimento, Series X, v. 35: 1105-1113, Feb. 16, 1965.

Using the impulse approximation for the deuteron in the Breit system corrections are presented to a previous calculation of the deuteron electromagnetic form factors, taking into account the momentum of the spectator nucleon. For the magnetic moment, the well-known nonrelativistic formula $\mu_d = (\mu_p + \mu_n)(1 - 3/2 P_D) + 3/4 p_D$, has been obtained. The most important corrections seem to be: (1) meson exchange current effects; (2) relativistic corrections to the neutron-proton deuteron vertex; and (3) off-mass-shell-dependence of the nucleon form factors.

2721

Stanford U. Dept. of Physics, Calif.

RELATIVISTIC EFFECTS IN THE FORM FACTORS OF He^3 AND H^3, by G. B. West. [1965] [7]p. incl. diagrs. refs. (AFOSR-65-1971) (AF 49(638)1389) AD 626330 Unclassified

Also published in Phys. Rev., v. 139: B1246-B1252, Sept. 2, 1965.

Relativistic corrections to Schiff's nonrelativistic analysis of the 3-body nuclei form factors are estimated. High-energy electron scattering from these nuclei is re-examined using an impulse approximation in which the intermediate nucleon states are taken to propagate and interact as free particles. It is concluded that the corrections to the form factors are small (5%) for $- q^2$ 8 F^{-2}. However, it is shown that they assume great importance if the experiments are used to investigate the neutron charge form factor. Various effects arising from the use of the impulse approximation are discussed. These include considerations of current conservation, of the static limit ($q^2 \cdot 0$), and of the extraction of nuclear form factors from the impulse-approximation nuclear current. (Contractor's abstract)

2722

Stanford U. Dept. of Physics, Calif.

MUON CAPTURE AND INELASTIC ELECTRON SCATTERING IN C^{12} AND O^{16}, by T. DeForest, Jr. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-1972) (AF 49(638)1389) AD 626331 Unclassified

Also published in Phys. Rev., v. 139: B1217-B1226, Sept. 6, 1965.

The dipole contribution to the muon-capture matrix elements, M_V, M_A, and M_P, is calculated using wave functions computed in the particle-hole theory. It is found that $(M_V^2)_D \quad (M_A^2)_D = (M_P^2)_D$ to within 13%. The assumption that the dipole part of the nuclear matrix element may be expressed as the unretarded dipole matrix element multiplied by the elastic form factor is found to hold to about 1%. Calculations of inelastic electron scattering from the 2-, T 1 states in these nuclei predict large cross sections for some of the states at about 100 mev c momentum transfer These giant-magnetic-quadrupole states are identified with observed levels found in recent 180° electron-scattering experiments (Contractor's abstract)

2723

Stanford U. Dept of Physics, Calif.

P- AND D-STATE CONTRIBUTIONS TO THE MAGNETIC MOMENT FORM-FACTORS OF H^3 AND He^3, by B. F. Gibson. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-1973) (AF 49(638)1389) AD 626332 Unclassified

Also published in Phys. Rev., v. 139: B1153-B1159, Sept. 6, 1965.

The effects of reasonable admixtures of P- and D-state ($J^P = 1^+$, $T = 1/2$) components to the ground-state wave function of H^3 and He^3 on their magnetic moment form factors are calculated. It is found that these form factors cannot be accounted for in this way. Inclusion of the S' state and a typical $T = 3/2$ state still leaves the magnetic form factors unexplained, although such an admixture is shown to account for the difference between the observed charge form factors. The empirical isoscalar and isovector exchange magnetic moment form factors that are needed to fit the experimental data are calculated. (Contractor's abstract)

2724

Stanford U. Dept. of Physics, Calif.

MESON STATES IN A NONLINEAR SPINOR MODEL OF ELEMENTARY-PARTICLE THEORY WITH SPONTANEOUS SYMMETRY BREAKDOWN, by N. Byrne, C. Iddings, and E. Shrauner. [1965] [12]p. incl. diagrs. refs. (AFOSR-65-1974) (AF 49(638)1389) AD 626814 Unclassified

Also published in Phys. Rev., v. 139: B933-B944, Aug. 23, 1965.

A self-coupled spinor model of elementary particles having $SU_2 \times SU_2$ symmetry is considered. It is demonstrated that for the case of complete spontaneous breakdown of the isospin symmetry the bubble approximation gives a method for treating the meson states that is compatible with symmetries of the model in that it gives the Goldstone bosons and Goldberger-Treiman relations exactly. It is also shown that by a continuation in the parameter characterizing the isospin breakdown a transformation can be made from a solution having isospin degeneracy to solutions in which the isospin, as well as the chiral symmetry is spontaneously broken. Calculational techniques for this approximation are explicitly given. (Contractor's abstract, modified)

2725

Stanford U. Dept of Physics, Calif.

THE $\eta \to \pi^+ \pi^- \pi^0$ DECAY WITH C-VIOLATION, by M. Nauenberg. [1965] [3]p. (AFOSR-65-1975) (AF 49(638)1389) AD 626812 Unclassified

Also published in Phys. Lett., v. 17: 329-331, July 15, 1965.

Calculations are presented for the effect of C violation on the η decay spectrum. It is assumed that in addition to a $I = 1$ $\eta \to 3\pi$ transition due to virtual electromagnetic interactions, there exists a $I = 0$ transition induced by the interaction H which violates C. The resultant $\pi^+ \pi^-$ asymmetry has very characteristic features due to the fact that the final $I = 0$, 3π state is antisymmetric under the exchange of any pair of pion momentum. Some details of a model for $\eta \to 3\pi$ decay are discussed. The possibility that the C-violating interaction H violates isospin, and in particular that it allows an η decay to the $I = 2$, 3π state is considered.

2726

Stanford U. Dept. of Physics, Calif.

BREAKDOWN OF UNITARY OCTET SYMMETRY IN A NONLINEAR SPINOR MODEL OF ELEMENTARY-PARTICLE THEORY, by N. Byrne, C. Iddings, and E. Shrauner. [1965] [15]p. incl. diagrs. tables, refs. (AFOSR-65-1976) (AF 49(638)1389) AD 626813 Unclassified

Also published in Phys. Rev., v. 139: B918-B932, Aug. 23, 1965.

The spontaneous breakdown of unitary octet symmetry in a nonlinear spinor model of elementary-particle theory is considered. This model is an adaptation to unitary octet symmetry of a previous model, and it contains $SU_3 \times SU_3$ symmetry in the same way that the previous model contained $SU_2 \times SU_2$ symmetry (Phys. Rev., v. 122: 345, 1961 and v. 124: 246, 1961). An exact formula is derived for the physical baryon mass that reduces to the usual superconductor-type formula in the lowest order approximation. Nonperturbative solutions that leave the physical Λ and Σ masses degenerate are obtained. The presence is confirmed in the nonperturbative solutions of massless pseudoscalar and scalar mesons transforming as components of F-type octets as predicted by the Goldstone theorem. Massless pseudoscalar and scalar mesons are found that transform as components of unitary spin decimets. Only the F octets are Goldstone mesons associated with the spontaneous breakdown of octet symmetry in this model, whereas the massless decimets are associated with the invariance of a restricted part of the Langrangian under a larger group and their masslessness is not a consequence of symmetry breakdown in these solutions. (Contractor's abstract)

2727

Stanford U. Dept. of Physics, Calif.

ELECTRON SCATTERING FROM NUCLEAR MAGNETIC MOMENTS, by T. A. Griffy and D. U. L. Yu. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-2091) (Rept. no. HEPL-375) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389, [Atomic Energy Commission], and Office of Naval Research) AD 463439 Unclassified

Also published in Phys. Rev., v. 139, B880-B885, Aug. 23, 1965.

The elastic scattering of high-energy electrons from the magnetic dipole and magnetic octupole moments of light nuclei is calculated using shell-model wave functions. The results of the calculation are compared with recent experimental results for Be^9 and B^{11} and the possibility of obtaining a value for the magnetic octupole moment from an analysis of these experiments is discussed. (Contractor's abstract)

2728

Stanford U. Dept. of Physics, Calif.

HYPERFINE STRUCTURE AND WEAK INTERACTIONS, by J. B. Adams. [1965] [2]p. incl. table. (AFOSR-65-2096) (AF 49(638)1389) AD 627633 Unclassified

Also published in Phys. Rev., v. 139: B1050-B1051, Aug. 23, 1965.

The contribution of possible 4-fermion V-A weak interactions to the hyperfine splitting is considered for the hydrogen-like bound systems (e^-, p^+), (μ^-, p^+), (e^-, μ^+), and (e^-, e^+). Numerical values are presented for the change in hyperfine splitting due to the weak interactions, ΔE_W, and the ratio of this splitting to the fundamental electromagnetic splitting, E_{EM}. Because there exists an uncertainty in the theoretical prediction of E_{EM} for the (e^-, p^+) system and because the finite lifetimes of the (e^-, μ^+) and (e^+, e^-) systems impose a minimum limit on the line breadth of the hyperfine transition, these systems do not prove practical to test theories of weak interactions. However, for the mesonic atom (μ^-, p^+) the size of the effect, 19 parts per million, might be experimentally measurable. (Contractor's abstract, modified)

2729

Stanford U. Dept. of Physics, Calif.

ABSORPTIVE CORRECTIONS AND FORM FACTORS IN THE PERIPHERAL MODEL, by M. Bander and G. L. Shaw. [1965] [7]p. incl. diagrs. refs. (AFOSR-65-2097) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1389, and Atomic Energy Commission) AD 629020 Unclassified

Also published in Phys. Rev., v. 139: B956-B962, Aug. 23, 1965.

Absorptive corrections applied to the peripheral model have provided a relatively successful interpretation of a variety of high-energy production processes. There exist, however, a number of difficulties associated with these calculations. This paper considers the reaction $\pi N \to N$, which is dominated by π exchange, in order to study the following three ambiguities: (1) the actual dependence of the absorptive corrections on the initial- and final-state elastic-scattering phase shifts, (2) the role of a form factor, and (3) the numerical values of the final-state elastic-scattering phase shifts. The comparison of the calculation made with the experimental data, in particular the density matrix of the leads to the following results. The $J = 1^+/2$ partial waves must be totally suppressed by the absorptive corrections and the form factor must play a very minor role in order to fit the observed deviation of the ρ's density matrix from that predicted by the exchange of a π in the peripheral model. Any form factor associated with π exchange is expected to have a weak t dependence, since there exists no resonance with the approximate quantum numbers (to couple to the π) with energy < 1.3 bev. It is plausible that form factors, while unimportant for π exchange, may play a significant role in vector exchange. (Contractor's abstract)

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Stanford U. Dept. of Physics, Calif.

EXCHANGE ELECTRICAL MOMENTS FOR NUCLEAR BETA AND GAMMA TRANSITIONS, by U. Fujii and J.-L. Fujita. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-2696) (AF 49(638)1389) AD 627781 Unclassified

Also published in Phys. Rev., v. 140: A239-A244, Oct. 25, 1965.

The relative importance of exchange electric currents in nuclear β and γ transitions is estimated by using their relation to the Van Vleck potential and to the sum rule for nuclear photoabsorption cross section. Though the exchange electric currents are not experimentally observable because of the Siegert theorem, the estimates give us an idea of the difference between a free nucleon and a nucleon inside a nucleus. It is found that the magnitude of the exchange electric current relative to the convection current is more than 40% at the Fermi surface. (Contractor's abstract)

2731

Stanford U. Dept. of Physics, Calif.

PROPERTIES OF A MASSIVE NEUTRAL GAUGE PARTICLE, by Y. Fujii. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-65-2786) (AF 49(638)1389) AD 629283 Unclassified

Also published in Phys. Rev., v. 138: B423-B429, Apr. 26, 1965.

The properties of a massive neutral vector particle were investigated which is assumed to be gauge particle associated with the baryon number and to bear strong interactions. The strong resemblance to quantum electrodynamics serves as a guide. Results are as follows: (1) A simple relation between the mass and wave-function renormalizations is obtained. (2) The theory of mixing between two vector particles cannot be applied in its simplest form if one or both of them are gauge particles. (3) There are some restrictions on the form of the interaction with mesons, which can be tested experimentally. The analysis of the production of two vector particles from a pion incident on a nucleon is proposed as an example. (Contractor's abstract)

2732

Stanford U. Dept. of Physics, Calif.

RADIATIVE LEPTON PRODUCTION BY A NEUTRINO BEAM, by J. B. Adams. [1965] [10]p. incl. diagrs. table, refs. (AFOSR-66-0433) (In cooperation with Brandeis U., AF AFOSR-63-368) (AF 49(638)1389) AD 630355 Unclassified

Also published in Phys. Rev., v 140· B1131-B1140, Nov. 22, 1965.

The reaction $\nu + n \rightarrow \mu + p + \nu$ is considered. To an extensive perturbation-theory type model for the nonradiative reaction ($\nu + n \rightarrow \mu + p$) are added electromagnetic interactions of the particles involved. Total and differential cross sections are computed for several neutrino energies in the BeV range. Results when normalized to the nonradiative cross sections are found to be insensitive to parameters in the model except the nucleon anomalous moments. For high-energy neutrinos, the effect of the anomalous moments is manifest as a striking peak in the photon spectrum when displayed as $d\sigma$ d lnk versus lnk. This offers the possibility of testing for the excitation of higher nucleon resonances in the reaction. (Contractor's abstract)

2733

Stanford U. Dept of Physics, Calif

ON THE ELECTROMAGNETIC STRUCTURE OF THE YUKAWA MESON, by L. I. Schiff [1965] [6]p. (AFOSR-66-0435) (AF 49(638)1389) AD 630398 Unclassified

Also published in Prog. Theoret. Phys., Suppl., Extra Number 400-405, 1965.

A discussion is presented of a recent proposal of hofstadter for the measurement of the electromagnetic form factor of the Yukawa meson, by comparing the elastic scattering of positive and negative pions on an isoscalar nucleus. A formalism is developed which permits coulomb effects to be calculated to first order without the use of coulomb wave functions. In particular, it is shown that the coulomb born amplitude is not enough in itself, but that there are additional first order coulomb effects that arise from distortion of the pion wave function by the nuclear interaction. (Contractor's abstract)

2734

Stanford U. Dept. of Physics, Calif.

COUPLING CONSTANTS IN MUON CAPTURE, by L. L. Foldy and J. D. Walecka. [1965] [12]p. incl. diagrs. table, refs. (AFOSR-66-0452) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638) 1389, and Atomic Energy Commission) AD 630087 Unclassified

Also published in Phys. Rev., v 140 B1339-B1350, Dec. 6, 1965

The measured capture rate of muons in C^{12} leading to the ground state of B^{12}, in combination with other data, is employed as a basis for a determination of the weak-interaction coupling constants associated with muon capture. The study of this transition has the advantages: (1) that the rate depends only weakly on the vector, induced pseudoscalar, and (possible) tensor coupling constants, but not at all on a possible scalar coupling constant; (2) that empirical information from inelastic electron scattering on C^{12} leading to the excitation of the 15.1-mev level, the M 1 lifetime of this level, and the ft 1/2 value for the β decay of B^{12} allows one to determine the required nuclear matrix elements of major importance (as well as some of minor importance) in practically a model-independent way. The capture rate can thus be expressed in terms of the axial vector coupling constant and the weak-magnetism coupling constants. Assuming the validity of the conserved-vector-current hypothesis (CVC), and $5 \; C_p \cdot 28$, one then finds that $F_A{}^\mu F_A{}^\beta = 1.04_{-0.10}^{+0.07}$. On the other hand, if one assumes $F_A{}^\mu = F_A{}^\beta$, one obtains for the isotopic vector magnetic moment of the nucleon (at the appropriate momentum transfer) $\mu(\nu^2) = 5.7_{-1.6}^{+1.1}$ nuclear magnetons, which is consistent with the CVC prediction of 4.60 nm and can be considered as evidence for weak magnetism in muon capture. (Contractor's abstract)

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Stanford U. Dept. of Physics, Calif.

SPONTANEOUS SYMMETRY BREAKDOWN IN A NON-LINEAR BOSON FIELD: A MODEL FOR C VIOLATION, by G. Marx. [11]p. [1965] incl. diagrs. refs. (AFOSR-66-0475) (AF 49(638)1389) Unclassified

Also published in Phys. Rev., v. 140: B1068-B1078, Nov. 22, 1965.

A boson field with quartic self-coupling is discussed in the BCS approximation. For certain values of the coupling constant the transition from simple products to normal ordered products by a Bogolyubov transformation implies a spontaneous breakdown of the original symmetries in the Lagrangian. In a real scalar field a discrete symmetry can be broken; in more complex fields mass splitting also occurs. If the boson is characterized by the assignment 0^{+-}, the nonvanishing vacuum expectation value of its field operator may result in tadpole diagrams, which offer an explanation of the C-violating transitions. The experimental consequences of different coupling schemes between the 0^{+-} meson and other particles are discussed in detail. The role of the $\varrho\pi\eta$ and $\varrho\pi X$ matrix elements is emphasized in explaining different C-violating transitions in SU(2)- and SU(3)-symmetric ways, respectively.

2736

Stanford U. Dept. of Physics, Calif.

PHOTOPRODUCTION OF π^0 FROM HYDROGEN NEAR

1.0 - 8.0 F^{-3}. Model-independent radii of the charge and magnetic-moment distributions are given and an attempt is made to deduce form factors describing the spatial distribution of the protons in tritium and helium-3. (Contractor's abstract)

2755

Stanford U. High-Energy Physics Lab., Calif.

ELECTRON SCATTERING FROM THE MAGNETIC DIPOLE AND OCTOPOLE MOMENTS OF BERYLLIUM-9 AND BORON-11, by R. E. Rand, R. Frosch, and M. R. Yearian. [1965] [4]p. incl. diagrs. refs. [Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission and Office of Naval Research under [Nonr-22567]) Unclassified

Published in Phys. Rev. Ltrs., v. 14: 234-237, Feb. 15, 1965.

Measurements were taken of the magnetic form factors of Be^9 and B^{11} by electron scattering at an angle of 180°. A method for studying the properties of the octopole moment in light nuclei was proposed. It was concluded that agreement between the experimental points and the theoretical curves would indicate that the single-particle model could be made to fit the data by multiplying the dipole and octopole moments by the same factor.

2756

Stanford U. [High-Energy Physics Lab.] Calif.

INELASTIC ELECTRON SPECTRA FROM THE ELECTRODISINTEGRATION OF DEUTERIUM (Abstract), by M. R. Yearian, E. B. Hughes and others. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under [Nonr-22567]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 95, Jan. 27, 1965.

The momentum spectrum of inelastic electrons from the electrodisintegration of the deuteron has been measured for values of the 4-momentum transfer, $q^2 = 1.5$, 2.5, 4.6, and 7.5 F^{-2}. The spectra were obtained for 3 different scattering angles for each value of q^2, with the exception of 7.5 F^{-2} where only one spectrum at $\theta = 120°$ was obtained. A comparison has been made between the observed cross sections and that predicted from a simplified form of the Durand theory, which neglects the D-state component of the deuteron wavefunction and the final-state n-p interaction. Discrepancies between the theory and experiment are observed for momenta close to the elastic peak and near the peak in the inelastic peak, the agreement is surprisingly good. For the lowest values of q^2, a peak appears in the inelastic spectrum corresponding to a strong $^1S_0$ n-p final-state interaction. Neutron form factors were obtained from the area under the inelastic peak and compared with those obtained using quasielastic-peak method.

2757

Stanford U. [High-Energy Physics Lab.] Calif.

NEUTRON FORM FACTORS FROM INELASTIC ELECTRON-DEUTERON SCATTERING (Abstract), by E. B. Hughes, T. A. Griffy and others. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under [Nonr-22567]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 95-96, Jan. 27, 1965.

Values of the neutron form factors G_{mn} and G_{en} have been obtained from electron-deuteron scattering for values of the 4-momentum transfer $q^2 = 1.0$ to 30.0 F^{-2}. The square of the neutron's charge form factor $(G_{en})^2$ was found to be zero for $q^2 > 6F^{-2}$, with an error of approximately 5% due to uncertainties in the theoretical expression for the electrodisintegration cross section. For values of $q^2 < 6F^2$, negative values were obtained for $(G_{en})^2$, suggesting a theoretical uncertainty greater than 5%. The results for the neutron form factors were combined with the recent determination of the proton form factors by Janssens to obtain the isotopic vector and scalar form factors. The isotopic form factors are analyzed in terms of the known vector mesons, ω, ϕ, and ρ. An adequate fit to the form factors is obtained if one uses an effective ρ mass of 567 mev. An attempt has also been made to obtain a fit to the form factors by including an additional isovector meson of variable mass and requiring that the ρ mass be near its experimental value of 750 mev.

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Stanford U. High-Energy Physics Lab., Calif.

PHOTODISINTEGRATION OF THE DEUTERON BY POLARIZED PHOTONS, by F. F. Liu. [1965] [7]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [Nonr-22567] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 94, Jan. 27, 1965.

Published in Phys Rev., v. 138: B1443-B1449, June 21, 1965.

2741

Stanford U. [Dept. of Physics] Calif.

EXPERIMENTS AT LIQUID HELIUM TEMPERATURES ON MACROSCOPIC QUANTUM EFFECTS AND GENERAL RELATIVITY, by W. M. Fairbank. Final rept. Aug. 7, 1965, 3p. (AFOSR-65-1600) (AF AFOSR-62-119) AD 623790 Unclassified

A review is presented of research in the following three areas: (1) preliminary research on the design of a low temperature gyro experiment to check the general theory of relativity by an experiment proposed by L. I. Schiff, (2) quantized flux in superconductors which is found to be in integral units of hc 2e instead of hc e; and (3) the scattering of light from He II to see quantized vortices. During this investigation, a superconducting circuit was developed capable in principle of measuring 10^{-11} gauss, and the idea of a truly zero magnetic field region was conceived, made possible by the fact of flux quantization in superconductors.

2742

Stanford U., Dept. of Physics. Calif.

SPIN AND GRAVITATION, by H. Pagels. [1965] [24]p. incl. refs. (AFOSR-65-0814) (AF AFOSR-62-452) AD 616217 Unclassified

Also published in Ann. Phys., v. 31: 64-87, Jan. 1965.

The presence of a gravitational or electromagnetic field can be regarded as altering the symmetries of flat spacetime in such a way that the group of translations for states with charge and spin is no longer abelian. Furthermore, just as invariance under gauge transformations implies current conservation, invariance under general coordinate and general similarity transformations implies that the stress-energy tensor must satisfy $T^{\alpha\beta}{}_{,\beta} = 0$ and $(T^{\alpha\gamma} x^{\beta} - T^{\alpha\beta} x^{\gamma})_{,\alpha} = 0$, ten conditions which lead to the Einstein equations. It is also possible to construct the gravitational analogue of the electromagnetic current, $J_{\alpha} = (K/2)\sigma_{\lambda\zeta} T_{\alpha}{}^{\lambda\zeta}$, which depends on the way in which the distribution of matter changes, and is divergence-free because of the Einstein equations. In this way the dynamical content of symmetry principles is emphasized, and it is shown that Einstein's equations essentially follow from covariance alone. (Contractor's abstract)

2743

Stanford U. Dept. of Physics, Calif.

CONSEQUENCES OF A WEAK VECTOR BOSON IN RADIATIVE MUON DECAY, by E. S. Ginsberg and R. H. Pratt. [1965] [6]p. incl. diagr. refs. (AFOSR-65-452) AD 621351 Unclassified

Also published in Nuovo Cimento, Series X v. 35: 114-119, Jan. 1, 1965.

Consequences of a weak vector boson, W, for radiative muon decay $\mu \rightarrow e + \nu + \bar{\nu} + \nu$ are calculated, including the effects of anomalous electromagnetic properties for the W-boson. All effects are small, of order $\lambda = m_{\mu}^{2} m_{W}^{-2}$, relative to the spectrum in the absence of a W-boson. This is consistent with present experiments. (Contractor's abstract)

2744

Stanford U. [Dept. of Physics] Calif.

MEASUREMENT OF THE LONDON MOMENT, by M. Bol and W. M. Fairbank. [1965] [4]p. incl. diagrs. [AF AFOSR-63-348] Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. A): 471-474, 1965.

It is shown that a solid rotating mercury cylinder reversibly obeys London's equations when cooled through the superconducting transition. Thus, when a mercury cylinder is cooled through the transition while rotating with angular velocity w, the electrons in the surface layer spontaneously l ; behind, producing a d.c. axial magnetic field within the superconducting of 10^{-7} wg. This same field is produced if the sample is cooled into the superconducting state without rotation and is subsequently set into rotation with an angular velocity w.

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Stanford U. Dept. of Physics, Calif.

QUANTIZED FLUX IN SUPERCONDUCTING CYLINDERS, by A. L. Kwiram and B. S. Deaver, Jr. [1965] [4]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-348] and Office of Naval Research) Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. A): 451-454, 1965.

The flux change occurring in small hollow superconducting cylinders cyclically cooled through the transition temperature in an applied axial magnetic field at frequencies up to 80 kcps was observed. A periodic variation as a function of applied field was found at all frequencies tried, indicating that the quantized flux is established in these cylinders at least at fast as 10^{-5} sec. The period has been measured and corresponds to a flux change of hc 2e through the cylinder. Measurements were made on tin, indium, lead, and vanadium cylinders about 1 cm long and about 40 μ 00. Various wall thicknesses from 500 A up to 15,000 A were used.

2746

Stanford U. Dept. of Psychology, Calif.

SPONTANEOUS AND SUGGESTED POSTHYPNOTIC AMNESIA, by E. R. Hilgard and L. M. Cooper. [1965] [13]p. incl. diagrs. tables. (AFOSR-66-2207) (AF 49(638)1436) AD 643591 Unclassified

Also published in Internat'l. Jour. Clin. and Exper. Hypnosis, v. 13: 261-273, 1965.

This investigation was carried out to obtain comparable figures on the prevalence of spontaneous and suggested posthypnotic amnesia. Ninety-one introductory psychology students were randomly assigned to 1 of 2 groups, and were required to serve as Ss for two consecutive days. The standard induction of the Stanford Hypnotic Susceptibility Scale, Form A was used on the first day, and that of Form B on the second. Suggestibility items were then presented and served to apprise susceptibility and to test for amnesia. For 1 group, spontaneous amnesia was tested on the first day, and suggested amnesia on the second day. This order was reversed for the second group. Using as evidence of amnesia that 4 or fewer of the 10 possible items were recalled, 6 (7%) showed spontaneous amnesia on one of the 2 days, while a significantly large number 32 (35%), showed suggested amnesia. When the groups were subdivided on the basis of susceptibility scores, it was found that there is a marked advantage for suggested amnesia over spontaneous amnesia for highly susceptible hypnotic Ss, while this difference essentially disappears for low Ss. It was further found that (a) suggested amnesia is significantly greater than spontaneous amnesia whether or not one follows the other, (b) there is a small effect of the suggested posthypnotic amnesia for all levels of susceptibility, but this becomes pronounced with susceptibility scores of 6 and above, (c) the highly susceptible hypnotic Ss show no more spontaneous posthypnotic amnesia than do others. While there may be a small amount of spontaneous amnesia, this amount, if any, is small compared with suggested amnesia. (Contractor's abstract)

2747

Stanford U. Dept. of Psychology, Calif.

THE FRONTIERS OF PSYCHOLOGY, by E. R. Hilgard. [1965] [15]p. incl. refs. [AF 49(638)1436] Unclassified

Published in Science in the Sixties; Tenth Anniversary AFOSR Scientific Seminar, Cloudcroft, N. M. (June 14-25, 1965), ed. by D. L. Arm, Albuquerque, New Mexico U. Office of Publications, 1965, p. 58-72.

In this discussion of psychology as both a basic and an applied science, the vitality of the field and its current breadth is presented. At the same time, it is shown that the difference between basic and applied science is not so great when both are good science, and that in fact, they mutually interact. Psychology as a basic science is described through a consideration of current work in 3 large fields: biological, general experimental, and social psychology. Psychology as a technology is described by a discussion of personality tests, programmed learning, psychotherapy, and persuasive techniques. It is pointed out that without basic research, the applications would often be ineffective and uncritical, and without the technological applications, important areas of investigation might have their basic problems overlooked.

2748

Stanford U. Dept. of Statistics, Calif.

ON A CHARACTERIZATION OF THE THREE LIMITING TYPES OF THE EXTREME, by J. Sethuraman. Feb. '1965, 12p. (Technical rept. no. 104) (AFOSR-65-0637) (Sponsored jointly by Air Force Office of Scientific, Army Research Office (Durham), and Office of Naval Research) AD 610845 Unclassified

If X and Y are independent random variables then they are said to be completely confounding if the distributions of Z, Z conditional on Z = X, Z conditional on Z = Y are the same. If X, Y, and Z completely confound one another where Y and Z have the same distribution as $a_1X + b_1$ and $a_2X + b_2$ which are basically different linear functions, then the distribution of X is one of the three limiting types of the extreme (minimum) observation from independent samples from the same population.

2749

Stanford U. [Div. of Engineering Mechanics] Calif.

ALGEBRAIC STRUCTURE OF LINEAR DYNAMICAL SYSTEMS. I. THE MODULE OF Σ, by R. E. Kalman. [1965] [6]p. (AFOSR-67-1469) (AF 49(638)1440) AD 654828 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 54: 1503-1508, Dec. 1965.

The main result of this first note is the theorem that a linear, constant, discrete-time dynamical system Σ is a (finitely generated) module over the polynomial ring K[z] with coefficients in an arbitrary field K. In other words, Σ may be viewed as the realization of a certain algebraic structure (a module), just as classical mechanics may be interpreted as the realization of a certain analytic structure (a differential equation). This result is applied to the proof of the existence of transfer functions, derivation of recursion relations, and controllability criteria associated with Σ algebraic ideas and methods are stressed.

2750

Stanford U. [Div. of Engineering Mechanics] Calif.

TWO-DIMENSTIONAL HYPERSONIC STAGNATION FLOW AT LOW REYNOLDS NUMBERS, by T. K. Fannelop and I. Flugge-Lotz. [1965] [15]p. incl. diagrs. tables, refs. (AFOSR-65-2332) (AF AFOSR-62-242) AD 629666 Unclassified

Also published in Zeitschr. Flugwissensch., v. 13: 282-296, 1965.

An accurate boundary-layer analysis for hypersonic high altitude flight requires consideration of second-order (low Reynolds-number) effects. In the case of viscous flow over a cylinder with finite nose radius the second-order effects are found to be those arising from wall curvature, from velocity slip and temperature jump at the wall and from displacement-thickness interaction. A complete theory which accounts for all these effects has been given by M. D. Van Dyke. Local solutions to Van Dyke's equations for the stagnation region can be obtained by an expansion in powers of s (the arclength from the stagnation point) without use of auxiliary transformations. These local solutions become independent of the free stream conditions when the exact Sutherland viscosity law is approximated by a power law. A large number of solutions for various wall-to-stagnation-temperature ratios and power-law exponents are tabulated. These solutions are sufficiently accurate (5 to 6 decimal places in most cases) to be used as initial values for step-by-step numerical procedures for solving the first-and second-order boundary layer equations. Perfect-gas relationships are used in the analysis and the solutions are strictly applicable only when the stagnation temperature is not too high. When the wall is cold the heat-transfer rate at the stagnation point is found to be reduced due to the second-order effects. The calculated reductions are, however, much smaller than the measured reductions reported by Tewfik and Giedt, but they agree with Lenard's theoretical results. (Contractor's abstract)

2751

Stanford U. Div. of Engineering Mechanics, Calif.

THE CHOICE OF TIME FOR ZEROING A DISTURBANCE IN A MINIMUM-FUEL CONSUMPTION CONTROL PROBLEM, by I. Flugge-Lotz and A. Craig. [1965] [10]p. incl. diagrs. (AFOSR-64-0729) (AF AFOSR-63-137) AD 436522 Unclassified

Presented at Winter Annual Meeting of the Amer. Soc. of Mech. Engineers, Nov. 17-22, 1963.

Also published in Jour. Basic Eng. v. 87: 29-38, Mar. 1965.

The choice of time T for zeroing an initial disturbance with minimum-fuel consumption influences the dependence of the switching instances on the phase variables. For a set of discrete values of time T this relation can be found easily and mechanized in a simple manner. The restriction of the free choice of time T is so mild that it does not impair the usefulness of the scheme. (Contractor's abstract)

2752

Stanford U. Div. of Engineering Mechanics, Calif.

INVESTIGATION OF OPTIMUM CONTROL, by I. Flügge-Lotz. Final rept. Nov. 1, 1962-Feb. 28, 1965, Mar. 2, 1965, 4p. (AFOSR-65-0515) (AF AFOSR-63-137) Unclassified

The investigation is concerned with time optimal control for third-order systems with two complex poles and one real pole and time optimal control for systems which contain delay in their feedback paths. In the latter case the problem is described by differential-difference equations.

2753

Stanford U. [High-Energy Physics Lab.] Calif.

ELASTIC AND INELASTIC ELECTRON SCATTERING FROM C^{12} FOR MOMENTUM TRANSFERS OF LESS THAN 1.0 F^{-1} (Abstract), by H. L. Crannell, L. R. Suelzle, and M. R. Yearian. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under [Nonr-22567] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 96, Jan. 27, 1965.

Using the beam of electrons from the Stanford Mark III linear accelerator, cross sections for elastic scattering and for excitation of the 4.43-, 7.65-, and 9.64-mev levels in C^{12} have been measured. Using a newly constructed 100-channel detector positioned at the focus of the 72-in., 180° double-focusing spectrometer, we observe peak widths that are less than 0.24%. This has allowed us to study the excitation of inelastic levels at values of q^2 as low as 0.12 F^{-2}. Using the method suggested by Crannell and Griffy, the form factors determined from the cross sections are used to determine transition widths of the three excited states in C^{12}.

2754

Stanford U. [High-Energy Physics Lab.] Calif.

ELASTIC ELECTRON SCATTERING FROM TRITIUM AND HELIUM-3, by H. Collard, R. Hofstadter and others. [1965] [9]p. incl. diagrs. tables refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission and Office of Naval Research under [Nonr-22567] Unclassified

Published in Phys. Rev., v. 138: B57-B65, Apr. 12, 1965.

The mirror nuclei of tritum and helium-3 have been studied by the method of elastic electron scattering. Absolute cross sections have been measured for incident electron energies in the range 110-680 Mev at scattering angles lying between 40 and 135° in this energy range. The data have been interpreted in a straightforward manner and form factors are given for the distributions of charge and magnetic moment in the 2 nuclei over a range of 4-momentum transfer squared

1.0 - 8.0 F^{-2}. Model-independent radii of the charge and magnetic-moment distributions are given and an attempt is made to deduce form factors describing the spatial distribution of the protons in tritium and helium-3. (Contractor's abstract)

2755

Stanford U., High-Energy Physics Lab., Calif.

ELECTRON SCATTERING FROM THE MAGNETIC DIPOLE AND OCTOPOLE MOMENTS OF BERYLLIUM-9 AND BORON-11, by R. E. Rand, R. Frosch, and M. R. Yearian, [1965] [4]p. incl. diagrs. refs. [Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission and Office of Naval Research under [Nonr-22567]) Unclassified

Published in Phys. Rev. Ltrs., v. 14; 234-237, Feb. 15, 1965.

Measurements were taken of the magnetic form factors of Be^9 and B^{11} by electron scattering at an angle of 180°. A method for studying the properties of the octopole moment in light nuclei was proposed. It was concluded that agreement between the experimental points and the theoretical curves would indicate that the single-particle model could be made to fit the data by multiplying the dipole and octopole moments by the same factor.

2756

Stanford U., [High-Energy Physics Lab.] Calif.

INELASTIC ELECTRON SPECTRA FROM THE ELECTRODISINTEGRATION OF DEUTERIUM (Abstract), by M. R. Yearian, E. B. Hughes and others. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under [Nonr-22567]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 95, Jan. 27, 1965.

The momentum spectrum of inelastic electrons from the electrodisintegration of the deuteron has been measured for values of the 4-momentum transfer, q^2 1.5, 2.5, 4.6, and 7.5 F^{-2}. The spectra were obtained for 3 different scattering angles for each value of q^2, with the exception of 7.5 F^{-2} where only one spectrum at 120 was obtained. A comparison has been made between the observed cross sections and that predicted from a simplified form of the Durand theory, which neglects the D-state component of the deuteron wavefunction and the final-state n-p interaction. Discrepancies between the theory and experiment are observed for momenta close to the elastic peak and near the peak in the inelastic peak the agreement is surprisingly good. For the lowest values of q^2, a peak appears in the inelastic spectrum corresponding to a strong $^1S_0$ n-p final-state interaction. Neutron form factors were obtained from the area under the inelastic peak and compared with those obtained using quasielastic-peak method.

2757

Stanford U. [High-Energy Physics Lab.] Calif.

NEUTRON FORM FACTORS FROM INELASTIC ELECTRON-DEUTERON SCATTERING (Abstract), by E. B. Hughes, T. A. Griffy and others. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under [Nonr-22567]) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 95-96, Jan. 27, 1965.

Values of the neutron form factors G_{inn} and G_{en} have been obtained from electron-deuteron scattering for values of the 4-momentum transfer q^2 1.0 to 30.0 F^{-2}. The square of the neutron's charge form factor $(G_{en})^2$ was found to be zero for q^2 6F^{-2}, with an error of approximately 5% due to uncertainties in the theoretical expression for the electrodisintegration cross section. For values of q^2 6F^2, negative values were obtained for $(G_{en})^2$, suggesting a theoretical uncertainty greater than 5%. The results for the neutron form factors were combined with the recent determination of the proton form factors by Janssens to obtain the isotopic vector and scalar form factors. The isotopic form factors are analyzed in terms of the known vector mesons, , , and . An adequate fit to the form factors is obtained if one uses an effective mass of 567 mev. An attempt has also been made to obtain a fit to the form factors by including an additional isovector meson of variable mass and requiring that the mass be near its experimental value of 750 mev.

2758

Stanford U. High-Energy Physics Lab., Calif.

PHOTODISINTEGRATION OF THE DEUTERON BY POLARIZED PHOTONS, by F. F. Liu. [1965] [7]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [Nonr-22567] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10 94, Jan. 27, 1965

Published in Phy. Rev., v. 138: B1443-B1449, June 21, 1965.

The asymmetry in the photodisintegration of the deuteron by polarized photons has been measured between photon energies of 75 and 230 mev. Measurements were made mostly at 90° in the center-of-mass system, but limited data at 45° and 135° were also obtained. The data below 140 MeV are compared with current theories. At 90° our results are generally smaller than theoretical calculations. The measured asymmetry changes sign at about 130 MeV and shows a backward peaking at the higher energies. (Contractor's abstract)

2759

Stanford U., [High-Energy Physics Lab.,] Calif.

PHOTOPRODUCTION OF NEUTRAL MESONS FROM HYDROGEN NEAR THRESHOLD, (Abstract) by F. Bulos and B. Richter, [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [Nonr-22567], Atomic Energy Commission, and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys., Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 446, Apr. 26, 1965.

Absolute and differential cross sections have been measured for the photoproduction of neutral pions from hydrogen at 3 different laboratory γ-ray energies: 185, 170, and 160 Mev. The recoil proton was momentum-analyzed and identified by 2 counters in coincidence. The coefficients A, B, C for the c.m. angular distribution ($d\sigma/d\Omega$), $A + B\cos\theta + \cos^2\theta$ were determined. Using the dispersion relation calculation of Chew, Goldberger, Low, and Nambu the coefficients A, B, C were expressed in terms of S and P waveshifts in the isotopic spin states 2 3, 1 2. Taking the better known phase shifts from scattering experiments the phase shifts δ_{11}, δ_{13} were calculated. It was found that δ_{11} is negative at the above energies and goes positive at γ-ray energy of 325 mev corresponding to pion energy in scattering experiments of 180 mev. Absolute and differential cross sections and values of phase shifts that best fit the experiment are presented

2760

Stanford U. High-Energy Physics Lab., Calif.

POSITRON-PROTON SCATTERING, by A. Browman, F. Liu, and C. Schaerf, Mar. 8, 1965, 28p. incl. illus. diagrs. tables, refs. (Rept. no. HEPL-351) (Sponsored jointly by [Air Force Office of Scientific Research, Atomic Energy Commission], and Office of Naval Research under Nonr-22567) AD 463448 Unclassified

Published in Phys. Rev., v. 139 B1079-B1085, Aug. 23, 1965.

The importance of 2-photon exchange in elastic electron-proton scattering was investigated by measuring the ratio of positron-proton to electron-proton scattering. Four-momentum transfers as large as 0.756 $(bev/c)^2$ (19.5 F^{-2}) were used. The data indicate that 2-photon effects are (4.0 ± 1.5)% larger than those predicted by the radiative corrections at the highest momentum transfers attained in these experiments. The 2-photon corrections predicted using a static charge distribution fit the data well at lower momentum transfer and forward angles, but appear to be small at higher momentum transfer and backward angles. (Contractor's abstract)

2761

Stanford U., Inst. for Mathematical Studies in the Social Sciences, Calif.

A CORRELATED URN-SCHEME FOR A CONTINUUM OF RESPONSES, by B. C. Arnold. July 20, 1965, 84p. incl. table, refs. (Technical rept. no. 75) (AFOSR-65-1594) (AF 49(638)1253) AD 623171 Unclassified

A new model to cover the case of simple learning with a continuum of responses is presented and analyzed. Called a correlated urn-scheme, it is an adaption of the continuous analog of the classical urn-scheme for learning. The behavior of the model under non-contingent reinforcement is investigated and tests of the applicability of the model are derived. Sufficient conditions, relating to reinforcement schedules, for ergodic behavior in the case of contingent reinforcement are developed using a theorem due to Ionescu-Tulcea. The relation of the correlated urn-scheme to existing models is discussed, with much attention to the much used linear model, and possible generalizations of the urn-scheme are suggested.

2762

Stanford U Inst. for Mathematical Studies in the Social Sciences, Calif.

THE GENERALIZATION FUNCTION IN THE PROBABILITY LEARNING EXPERIMENT, by M. V. Levine, June 3, 1965, 109p. incl. diagrs. table, (Technical rept. no. 73) (AFOSR-65-1595) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49 (638)1253], National Institutes of Health and National Science Foundation) AD 622587 Unclassified

This report formulates and studies some methods for obtaining generalization functions from learning data. First it considers mathematical questions and concludes that the generalization function defined with respect to a slight modification of a familiar learning model is essentially determined by the behavior of the individual subject in one experiment. Next it is shown that generalization functions obtained by application of the methods can be used to predict certain empirical functions with great accuracy. Finally, it studies the empirical generalization functions and attempts to describe and account for the relationship between the function and distribution of reinforcements (Contractor's abstract, modified)

2763

Stanford U. [Inst. for Mathematical Studies in the Social Sciences] Calif.

LANGUAGE IDENTIFICATION IN THE LIMIT, by E. M. Gold. [Dec. 1965] 33p. incl. refs. (Rand RM-4136-PR) (AFOSR-66-0419) [AF AFOSR-65-856]
AD 631779 Unclassified

Language learnability is investigated. That is, given a specified class of possible languages and given a method of presenting information about the unknown language, which is to be chosen from the class, the question is asked, "Is the information sufficient to distinguish the unknown language?" Many definitions of distinguishability are possible, but only one is considered here. In this preliminary investigation, a language is taken to be only a set of strings on some finite alphabet which is specified a-priori. Several variations of each of two basic methods of information presentation are investigated: A text for a language generates strings of the language in any order such that every one occurs at least once. An informant for a language can tell the learner whether or not a string is in the language and does so at each time. It is found that the class of context sensitive languages is learnable from an informant, but not even the class of regular languages is learnable from a text. (Contractor's abstract, modified)

2764

Stanford U. Microwave Lab.] Calif.

GALACTIC FLARES AND QUASI-STELLAR RADIO SOURCES, by P. A. Sturrock. [1965] [4]p. incl. refs. (AFOSR-65-1079) [AF 49(638)1321] AD 619755 Unclassified

Also published in Nature, v. 205: 861-864, Feb. 27, 1965.

A theory of galactic explosions is proposed on the basis that the requirements for such a theory are the same as for a theory of solar flares. The pre-flare state on a galactic scale comprises a large mass of gas which is prevented from collapsing by the pressure of a trapped magnetic field; such a configuration is called a galaxoid. Both gravitational and magnetic energies will be released if the magnetic field and the gas can be de-coupled. Evidence in support of the theory is discussed.

2765

Stanford U. [Microwave Lab.] Calif.

RADIATION AT THE PLASMA FREQUENCY AND ITS HARMONIC FROM A TURBULENT PLASMA, by P. A. Sturrock, R. H. Ball, and D. E. Baldwin. [1965] [8]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1321 and National Aeronautics and Space Administration) Unclassified

Published in Phys. Fluids, v. 8: 1509-1516, Aug. 1965.

Any mechanism which couples electrostatic waves (plasma oscillations) and electromagnetic waves in a plasma will lead to radiation from plasma oscillations. The most important consequence of nonlinearity of the equations is that 2 electrostatic waves are coupled to one electromagnetic wave; this process is therefore responsible for radiation at the second harmonic ($2\omega_p$). Low-frequency or static inhomogeneities of the plasma couple one electrostatic wave to one electromagnetic wave, and therefore, produce radiation at (or near) the plasma frequency. Two types of inhomogeneity are considered: "isotropic" inhomogeneities, which are fluctuations in the plasma density, and "anisotropic inhomogeneities," which comprise an inhomogeneous distribution of currents and magnetic fields These radiation mechanisms are analyzed by means of a set of fluid equations for the electron component, which should provide an adequate description for plasma oscillations with wavenumbers small compared with the Debye wavenumber. The radiation field is evaluated by a Green function method, ignoring re-absorption, which one expects to be a very weak process. For each radiation mechanism, a formula is obtained for the volume emissivity of a turbulent plasma representing the plasma oscillations and the inhomogeneities each by a correlation function and an energy spectrum. Useful approximate forms of these formulas are given. (Contractor's abstract)

2766

Stanford U. Microwave Lab., Calif.

INTERACTION OF MICROWAVES WITH MATTER. Final technical rept. May 1, 1963-Sept. 30, 1964. Aug. 1965, 20p. incl. diagrs. refs. (M. L. rept. no. 1357) (AFOSR-65-1694) (AF AFOSR-63-322)
AD 624102 Unclassified

The research conducted during this study was performed with the following objectives: (1) to provide a perturbation method for analyzing waves in time-varying plasmas, (2) to provide a model for computing the electromagnetic radiation from the interaction of plasma oscillations with density fluctuations; (3) to gain understanding of the line widths and positions of the sharp lines in the fluorescence spectrum of ions in crystals; (4) to investigate frequency conversion and amplification at microwave frequencies utilizing the Doppler shift effect in solid materials; (5) to perform experiments on ferromagnetic relaxation; (6) to study the transient behavior of solid state lasers; and (7) to study the scattering of electrons and phonons through the effect of a magnetic field on the thermoelectric properties.

2767

Stanford U. Microwave Lab., Calif.

MICROWAVE RESEARCH. Quarterly status rept. no. 26, May 1-July 31, 1965, 16p. incl. illus. diagrs. (M. L. rept. no. 1372) (AFOSR-65-2309) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-225(48) AD624567 Unclassified

This report reviews the eight work projects which are now active under this contract. They are: (1) acoustic wave amplification sutdies; (2) optical maser research; (3) tunable lasers; (4) electron-phonon interactions; (5) geometrical optics of acoustic waves; (6) oscillations in semiconductors; (7) solid state plasma studies; (8) diffraction of light by transverse hypersonic waves.

2768

Stanford U. Microwave Lab., Calif.

HARMONIC GENERATION AND PARAMETRIC OSCILLATIONS IN A PLASMA, by J. H. Krenz and G. S. Kino. [1965] [9]p. incl. illus. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research under Nonr-225-48) Unclassified

Published in Jour. Appl. Phys , v. 36: 2387-2395, Aug. 1965.

Nonlinear rf effects in plasmas are discussed. It is shown that the strong type of harmonic generation mechanism is due to the equation of motion for the plasma electrons being nonlinear, as is the relationship between current and velocity. A theory of plasma harmonic generators and parametric oscillators is given. Input reaction is taken into account and it is shown that a resonance at the output frequency tends to lead to high efficiency. Such a resonance is the electrostatic resonance of a plasma sphere. Experiments carried out with a small spherical rf discharge are described. A 25% conversion efficiency to the second harmonic of an S-band signal has been obtained. Measurements have been made up to the seventh harmonic. For maximum efficiency a plasma resonance at the harmonic of interest is required. By tuning the system to be resonant at half the input frequency, parametric oscillations were obtained at this frequency, thus proving that the nonlinearity must be of a reactive type. It is believed this is the first time that parametric oscillations have been observed in a plasma.

2769

Stanford U. [Microwave Lab.] Calif.

INTERACTION OF LIGHT AND MICROWAVE SOUND, by C. F. Quate, C. D. W. Wilkinson, and D. K. Winslow. [1965] [21]p. incl. illus. diagrs. refs. (Sponsored jointly by Air Force Aeronautical Systems Division; Air Force Office of Scientific Research under AF 49(638)1429, and Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-22548) Unclassified

Published in Proc. IEEE, v. 53: 1604-1623, Oct. 1965.

The interaction of sound waves at microwave frequencies and electromagnetic waves at optical frequencies is denoted by the term Brillouin scattering. In the past, this type of scattering has been used for measuring elastic constants of materials. Interest in this subject has been renewed with the availability of coherent light from a laser and there are now a variety of problems where this interaction can be utilized. It can be used to modify an optical beam by either deflecting it in space or translating it in frequency. It can be used to monitor the spatial distribution of acoustic energy. Brillouin scattering from thermal sound waves can be used to determine the velocity of sound and attenuation in media where it is difficult to use more conventional means. With stimulated Brillouin scattering, an intense light beam can generate coherent sound of great intensity. The authors discuss each of these cases and calculate the interaction in terms of classical parametric amplifiers and parametric oscillators are exhibited. Recent experimental results are summarized and serve to confirm the simple picture wherein the 2 wave systems are coupled together by the photoelastic and electrostrictive constants of the medium. (Contractor's abstract)

2770

Stanford U. Microwave Lab., Calif.

PHONON DRAG AND PHONON INTERACTIONS IN N-InSb, by S. M. Puri. [1965] [15]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham) and Office of Naval Research under [Nonr-22548]) Unclassified

Published in Phys. Rev., v. 139: A995-A1009, Aug. 2, 1965.

The experimental results of phonon-drag thermoelectric power of n-InSb are analyzed to obtain information about electron-phonon and phonon-phonon interactions. We find that for temperatures greater than 6°K, the piezoelectric mode of electron scattering is negligible as compared to the deformation potential type of scattering. A value of 8.25 ev is found for the deformation-potential constant. The relaxation time of long-wavelength acoustical phonons is given by $\tau_q(T) = 4.4 \times 10^3 / qT^3$ for temperatures $\tau < 40°K$. The data also indicate that inelasticity of electron-phonon collisions broadening of the electron energy levels are the dominant "cutoff" mechanisms involved in the quantum theory of magnetoresistance; the first dominates in relatively low fields, while the latter takes over for fields greater than 60 kgauss. (Contractor's abstract)

2771

Stanford U. [Stanford Electronics Labs.] Calif.

ELECTRON DENSITY AND PATH LATITUDE DETERMINATION FROM V. L. F. EMISSIONS, by N. Brice. [1965] [7]p. incl. illus. diagrs. table, refs. (AFOSR-65-0897) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1060 and National Science Foundation) AD 617851 Unclassified

Also published in Jour. Atmos. and Terrest. Phys., v. 27: 1-6, 1965.

A new technique has been developed for determining nose frequencies and time delays at the nose frequency for propagation paths in the outer magnetosphere. The computed normalized whistler shape is plotted on a log-log scale, allowing the nose frequency and nose time delay to be found very simply by an overlay method, from measurements of time delays at any two other frequencies. The versatility and simplicity of this method make it particularly suited for use with periodic vlf emissions. (Contractor's abstract)

2772

Stanford U. [Stanford Electronics Labs.] Calif.

WHISTLER MEASUREMENTS OF THE EQUATORIAL PROFILE OF MAGNETOSPHERIC ELECTRON DENSITY, by D. L. Carpenter. [1965] [16]p. incl. diagrs. refs. (AFOSR-65-0899) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(628)1060 and National Science Foundation) AD 617850
Unclassified

Presented at Fourteenth Gen. Assembly URSI, Tokyo (Japan) Sept. 1963.

Also published in Prog. Radio Sci. 1960-1963, v. 3: 76-91, 1965.

A whistler method of deducing the equatorial profile of electron density is described. Results of several investigations are compared, and it is found that there is excellent agreement on the shape of the profile. Its average behavior in the range 2 R_E to 5 R_E geocentric distance is estimated to fall between about $N \propto R^{-3}$ and $N \propto R^{-4}$. Several roughly comparable estimates of numerical values are found to be within a factor of about 2. It is found that the results from whistlers are generally consistent with 5000-km values of electron density obtained by incoherent scatter measurements at the geomagnetic equator. Whistler evidence of a knee in the equatorial profile is presented which is consistent with measurements made by the Lunik I and Lunik II probes. Some of the recently obtained results on temporal variations in magnetospheric density are also discussed.

2773

Stanford U. [Stanford Electronics Labs.] Calif.

EFFECTIVE TRANSPORT COEFFICIENTS AT LOW AND HIGH COLLISION FREQUENCIES (Abstract), by O. Buneman. [1965] [1]p. [AF 49(638)1524]
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Nov. 4-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 232, Feb. 25, 1965.

It has been found possible to employ gasdynamical concepts and terminology for the description of a plasma even at low and vanishing collision frequencies. The plasma must be near thermal equilibrium and nearly uniform. It must be treated as a gas mixture (neutrals, ions, electrons), each component having its "effective" coefficients of specific heat, viscosity, thermal conduction, and Van der Waals force. The components are brought into interaction by momentum and energy-exchange terms, the macroscopic Coulomb interaction being included here as a link between ions and electrons. The four transport coefficients are functions of the wavenumber and frequency of the deviations from thermodynamic equilibrium. The exact functional dependence is determined by the choice of a model for the collision term, such as B-G-K or Fokker-Planck. Formulas valid at all values of collision frequency are obtained from these models, and, in the limits of high and zero collision frequencies, one finds the correct dispersion laws for sound waves, ion waves, and (Landau-damped) plasma oscillations.

2774

Stanford U. Stanford Electronics Labs., Calif.

EXPERIMENTAL SEPARATION OF COLLECTIVE AND INDIVIDUAL PHENOMENA IN PLASMAS-ANOMALOUS RESISTANCE, by K. I. Thomassen. [1965] [4]p. incl. diagrs. refs. (AF AFOSR-62-286)
Unclassified

Published in Jour. Appl. Phys., v. 36, 62-65, Jan. 1965.

An experimental method for separating collective effects from collision dominated phenomena in plasmas consists of probing the plasma at a frequency between the collision and plasma frequencies that govern the rates of the individual and collective processes. This method is applied to the measurement of anomalous resistance by utilizing a re-entrant cavity to expose a quiescent plasma to the strong electric fields at this intermediate frequency, thus provoking anomalous resistance. The resistive loading of the cavity is then observed as a function of power level or field strength, giving evidence of an anomalous resistance above power levels which initiate the two-stream instability.

2775

Stanford U. Stanford Electronics Labs., Calif.

PROPERTIES OF GALLIUM ARSENIDE DIODES BETWEEN 4.2° AND 300°K, by D. J. Dumin and G. L. Pearson. [1965] [9]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Army Research Office (Durham) under Nonr-22524)
Unclassified

Published in Jour. Appl. Phys., v. 36: 3418-3426, Nov. 1965.

The current-voltage characteristics of zinc-diffused gallium arsenide diodes have been measured between 4.2° and 300°K, with carrier concentrations in the n-type region varying from 6×10^{15} to 9×10^{18} cm^{-3}. In the forward direction it is shown that the current is

due to tunneling at low temperatures and high carrier concentrations whereas it arises from thermal processes involving recombination in the space-charge region at higher temperatures and low carrier concentrations. The temperature at which the current changes from predominantly tunneling to predominantly thermal in origin has been determined as a function of the n-type carrier concentration. In the reverse direction the current in these diodes appears to be dominated by tunneling at all temperatures and doping densities tested.

2776

Stanford U. [Stanford Electronics Labs.] Calif.

MULTIPHASE PERIODIC VERY-LOW-FREQUENCY EMISSIONS, by N. Brice. [1965] [9]p. incl. illus. diagrs. refs. (AFOSR-65-0907) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-370 and National Science Foundation) AD 617240 Unclassified

Also published in Jour. Research Nat'l. Bur. Stand., v. 69D: 257-265, Feb. 1965.

When periodic very-low-frequency (VLF) emissions of more than 1 set are observed concurrently (multiphase emissions) the observation of 3 sets symmetrically spaced is surprisingly frequent. Evidence is presented which suggests that 2 sets represent a transient situation, and that the strength of 1 emission may depend on the strength of, and the elapsed time since the preceding emission. The data are interpreted as evidence of a relaxation phenomenon in the generation of discrete VLF emissions, and a qualitative explanation of the stability of symmetrical 3-phase emissions is given. (Contractor's abstract)

2777

Stanford U. [Stanford Electronics Labs.] Calif.

EFFECT OF GAUSSIAN BEAM SPREAD ON PHASE VELOCITY MATCHING IN CW OPTICAL SECOND-HARMONIC GENERATION, by G. E. Francois and A. E. Siegman. [1965] [6]p. incl. diagrs. (AFOSR-65-1957) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-323 and Aeronautical Systems Division) AD 626518 Unclassified

Also published in Phys. Rev., v. 139: A4-A9, July 5, 1965.

This paper reports the results of an experimental and theoretical study of the angular variation of optical second-harmonic generation in ammonium dihydrogen phosphate using a Gaussian single-transverse-mode cw gas-laser beam. The observed angular dependence of the second-harmonic output near the phase matching angle is significantly different from the $|(\sin c)^{\epsilon}|^2$ angular dependence predicted by plane-wave theory. The difference can be quantitatively explained by an extended analysis which takes into account the Gaussian amplitude distribution and spherical wavefront of the cw laser beam. The theory predicts small but significant corrections to the results of measurements of the nonlinear coefficients of materials. These corrections can also account, at least approximately, for the effects of small crystal defects and imperfectly Gaussian beam patterns. (Contractor's abstract)

2778

Stanford U. Stanford Electronics Labs., Calif

APPARENTLY LOSSLESS TIME-VARYING NETWORKS, by B. D. O. Anderson and R. W. Newcomb Sept. 1965. [28]p. incl. diagrs (Technical rept no 6559-1) (AFOSR-65-1734) (AF AFOSR-63-337) AD 474063 Unclassified

Time-varying multiport transformers with secondary ports terminated in passive time-invariant capacitors are shown to be not necessarily lossless. A theorem is proved giving necessary and sufficient conditions on the transformer turns-ratio for there to be finite energy excitations at the transformer primary producing arbitrary charges on the capacitors. (Contractor's abstract)

2779

Stanford U. Stanford Electronics Labs., Calif

USEFUL TIME-VARIABLE CIRCUIT-ELEMENT EQUIVALENCES, by B. D. Anderson, D. A. Spaulding, and R. W. Newcomb. [1965] [2]p. incl. diagrs. (AFOSR-65-2357) (AF AFOSR-63-337) AD 627970 Unclassified

Also published in Electron. Ltrs., v. 1: 56-57, May 1965.

Because time-variable circuit elements have properties not possessed by time-invariant ones, such as the ability to modulate or amplify with low noise, it is useful to have different ways of looking at them. Here general equivalences are presented for time-variable inductors, capacitors, resistors and gyrators, using time-invariant elements and time-variable transformers, which allow various properties to be determined and interpreted on physical grounds.

2780

Stanford U. Stanford Electronics Labs., Calif.

THE TIME-VARIABLE TRANSFORMER, by B. D. Anderson, D. A. Spaulding, and R. W. Newcomb. [1965] [2]p. incl. diagrs. (AFOSR-65-2358) (AF AFOSR-63-337) AD 627738 Unclassified

Also published in Proc. IEEE, v. 53: 634-635, June 1965.

A theorem is presented which states the conditions under which a time-variable scattering matrix exists, showing that it satisfies an antecedance (causality) restriction. Because of its importance, the lossless condition has also been stated. The statements have been worded in terms of network theory, but because

of the importance of general scattering systems, the results should be of use in other disciplines.

2781

Stanford U. Stanford Electronics Labs., Calif.

THE TIME-VARIABLE SCATTERING MATRIX, by D. A. Spaulding and R. W. Newcomb. [1965] [2]p. incl. diagr. refs. (AFOSR-65-2359) (AF AFOSR-63-337) AD 627740 Unclassified

Also published in Proc. IEEE, v. 53: 651-652, June 1965.

Uses and realizations of the ideal time-variable transformer are pointed out. Although physical realizations must of necessity only be approximate, the uses in modeling and synthesis of time-variable systems make it an object for consideration in its own right.

2782

Stanford U. Stanford Electronics Labs., Calif.

ON THE DEFINITION OF A NETWORK, by R. W. Newcomb. [1965] [2]p. incl. refs. (AFOSR-65-2360) (AF AFOSR-63-337) AD 627741 Unclassified

Also published in Proc. IEEE, v. 53: 547-548, May 1965.

A more general definition of a network is outlined following the approach of McMillan in terms of voltages and currents allowed at the terminals. A network N being defined as a set of allowed pairs of port variables v and i, these being allowed by virtue of their satisfying the network constraints C_N.

2783

Stanford U. Stanford Electronics Labs., Calif.

ON RELATIONS BETWEEN SERIES- AND SHUNT-AUGMENTED NETWORKS, by B. D. Anderson and R. W. Newcomb. [1965] [1]p. incl. diagrs. (AFOSR-65-2422) (AF AFOSR-63-337) AD 627739 Unclassified

Also published in Proc. IEEE, v. 53: 725, July 1965.

The shunt-augmented impedance matrix for a linear time-varying network was introduced The existence of this matrix guarantees and is guaranteed by the existence of the augmented network admittance matrix, or the scattering matrix. Further these 3 matrices are related in a simple fashion.

2784

Stanford U. Stanford Electronics Labs., Calif.

ON THE TERMINAL DESCRIPTION OF NONLINEAR NETWORKS, by R. W. Newcomb. [1965] [2]p. incl. diagr. refs. (AFOSR-65-2788) (AF AFOSR-63-337) AD 629686 Unclassified

Also published in Proc. IEEE, v. 53. 1149-1150, Aug. 1965.

A general description is introduced as a means for expressing the terminal constraints on port variables for nonlinear networks.

2785

Stanford U. Stanford Electronics Labs., Calif.

LOSSLESS TIME-VARYING IMPEDANCE SYNTHESIS, by D. A. Spaulding. [1965] [3]p. incl. diagrs. (AFOSR-66-0110) (AF AFOSR-63-337) AD 641468 Unclassified

Also published in Electron. Ltrs., v. 1: 165-167, Aug. 1965.

Finite n-port networks are characterized in terms of their impulse responses. The properties of passivity and losslessness are used to specify the form of the impulse response and to give a synthesis using time-varying transformers and time-invariant inductors, capacitors and gyrators.

2786

Stanford U. Stanford Electronics Labs., Calif.

PROOF OF THE MANLEY-ROWE RELATIONS FROM QUANTUM CONSIDERATIONS, by B. D. Anderson. [1965] [1]p. (AFOSR-66-0192) (AF AFOSR-63-337) AD 631124 Unclassified

Also published in Electron. Ltrs., v. 1: 199, Sept. 1965.

The document is comprised of critical comments by Anderson of the paper "Proof of the Manley-Rowe Relations from Quantum Considerations", by J. Brown (Electron. Ltrs, v. 1: 23, Mar. 1965), and, of Brown's reply.

2787

Stanford U. Stanford Electronics Labs, Calif.

A CAPACITOR-TRANSFORMER GYRATOR REALIZATION, by B. D. O. Anderson and R. W. Newcomb. [1965] [1]p. incl. diagr. (AFOSR-66-0195) (AF AFOSR-63-337) AD 631123 Unclassified

Also published in Proc. IEEE, v. 53: 1640, Oct. 1965.

By cancelling the capacitors in a previous realization, a new method of gyrator realization is added to the somewhat more practical ones already in existence. It is shown that all linear, finite, nonreciprocal time-invariant networks can be realized by time-invariant resistor, capacitors, inductors, and time-varying transformers.

2788

Stanford U. Stanford Electronics Lab., Calif.

ON RECIPROCITY AND TIME-VARIABLE NETWORKS, by B. D. O. Anderson and R. W. Newcomb. [1965] [1]p. incl. diagrs. refs. (AFOSR-66-0197) (AF AFOSR-63-337) AD 631115 Unclassified

Also published in Proc. IEEE, v. 53: 1674, Oct. 1965.

Reciprocity of an n-port network is defined by the convolution relationship between the allowed pairs (v, i) of time-domain voltage v and current i n-vectors, with matrix transportation of the v quantities. The definition places symmetry and time-invariance constraints on a scattering matrix. This indicates that some non-reciprocal time-invariant networks are equivalent to time-variable ones constructed only from resistors, inductors, capacitors, and transformers.

2789

Stanford U. Stanford Electronics Labs., Calif.

AN INTEGRATABLE TIME-VARIABLE GYRATOR, by W. New and R. W. Newcomb. [1965] [2]p. incl. diagrs. (AFOSR-66-0558) (AF AFOSR-63-337) AD 641471 Unclassified

Also published in Proc. IEEE, v. 53: 2161-2162, Dec. 1965.

The article presents a gyrator realization which allows time-variable gyration resistances and which appears natural for integrated circuitry. The circuit which is discussed has been constructed in nonintegrated form and has worked rather satisfactorily.

2790

Stanford U. Stanford Electronics Labs., Calif.

FOSTER-TYPE TIME-VARYING LOSSLESS SYNTHESIS, by D. A. Spaulding. [1965] [2]p. incl. diagrs. (AF AFOSR-63-337) Unclassified

Also published in Electron. Ltrs., v. 1: 248-249, Nov. 1965.

This letter outlines a lossless time-varying one-port synthesis. This synthesis is converted to a Foster-type synthesis using a network equivalence in which a time-varying transformer terminated in 2 fixed capacitors is shown to be equivalent to a time-varying transformer terminated in a fixed inductor and a fixed capacitor. (Contractor's abstract)

2791

Stanford U. [Stanford Electronics Labs.] Calif.

AN INTERPRETATION OF TRANSVERSE WHISTLERS, by I. Kimura, R. L. Smith, and N. M. Brice. [1965] [6]p. incl. diagrs. refs. (AFOSR-66-0546) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-783, National Aeronautics and Space Administration, and National Science Foundation) AD 641215 Unclassified

Also published in Jour. Geophys. Research, v. 70: 5961-5966, Dec. 1, 1965.

An explanation is offered for the transverse whistler. This type of whistler was first observed in the Alouette 1 Satellite VLF recordings. It appeared in the frequency range of 1-8 kc/s and was observed late at night (2100 - 0100 local time) from moderate to low latitudes (44° - 30° dipole latitudes). One peculiar characteristic of this whistler is that the variation of time delay with frequency, observed at 1000-km altitude, is given by the sum of the Eckersley law time delay, characteristic of normal whistlers, and an additive correction term.

2792

[Stanford U. Stanford Electronics Labs., Calif.]

AN ANISOTROPIC ELECTRON VELOCITY DISTRIBUTION FOR THE CYCLOTRON ABSORPTION OF WHISTLER AND VLF EMISSIONS, by H. Guthart. [1965] [13]p. incl. diagr. refs. (AFOSR-66-1074) (AF AFOSR-65-783) AD 641213 Unclassified

Also published in Jour. Research Nat'l. Bur. Stand., v. 69D: 1403-1415, Nov. 1965.

In 1962, Scarf proposed cyclotron absorption as the physical mechanism explaining the high-frequency cutoff of nose whistlers. Using the Scarf proposal, two anisotropic electron velocity distributions for the magnetosphere are assumed and the complex refractive index is evaluated for each. The transverse (with respect to the ambient earth's field) velocity distribution in each case is assumed Maxwellian. The first longitudinal distribution of velocities considered is Maxwellian to several mean square velocities and then is proportional to v^{-1}. The cyclotron damping term is then evaluated; however, upon investigation, the rate of change of whistler damping with frequency is found to be insufficiently rapid to agree with the observed whistler cutoff. The second velocity distribution considered is a double-humped Maxwellian, i.e., a thermal electron distribution, and a resonant electron stream. This distribution allows for cyclotron absorption and, at the same time, is consistent with the whistler dispersion and attenuation. Arising from the analysis of the double-humped Maxwellian distribution is a transverse instability developed by Bell and Buneman which leads to VLF emissions. The relative importance of cyclotron damping vis-a-vis VLF emissions is examined and a qualitative explanation of some whistler-induced emissions is suggested. (Contractor's abstract)

2793

[Stanford U. Stanford Electronics Labs., Calif.]

NOSE WHISTLER DISPERSION AS A MEASURE OF MAGNETOSPHERE ELECTRON TEMPERATURE, by H. Guthart. [1965] [3]p. incl. illus. diagrs. table, refs.

(AFOSR-66-1075) (AF AFOSR-65-783) AD 641214
Unclassified

Also published in Jour. Research Nat'l. Bur. Stand., v. 69D: 1417-1424, Nov., 1965.

The fractional deviation of nose whistler group delay from the zero - temperature model has been calculated assuming a Maxwellian magnetosphere and a gyrofrequency electron density distribution; i.e., the electron density varies as the inverse cube with distance from the earth's center. The thermal correction to the zero-temperature group refractive index has been inserted into the nose-whistler group delay integral to determine the modified group delay. Significant deviations from the zero-temperature group delay for frequencies above the nose frequency have been calculated. Since deviations from the zero-temperature dispersion of a few percent are readily discernible, nose whistler data should provide at least an estimate of the upper bound on magnetosphere temperature. Twenty-three whistlers have been analyzed and an upper bound on magnetosphere temperature of $2(10^4)$°K has been determined. (Contractor's abstract)

2794

Stanford U. Stanford Electronics Labs., Calif.

OPTIMAL ADAPTIVE ESTIMATION OF SAMPLED STOCHASTIC PROCESSES, by D. T. Magill. Dec. 1963, 67p. incl. diagrs. refs. (Technical rept. no. 6302-3) (AFOSR-64-1333) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under Nonr-225(24)
AD 436021 Unclassified

Also published in IEEE Trans. Automatic Control, v. AC-10, 434-439, Oct. 1965.

An adaptive approach is presented to the problem of estimating a sampled, scalar-valued, stochastic process described by an initially unknown parameter vector. Knowledge of this quantity completely specifies the statistics of the process, and consequently the optimal estimator must learn the value of the parameter vector. In order that construction of the optimal estimator be feasible it is necessary to consider only those processes whose parameter vector comes from a finite set of a priori known values. Fortunately, many practical problems may be represented or adequately approximated by such a model. The optimal estimator is found to be composed of a set of elemental estimators and corresponding set of weighting coefficients, one pair for each possible value of the parameter vector. This structure is derived using properties of the conditional mean operator. For gaussmarkov processes the elemental estimators are linear, dynamic systems, and evaluation of the weighting coefficients involves relatively simple, nonlinear calculations. The resulting system is optimum in the sense that it minimizes the expected value of a positive-definite, quadratic form in terms of the error (a generalized mean-square-error criterion) (Contractor's abstract)

2795

[Stanford U.] Stanford Electronics Labs., Calif.

QUANTUM EFFICIENCY AND RADIATIVE LIFETIME IN p-TYPE GALLIUM ARSENIDE, by J. Vilms and W. E. Spicer. [1965] [7]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, [Army Research Office (Durham)], and Office of Naval Research under Nonr-22524)
Unclassified

Published in Jour. Appl. Phys., v. 36: 2815-2821, Sept. 1965.

A new method for the study of radiative recombination in uniformly doped semiconductors has been developed and applied to p-type gallium arsenide. The bulk quantum efficiency is obtained by measurement of photoluminescence as a function of the penetration length of the exciting radiation. Using an estimated electron mobility, the total recombination lifetime of electrons (minority carriers) is found from this photoluminescence measurement and also independently by the measurement of surface photovoltage. The radiative lifetime is determined from the bulk quantum efficiency and the total electron lifetime. The model on which the measurements are based accounts for the principal effects affecting the intensity of photoluminescence, i.e., bulk quantum efficiency, surface recombination, and refraction and reflection of luminescence at the sample surface. The model is consistent with the experimental data for the p-type gallium arsenide samples studied. The bulk quantum-efficiency values obtained here are 8% at 300°K and 28% at 80°K for 2 higher-efficiency samples and 6 times lower for a third sample. The radiative lifetime of electrons is found to be approximately 2×10^{-8} sec at 300°K, and 3×10^{-10} sec at 80°K. The total lifetime of electrons (minority carriers) is found to be approximately 1.5×10^{-9} sec at 300°K and 10^{-10} sec at 80°K for the 2 higher-efficiency samples, and 10^{-10} sec at both temperatures for the third sample. (Contractor's abstract)

2796

[Stanford U., Stanford Electronics Labs., Calif.

SURFACE STATES AND BARRIER HEIGHT OF METAL-SEMICONDUCTOR SYSTEMS, by A. M. Cowley and S. M. Sze. [1965] [9]p. incl. diagrs. tables, refs. ([Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Army Research Office (Durham)] under Nonr-22524)
Unclassified

Published in Jour. Appl. Phys., v. 36: 3212-3220, Oct. 1965.

The barrier height for n-type semiconductor-metal contacts is found to be a linear combination of the metal work function φ_m and a quantity φ_0 which is defined as the energy below which the surface states must be filled for charge neutrality at the semiconductor

surface. The energy φ_0 is measured from the edge of the valence band. For constant surface state density the theoretical expression obtained is $\varphi_{B_n} = \gamma(\varphi_m - \chi) + (1 - \gamma)(E_g - \varphi_0) - \Delta\varphi_n$, where χ and E_g are electron affinity and the band gap of the semiconductor, respectively, $\Delta\varphi_n$ is the image force barrier lowering, and γ is a weighting factor which depends mainly on the surface state density and the thickness of the interfacial layer. The parameter γ is found to range from 0.07 for GaAs to almost unity for the CdS data, indicating weak and strong dependence of the surface barrier height on the metal work function. The value of φ_0 is roughly a third of the respective band gap energies for Si, GaP, and GaAs, and the surface state density for these semiconductors is found to be in the range 10^{13} - 10^{14} states/cm^2/ev, for the experiments cited.

2797

Stanford U. Stanford Electronics Labs., Calif.

SURFACE STATES AND BARRIER HEIGHT IN METAL-SEMICONDUCTOR SURFACE BARRIER DIODES, by A. M. Cowley. May 1965, 187p. (Technical rept. no. 0414-1; rept. no. SU-SEL-65-051) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Army Research Office (Durham), under Nonr-22583) AD 467489 Unclassified

Metal-semiconductor surface barrier diodes were investigated from the standpoint of the mechanism for the formation of the potential barrier at the metal-semiconductor interface and the measurement of the barrier height. The dependence of the barrier height of metal-semiconductor systems upon the metal work function was derived with the following assumptions: (1) The contact between the metal and the semiconductor has an interfacial layer of the order of atomic dimensions; it was further assumed that this layer is transparent to electrons with energy greater than the potential barrier, but can withstand potential across it. (2) The surface state density (per unit area per electron volt) at the interface is a property only of the semiconductor surface and is independent of the metal. Several models for describing the bias behavior of the MOS structure with surface states are also discussed. For thin interfacial layers, the model which specifies that the surface states charge is independent of bias seems to best describe the variation of the depletion capacitance with voltage for GaP and Si diodes.

2798

STD Research Corp., Pasadena, Calif.

ELECTRICAL BREAKDOWN OF GASES AT ELEVATED TEMPERATURES, by A. N. Kontaratos and S. T. Demetriades. [1965] [2]p. incl. tables. (AFOSR-65-1417) (AF 49(638)1445) AD 622646 Unclassified

Also published in Phys. Rev., v. 137: A1685-A1686, Mar. 15, 1965.

A recently developed analytical expression relating α/p with E/p (α is the Townsend ionization coefficient, E the applied field strength, p the pressure) is used in conjunction with an appropriate breakdown criterion to theoretically formulate the experimental Paschen's law. Variations of both temperature and pressure are considered in this derivation. Theoretical and experimental values of both αd(d is the length of the discharge gap) and the minimum breakdown voltage for air are in close agreement in the region of validity of the streamer theory, i.e., for pd > 500mm Hg x cm. (Contractor's abstract)

2799

STD Research Corp., Pasadena, Calif.

APPLICATIONS OF OHM'S LAW FOR MULTICOMPONENT PLASMAS (Abstract), by S. T. Demetriades. [1965] [2]p. (Bound with AFOSR-65-1266; AD 622527) AF 49(638)1445 Unclassified

Presented at Eighth AFOSR Contractor's meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

A generalized Ohm's law for non-isothermal multicomponent plasmas with temperature and pressure gradients is derived from a system of differential equations describing the transport of momentum for each species α of a multicomponent plasma in electric and magnetic fields. This system of differential equations is derived from the Boltzmann equation by defining the drift velocity of species α with respect to the velocity of the plasma as a whole. An advantage of this formulation is that it removes some of the restrictive assumptions of Polovin and Tserkasova while it retains their generalized multicomponent results. This generalized Ohm's law is used to determine the scaler conductivity, Hall and ion-slip coefficients and the pressure and temperature gradient coefficients for any 3 or 4 component plasmas. It is shown that the electron temperature gradient must be used in computing the effect of temperature gradients. These results can be extended to an n-component plasma. On the basis of this investigation it is shown how particle concentrations computed for equilibrium mixtures can be corrected and used in the computation of the Ohm' law for non-equilibrium (2-temperature) mixtures.

2800

STD Research Corp., Pasadena, Calif.

OHM'S LAW IN MULTICOMPONENT NON-ISOTHERMAL PLASMAS WITH TEMPERATURE AND PRESSURE GRADIENTS, by S. T. Demetriades and G. S. Argyropoulos. Final rept. Sept. 1965 [183]p. incl. tables, refs. (Research rept. no. STD-65-12) (AFOSR-66-0004) (AF 49(638)1445) AD 628029 Unclassified

A closed set of transport equations with collision terms that have been evaluated by the 13-moment approximation is used, under well-defined assumptions, to derive a generalized Ohm's law in multicomponent

non-isothermal plasmas as a function of the electric and magnetic fields and the temperature and pressure gradients. The nine coefficients defining this dependence are expressed in matrix form in terms of component properties for any number N of components in the plasma, each component having its own temperature. The matrix expressions are evaluated in detail for N = 4, 5; this allows the investigation of effects that cannot be studied with the available three-fluid expressions. It is shown that in any plasma in which this theory applies, the only temperature gradient that needs to be considered in Ohm's law is that of the electrons and that all the plasma properties, except those that describe or include interactions between heavy species, must be determined at the electron temperature.

2801

Stevens Inst. of Tech. Dept. of Physics, Hoboken, N. J.

MECHANISM AND DYNAMICS OF COAXIAL PLASMA ACCELERATION, by W. H. Bostick. Final technical rept. July 1965, 7p. (Rept. no. SIT-P161) (AFOSR-65-1532) (AF AFOSR-64-465) AD 619527 Unclassified

The character of the current sheet which separates a plasma from a magnetic field is explored. One interesting configuration of this current sheet is that formed by the flow of plasma over the dipole magnetic field produced by a loop coil inserted in the vacuum system. Magnetic field probes and electric field probes have already shown that this current sheet exhibits turbulence in the form of plasma vortices. The study of this turbulence, in order to understand its onset and its scale is now an objective. The correlation of this plasma behavior with that of the solar wind on the geomagnetic field is also an objective. The character of turbulence in the current sheet of the plasma coaxial acceleration is studied. The mechanism of plasma propulsion in the small 2 wire and coaxial button guns is investigated. (Contractor's abstract)

2802

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

PLASMA VORTICES IN THE COAXIAL PLASMA ACCELERATOR, by W. H. Bostick, W. Prior, and E. Farber. [1965] [3]p. incl. illus. diagrs. (Sponsored jointly by Air Force Cambridge Research Laboratories; and Air Force Office of Scientific Research under AF AFOSR-64-465) AD 629800 Unclassified

Also published in Phys. Fluids, v. 8: 745-747, Apr. 1965.

Considerations of conservation of mass and momentum flow in the plasma coaxial accelerator make it apparent that plasma eddies or vortices should be produced behind the current sheet. Measurements of axial and radial electric fields of radial current density and ion flow density, show experimentally that these vortices are present.

2803

Stevens Inst. of Tech. Dept. of Physics, Hoboken, N. J.

FLOW OF PLASMA AROUND A MAGNETIC DIPOLE by W. H. Bostick, H. Byfield and others. Mar. 1965. [13]p. incl. illus. (Scientific rept. no. 1) (AFOSR-65-1624) (Sponsored jointly by Air Force Cambridge Research Laboratories and Air Force Office of Scientific Research under AF AFOSR-65-465) AD615786 Unclassified

Also published in Phys. Fluids, v. 8: 1397-1399, July 1965.

Plasma flow over a 3-dimensional dipole is examined to determine the existence and character of turbulent electric fields. Image converter photographs exhibit general boundary shapes which are in accord with theoretical shapes. Magnetic probe measurements show that the magnetic field is highly turbulent in the magnetic boundary and that the character of the turbulence is asymmetric. Electric-field probe and ion density measurements also show that the plasma is turbulent in the boundary of the magnetic cavity and that the plasma penetrates the cavity in a turbulent state. The character of the signals suggests that the turbulence is in the form of plasma eddies or vortices. (Contractor's abstract, modified)

2804

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

PLASMA VORTICES (Abstract), by W. H. Bostick, E. Farber and others. [1965] [1]p. (Bound with its AFOSR 65-1266; AD 622527) (AF AFOSR-65-465) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr 29-30, 1965.

Plasma vortices were observed in the coaxial plasma accelerator, the parallel plate plasma accelerator, the magnetic cavity and the boundary of the magnetic cavity in plasma flow over the magnetic dipole, the firing of a small button plasma gun in a dipole magnetic field, and in the firing of a small button plasma gun across a magnetic field. Electric field measurements of rotational velocity profiles show that the plasma vortices rotate as rigid bodies around the magnetic field lines. Double probe measurements of plasma density profile are shown. Measurements were taken on the rate of increase of this vortex radius R with time.

2805

Stockholm U. Dept. of Zoology (Sweden).

LONG RANGE NAVIGATION IN ANIMALS, by C. G. Edelstam. Final scientific rept. June 10, 1965 [50]p. incl. diagrs. tables, refs (AFOSR-65-1566) (Sponsored jointly by Air Force Office of Scientific

Research under AF EOAR-63-6, King's Fund for Swedish Culture, and Swedish Fisheries Research Board) AD 623338 Unclassified

The physical and sensory basis of navigation in fish, turtles, birds, and bats has been examined theoretically and by experiment. The stars are found to be superior for several reasons to the sun as potential cues in visual navigation. The advantage of non-visual over visual navigation increases rapidly with increasing size of the sense organs, which may help to explain certain differences in homing behavior between small and large animals. Methods are suggested to differentiate between navigation systems based on measurements of (a) the altitude of the stars, (b) the altitude of the sun, (c) the position of celestial radio sources, (d) the inertial forces experienced during the outward journey prior to homing, (e) the intensity of gravity, (f) the intensity and direction of the Coriolis force, and (g) the intensity and direction of the geomagnetic field. Some results of such tests and of other experiments are reported. (Contractor's abstract)

2806

Stockholm U. Dept. of Zoology (Sweden).

NEURAL MECHANISMS INVOLVED IN INSTINCTIVE BEHAVIOR, by E. Fabricius. Final scientific rept. Oct. 29, 1965 [53]p. incl. diagr. tables, refs. (AFOSR-66-0179) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-25 and Swedish Natural Science Research Council) AD 628322 Unclassified

Lesions at particular telencephalic loci may effect reproductive behavior, fear responses and or learning and retention in the pigeon. Certain critical periods are described in the ontogeny of social behavior in the pigeon and building behavior in the beaver.

2807

Stockholm U. Dept. of Zoology (Sweden).

BEHAVIORAL EFFECTS OF TELENCEPHALIC RADIO-LESIONS IN THE PIGEON (COLUMBA LIVIA), by L. Steen. Final scientific rept., Appendix I, Oct. 29, 1965, 28p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-25 and Swedish Natural Science Research Council) Unclassified

The effects of restricted telencephalic radiolesions on learning and retention reported earlier were studied in pigeons with lesions mainly in the caudal and median parts of the telencephalon. To give a more complete picture, more frontally located lesions were produced in a group of pigeons. In addit on attempts were made to sever the occipito-mesencephalic tracts to verify the suggestion that these tracts are conveying impulses giving fear responses. The pigeons were subjected to learning and retention experiments, observation of fear responses, of the occurrence of mating behavior and of the occurrence of social behavior towards man.

2808

Stockholm U. Dept. of Zoology (Sweden).

EFFECTS OF ELECTROLYTIC TELENCEPHALIC LESIONS IN THE PIGEON (COLUMBA LIVIA). A PRELIMINARY STUDY, by E. Fabricius and L. Steen. Final scientific rept., Appendix II, Oct. 29, 1965, 7p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-25 and Swedish Natural Science Research Council) Unclassified

The technique of making telencephalic lesions in pigeons by local irradiation with high energy protons has 2 serious difficulties: The obtainable material is limited and the localization of the lesions involves problems. To meet this situation, preliminary experiments were performed with electrolytic lesions. The main purpose was to see if satisfactory localizations are possible, if the lesions obtain favorable shape, size and limitation and if the method allows the production of a large material. If these conditions are fulfilled the material itself can also be used for the discussion of lesion effects. In this preliminary material attempts were made to locate the lesions in such a way that information regarding possible relations between telencephalic structures and fear responses could be obtained, i.e. by aiming at the archstriata and their nervous connections.

2809

Stockholm U. Dept. of Zoology (Sweden).

OBSERVATIONS ON THE ONTOGENY OF BUILDING BEHAVIOR IN THE BEAVER (CASTOR FIBER), by L. Wilsson. Final scientific rept., Appendix IV, Oct 29, 1965, 3p. (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-63-25 and Swedish Natural Science Research Council) Unclassified

The ontogeny of building behavior was studied in young beavers brought up under almost natural conditions, within a wild group of beavers in an enclosure, in a young beaver brought up by a tame female in a terrarium and in young beavers taken captive at ages ranging from less than 10 days to more than 2 months. Motor patterns were observed in connection with treefelling, transport of all sorts of material, digging and building. The motor patterns and the ability to react to a releasing and directing stimulus situation seem to be inborn to such a degree that good results are obtainable at first confrontation without it being necessary to learn by trial and error.

2810

Stockholm U. Dept. of Zoology (Sweden).

ONTOGENY OF SOCIAL BEHAVIOR IN THE PIGEON (COLUMBA LIVIA), by L. Fall. Final scientific rept., Appendix III, Oct. 29, 1965, 9p. incl. diagr. table, refs (Sponsored jointly by Air Force Office of

Scientific Research under AF EOAR-63-25 and Swedish Natural Science Research Council) Unclassified

This study mainly deals with the imprinting processes in the common pigeon (Columba livia). A short survey of the general development of behavior in young pigeons is given. With the hypothesis that the onset of fear responses is an inhibiting factor for the imprinting these processes are studied in more detail. The squabs are so far taken from the nests in 2 groups of age: 5 days (before the onset of fear responses), and 15 days (the fear responses are well established). Hitherto the tests (a choice situation between the imprinting object - man - and a pigeon) that are done when the animals are sexually mature, are too few to tell anything about the truth in the above hypothesis and the critical period of imprinting in the pigeon. (Contractor's abstract)

2811

Stockholm U. Inst. of Physics (Sweden).

SEARCH FOR Y^*_η PRODUCTION IN K^- CAPTURES IN NUCLEI, by P. J. Carlson, O. Danielsson and others. [1965] [15]p. incl. diagrs. tables, refs. (AFOSR-66-1285) (Sponsored jointly by Air Force Office of Scientific Research under [AF EOAR-64-57] and Swedish Atomic Research Council) AD 639536 Unclassified

Also published in Nuclear Phys., v. 74: 642-656, 1965.

An investigation of 128 K^- interactions at rest in emulsions with a final state of a Σ^- hyperon, a pion and a recoiling nucleus is reported. The main emphasis is laid on the study of the momentum and invariant mass distributions of the $\Sigma^-\pi^-$ system in order to detect possible isobar Y* production. The distributions show, however, no features which can unambiguously be interpreted as due to resonance production. These results are at variance with results in an earlier experiment at this laboratory where a highly significant peak in the $\Sigma^-\pi^-$ momentum was reported. Our results as well as the collected world data are compared with Adair's theoretical model without appeal to Y* production. Good agreement is obtained with both samples. (Contractor's abstract)

2812

Stockholm U. Psychological Labs. (Sweden).

THE INFLUENCE OF INTENSITY AND DURATION OF ELECTRICAL STIMULATION ON SUBJECTIVE VARIABLES, by G. Ekman, M. Frankenhaeuser and others. Jan 1965, 8p incl. diagrs tables, refs. (Rept. no 179) (AFOSR-65-1304) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-29 and Swedish Council for Social Science Research) AD 618081 Unclassified

The unpleasantness and subjective duration of an ac current of 50 c sec applied to 2 fingers was scaled by subjects using the method of magnitude estimation. Stimulation was varied with regard to both intensity, ranging between 1.5 and 3.5 times the individual sensation threshold, and duration, ranging from 0.18 to 1.72 sec. It was found (1) that unpleasantness increased approximately logarithmically with stimulus duration; (2) that unpleasantness was a power function, with the exponent 1.5, of stimulus intensity measured with the sensation threshold as zero point; (3) that subjective duration was essentially linearly related to stimulus duration; and (4) that subjective duration increased approximately logarithmically with intensity of stimulation. (Contractor's abstract)

2813

Sussex U. [Physics Lab] Brighton (Gt. Brit.).

GAPLESS SURFACE EXCITATIONS IN LIQUID HELIUM, by D. F. Brewer, A. J. Symond, and A. L. Thomson. [1965] [4]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF-EOAR-64-13 and Science Research Council) Unclassified

Published in Phys. Rev. Ltrs. v. 15: 182-184, Aug. 2, 1965.

It has long been known that boundary effects can influence appreciably the behavior of superfluid helium. In the unsaturated helium film, in which one dimension is restricted to less than 100 A, Frederikse (1949) found that the superfluid transition temperature is depressed below that of the bulk liquid, and the maximum in the specific-heat anomaly also occurs at lower temperatures, and becomes smeared. The measurements appeared to show that for a given film thickness the onset temperature for superflow was well below that of the specific-heat maximum by as much as 0.4°K, although in the bulk liquid the 2 temperatures coincide. A later experiment by Brewer et al (1960) showed that in very fine channels of diameter approximately 70 A the 2 temperatures were the same (~2.05 K) to within ± 0.05°K. The authors have examined this problem experimentally in some detail, and conclude that the above results are in essentially correct, and are consistent with the presence of excitations associated with a free liquid surface, and possessing a temperature-dependent energy gap which becomes zero at a temperature lower than that where the ordered phase disappears.

2814

Sussex U. Physics Lab., Brighton (Gt. Brit.).

SURFACE EFFECTS IN ^{3}He AT LOW TEMPERATURES, by D. F. Brewer, A. J. Symonds, and A. L. Thomson [1965] [3]p. incl. diagrs. [AF EOAR-64-13] Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept 4, 1964), ed by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. A): 371-372, 1965.

Preliminary experiments to determine the influence of assembly size on the properties of liquid ^{3}He have been conducted. Specific heat measurements of ^{3}He adsorbed

on vycor porous glass in the range of 0.4° to 2.5°K are reported. Comparing the specific heat of the saturated liquid and of the liquid under pressure, in the range below 1.3°K, the bulk liquid values at any pressure are higher. The full vycor specific heat cannot therefore be explained as a sum of compressed liquid values alone; it is necessary to assume either the presence of an appreciable amount of solid with very small specific heat or of size effects (or both). Measurements on monolayer and 2-layer coverage show large specific heat anolomies.

2815

Sydney U. School of Physics (Australia).

TRIANGULAR FACTORS OF MODIFIED MATRICES, by J. M. Bennett. [1965] [5]p. incl. diagr. (AFOSR-65-2351) (AF AFOSR-62-402) AD 629530 Unclassified

Also published in Numerische Math., v. 7: 217-221, 1965.

This paper is concerned with obtaining the inverse of a matrix of the form $B = A + XCY^T$, where A is n x n, C m x m, and X and Y are n x m matrices. It is assumed that A^{-1} is known. Rather than obtain B^{-1} directly, the author wishes to obtain the factorization B = l du from the (assumed known) factorization A = LDU. Here L and l are lower triangular, D and d are diagonal, and U and u are upper triangular. To factor a general matrix A by the Crout method into LD and U requires about n^3 3 operations. The author's algorithm factors B in about $2mn^2$ operations. He omits additions in making these operation counts (an unrealistic procedure for the latest computers). The author assumes that, where matrixes are factored, rows and columns are arranged so that zero pivots do not occur. He does not say how this is to be accomplished in practice. Furthermore, he does not mention the question of numerical instability when small pivots occur. A numerical example is given.

2816

Sydney U. School of Physics (Australia).

THE DENSITY SPECTRUM OF AIR SHOWERS AT SEA LEVEL AND MOUNTAIN ALTITUDES, by J. B. T. McCaughan, C. B. A. McCusker and others. [1965] [10]p. incl. illus. diagr. table. (AFOSR-66-0037) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-410, National Research Council of Canada, and Nuclear Research Foundation) AD 630387 Unclassified

Also published in Nuovo Cimento, Series X, v. 38: 697-706, July 16, 1965.

The cosmic-ray differential density spectrum in the range 3 to 10 000 p/m^2 has been obtained, using Wilson cloud chambers, at sea level and at 2285 m a.s.l. In neither case can the whole spectrum be fitted by a single power law. Using a three-parameter fit the sea-level spectrum is best approximated by two power laws of exponents -2.491 ± 0.036 and -3.42 ± 0.32, respectively, joining at 560 ± 180 particles per square metre. At 2285 m a.s.l. the three best parameters are -2.431 ± 0.015, $-4.8^{+1.3}_{0.8}$ and 6000^{+1000}_{800} particles per square metre. The change with altitude supports the hypothesis that the change in exponent is due to a steepening of the primary cosmic-ray energy spectrum. (Contractor's abstract)

2817

[Sydney U. School of Physics (Australia)]

MEASURING THE STARS. THE STELLAR INTERFEROMETER AT NARRABRI OBSERVATORY, by R. H. Brown. [1965] [6]p. incl. illus. diagrs. (AFOSR-65-1115) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-302] and British Department of Scientific and Industrial Research) AD 620963 Unclassified

Also published in Scient. Australian, v. 2: 14-19, Feb. 1965.

The stellar intensity interferometer at Narrabri Observatory is described and its advantages compared to former interferometers. The intensity interferometer is capable of measuring the angular sizes of stars much smaller, hotter, and further away than those measured by other systems. It's advantages are that there is no need for high mechanical precision either in constructing it or guiding it on a star, it does not seem significantly affected by atmospheric scintillation; and measurements are objective and independent of the observer's skill. Development, installation, and initial testing are discussed, and a short theoretical explanation is presented.

2818

Sydney U. School of Physics (Australia).

ELASTIC AND ELECTROMAGNETIC PROTON INTERACTIONS AT 3 TEV, by C. B. A. McCusker, L. S. Peak, and R. L. S. Woolcott. [1965] [6]p. incl. diagr. table. (AFOSR-65-1812) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-305 and Nuclear Research Foundation) AD 626487 Unclassified

Also published in Australian Jour. Phys., v. 18: 277-282, June 1965.

Results of a line scan of protons of average energy 3 tev in nuclear emulsion are presented. No elastic scatters are detected in the scanned length of 594 cm. The probability of detecting an elastic scatter in emulsion is calculated, and it is found that the proton-proton elastic cross section at 3 tev is ~ 5 mbn. Five examples of proton direct pair production are found in the above path length. It is shown that this result is consistent with the predictions of quantum electrodynamics. (Contractor's abstract)

2819

Sydney U. School of Physics (Australia).

RESPONSE OF PLASTIC SCINTILLATORS TO COSMIC RAY AIR SHOWERS, by A. D. Bray, D. F. Crawford and others [1965] [5]p. incl. illus. diagrs. tables. (AFOSR-65-1954) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-305 and Nuclear Research Foundation) AD 626826 Unclassified

Also published in Rev. Scient. Instr., v. 36: 587-591, May 1965.

The response of plastic scintillators to the flux of particles occurring in cosmic ray air showers was measured at various distances from the center of showers of various sizes. The number of scintillator particles S obtained by dividing the observed pulse height by the mode of the pulse-height distribution due to single fast muons was compared with the number of incident ionizing particles G seen by Wilson cloud chambers and Geiger counters. The ratio S/G is always greater than unity. It increases with increasing number of charged particles m^2, being 1.1 for 100 scintillator particles/m^2 and 4.0 for 10,000 scintillator particles/m^2. It varies with radial distance from the shower center and with shower size, being 1.2 on average at 30 m from the center of showers of $\sim 10^5$ particles and greater than 4 near the center of large showers. The increase in S/G is partly due to cascading of the electromagnetic component within the plastic scintillator but mostly to nuclear interactions produced in the scintillator by strongly interacting particles. (Contractor's abstract)

2820

Sydney U. School of Physics (Australia).

THE STRONGLY INTERACTING PARTICLES IN AIR SHOWER CORES, by M. M. Winn, R. H. Wand and others. [1965] [32]p. incl. diagrs tables refs. (AFOSR-65-1955) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-305 and Nuclear Research Foundation) AD 626506 Unclassified

Also published in Nuovo Cimento, Series X, v. 36: 701-732, Apr. 1, 1965.

An experiment using the Sydney extensive air shower array with its 64 large plastic scintillators is described for studying the strongly interacting particles in air shower cores. It is shown that there is no unique structure function for the strongly interacting particles which will fit all showers. Rather, showers can be classed as single-core or multi-core; the former appearing due to proton primaries, the latter to primaries of $A \geq 2$. With the apparatus it has proved possible to study individual nuclear interactions in the showers. In contrast with much emulsion work, the surviving baryon can often be easily identified and its momentum determined. Results concerning the elasticity in individual nucleon-air nucleus collisions are also reported. (Contractor's abstract, modified)

2821

Syracuse U. Dept. of Chemistry, N. Y.

NEAR-INFRARED SPECTRUM OF LIQUID WATER FROM 30 TO 374°, by E. Fishman and P. Saumagne. [1965] [1]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638) 3 and French Atomic Energy Commission) AD 629388 Unclassified

Also published in Jour. Phys. Chem., v. 69: 3671, Oct. 1965.

Much attention has been given to the structure of liquid water and questions have been raised regarding the fraction of monomeric water present in the liquid. From the spectra shown it has been concluded that: (1) There is a very strong effect of temperature since the single band becomes 2 bands and the frequencies shift. (2) The structure changes; no totally free water molecules are present since no band is observed at 3750 cm^{-1}. (3) If the higher frequency band appearing at 200° is assumed to result from nonhydrogen-bonded species, then these results are consistent with the theory of Marchi and Eyring giving the fraction of monomeric molecules as a function of temperature. (4) These 2 peaks can also reasonably be explained as ν_3 and ν_1, since their frequency difference is the same as found for ν_3 and ν_1 in the vapor phase and in dilute solutions of water in inert organic solvents. As the environment of the liquid water becomes more and more like that in the vapor, there is apparently a continuous change in relative intensity both in pure water and in organic solvents.

2822

Syracuse U. Dept. of Chemistry, N. Y.

STRUCTURE AND MAGNETIC PROPERTIES OF TRANSITION AND LANTHANIDE METAL COMPOUNDS. UNUSUAL OXIDATION STATES, by W. A. Baker, Jr. Final rept. [1965] [5]p. incl. diagr. table. (AFOSR-65-1920) [AF AFOSR-62-213] AD 628523 Unclassified

Magnetic and structural data for ZrI_3 and HfI_3 are reported. Magnetic data for Nd_2O_3, NdX_3(X F^-, Cl^-, Br^-, I^-) indicate Curie-Weiss behavior. A magnetic balance for low temperature work is described.

2823

Syracuse U. [Dept. of Electrical Engineering] N. Y.

INTERACTION OF PLASMAS WITH HIGH INTENSITY R-F FIELDS (Abstract), by H. Gruenberg [1965] [2]p. (Bound with its AFOSR 65-1266, AD 622527) (AF 49(638)1374) Unclassified

Presented at Eighth AFOSR Contractor's meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Work was continued on the resonant frequency spectrum of a plasma-filled cavity in the microwave region with a static magnetic field present. Numerical programs were set up to compute the resonance frequency shifts, changes in Q, and changes in the r-f field configuration. This was done for a number of cavity modes as a function of cyclotron frequency, plasma frequency and collision frequency. The results agree very well with those obtained from variational and perturbational computations. In the measurement of electron temperature and density by means of Langmuir probes results appear reasonable in the absence of a static magnetic field. Preliminary experiments have been carried out with a plasma-filled cavity excited by a few watts of X-band power (about 8,600 mc) and small probing fields in the 12,000 to 18,000 mc range. It was possible to measure the shifts in resonance frequency for seven cavity modes due to the presence of the plasma. Since the resonance frequencies of these modes are far from the cyclotron frequency, it is possible to use perturbation methods to compute these resonances provided the electron density distribution is given. Conversely, by expanding the density distribution in a triple Fourier series, it is possible to compute the Fourier coefficients in terms of the resonance frequency shifts of a sufficient number of modes.

2824

Syracuse U. Dept. of Mathematics, N. Y.

SUMS OF DEFICIENCIES OF MEROMORPHIC FUNCTIONS, by A. Edrei. [1965] [29]p. incl. refs. (AFOSR-65-2158) (AF 49(638)571) AD 629029 Unclassified

Also published in Jour. D'Anal Math., v. 14: 79-107, 1965.

Let f(z) be meromorphic in the plane and of lower order μ, where $0 \quad \mu \quad \infty$. Let $\tau_1, \tau_2, \tau_3, \ldots$ be the deficient values of f(z) arranged so that $\delta(\tau_\nu, f)$ is a non-increasing sequence of ν. Denote by $\nu(f)$ the total number of deficient values and write $\quad (f) \quad \sum \delta(\tau_\nu, f)$. The author's key result (Theorem 2) is that if q is an integer such that (1) $q \geq 2\mu$, $\delta(\tau_\nu, f) \leq 1 - \cos(\pi \mu q)$, then $f(re^{i\theta})$ is close to τ_ν on a set of having measure at least $2 \quad q + 0(1)$, and this holds for a sequence of r which tends to infinity and is independent of ν. From this result a number of interesting consequences follow. The first is Theorem 1: $\delta(f) \leq 1 - \cos \quad \mu$ if $\mu < .64$ and $\nu(f) \leq 2$. The result is sharp if $\mu = 1 \quad 2$ and shows that in this case (f) can reach its maximal value 1 only if $\nu(f) \quad 1$, i.e., for instance, if f(z) is entire. The author conjectures that for $1 \quad 2 < \mu \quad 1$, $\delta(f) \leq 2 - \sin \quad \mu \quad 2$, with equality only if $\nu(f) \quad 2$. It would follow from this in particular that $\delta(f) \quad 2$ if $\mu \quad 1$. The proof of Theorem 2 is not too easy, one main problem being to define a suitable sequence of r. This is done by means of constructing a rather elaborate sequence of Polya peaks for the function T(r, f). By an ingenious device the general case is reduced fairly simply to the case q = 1. (Math. Rev. Abstract, modified)

2825

[Syracuse U. Dept of Mathematics, N. Y.]

ENTIRE AND MEROMORPHIC FUNCTIONS WITH ASYMPTOTICALLY PRESCRIBED CHARACTERISTIC, by A. Edrei and W. H. J. Fuchs. [1965] [13]p. (AFOSR-65-2159) (AF 49(638)571) AD 629028 Unclassified

Also published in Canad. Jour. Math., v. 17: 383-395, 1965.

The authors establish the following powerful analogue of a theorem of Valiron, for the characteristic of Nevanlinna T(r, f). Given a function $\Lambda(r) = \text{const} + \int_\alpha^r t^{-1}\Psi(t)dt$, where $\alpha > 0$ and $\Psi(t)$ is non-negative, non-decreasing and unbounded; if for some positive K and sufficiently large r, (*) $\Lambda(r) \quad r^K$, then there exists an entire function f(z), of finite order, such that (**) $T(r, f) \sim \Lambda(r)$ $(r \to \infty)$. If the condition (*) is omitted, then (**) still holds provided r tends to infinity avoiding an exceptional set E of finite measure. If, however, $\Lambda(r)$ satisfies the relation $\Lambda(r + 1) \leq \Lambda(r))^{\eta} \exp(\Lambda^{\eta}(r))$ for some η in $0 \quad \eta \quad 1 \quad 2$, then (**) holds without reference to an exceptional set. Furthermore, the authors prove that if $E(r, \eta)$ denotes the portion of the exceptional set E in (r, ∞), then meas $E(r, \eta) = 0(1/\Lambda(r))$. It is also observed that the entire functions constructed to solve the above problem satisfy the following interesting inequality: (***) $T(r, f) \geq \log M(r, f) \geq T(r, f) + KT^{2\eta}(r, f) \log^{(1 - 2\eta)} r$ $(r \notin E)$. The relation (***) has some far reaching consequences; besides it helps one deduce the theorem of Valiron, together with additional information. (Math. Rev. abstract)

2826

Syracuse U. [Dept. of Mathematics] N. Y.

RUSSIAN LITERATURE ON APPROXIMATION IN 1958-1964, by G. G. Lorentz. [1965] [25]p. incl. refs (AFOSR-65-2658) (AF 49(638)1401) AD 627786 Unclassified

Also published in Approximation of Functions; Proc. [Eighth] Symposium, General Motors Research Laboratories, Warren, Mich. (Aug. 31-Sept. 2, 1964), ed. by H. L. Garabedian. Amsterdam, Elsevier, 1965, p. 191-215.

This expository paper does not pretend to give a complete coverage of the subject. The author has tried to review only the more important and original papers and thus has covered only 45-50% of the total output. There is a bibliography of 156 items.

2827

[Syracuse U. Dept. of Physics, N Y.]

BOLTZMANN EQUATION APPROACH TO PHOTOCONDUCTIVITY IN SEMICONDUCTORS WITH OPTICAL PHONONS, by H. J. Stocker. Doctoral thesis June

1965 [142]p. incl. diagrs. refs. (AFOSR-65-2311) (AF AFOSR-63-420) AD 620886 Unclassified

The Boltzmann equation for the distribution function of conduction electrons is an electric field, including generation of electrons due to photon absorption, recombination, elastic scattering, and optical phonon emission, is constructed and solved with the aid of some simple assumptions about the energy dependences of the various transition rates. The photoconductive current, as a function of photon energy, shows oscillations with minima at multiples of the optical phonon energy, in agreement with recent observations in the low temperature photoconductivity of several semiconductors. The oscillations are the result of the strong interaction of electrons with longitudinal optical phonons. An energy variation of either lifetime or elastic scattering is not necessary for the existence of these oscillations, although their exact shape depends on it. The calculated field dependence of the shape of the oscillatory photoconductivity agrees qualitatively with experiments in InSb. (Contractor's abstract)

2828

Syracuse U., [Dept. of Physics] N. Y.

NUCLEAR SPIN RELAXATION IN p-TYPE InSb AT LIQUID-HELIUM TEMPERATURES, by J. Hofland and A. Honig. [1965] [5]p. incl. diagrs. (AFOSR-65-1904) [AF AFOSR-63-425] AD 625578 Unclassified

Also published in Phys. Rev. Ltrs., v. 14: 700-704, Apr. 26, 1965.

The spin-lattice relaxation rate 1 T_1 of In^{115} nuclei in the semiconductor InSb was studied and explained for samples ranging in net acceptor impurity concentration from 10^{14} cm^3 to $10^{17}/cm^3$. The temperature dependence of the relaxation rate between 1.0 and 4.2°K was determined as well as the magnetic field dependence between 300 Oe and 10 kOe. Three distinct relaxation mechanisms were found, which are operative singly in each of 3 different concentration regions. It is hypothesized that the relaxation in the low-concentration region arises from the Bloembergen mechanism. The intermediate-concentration mechanism has special properties but is related to the low concentration relaxation mechanism. A theory for the expression of relaxation governed by fast centers and nuclear spin diffusion is discussed which is applicable to both concentration regions. Brief consideration is also given to the high concentration sample.

2829

[Syracuse U., Dept. of Physics, N. Y.]

QUASI-STELLAR SOURCES AND GRAVITATIONAL COLLAPSE: CHAPTER 35-SUMMARY, by P. G. Bergmann. [1965] [2]p. (AFOSR-65-2789) [AF AFOSR-65-789] Unclassified

Also published in Quasi-Stellar Sources and Gravitational Collapse, Proc. First Texas Symposium on Relativistic Astrophysics, Dallas, Tex. (Dec. 16-18, 1963), ed. by I. Robinson, A. Schild, and E. L. Schucking, Chicago U. Press, 1965, p. 431-432. (AFOSR-65-1494)

The remarks of this summary are confined to one major topic, the relevance of general relativity to a better understanding of quasi-stellar objects, and the relevance of the information that is being developed concerning these objects to research in general relativity.

2830

Syracuse U., [Dept. of Physics] N. Y.

TWO-COMPONENT SPINORS IN THE HAMILTONIAN FORMULATION OF GENERAL RELATIVITY, by C. G. Oliveira. [1965] [53]p. (AFOSR-66-0816) [AF AFOSR-65-789] AD 641233 Unclassified

Also published in Nuovo Cimento, Series I, Suppl., v. 3. 192-244, 1965.

The Dirac Hamiltonian formulation of general relativity is developed in terms of 2 component spinors. In this way it is hoped to be able to treat interactions in a uniform fashion, and to discuss fluctuations in the q-number metric field. Subject headings are: Four-dimensional formulation of general relativity in terms of two-component spinors; The Dirac formulation of the gravitational field; The spinor formulation, The Hamiltonian and the primary spin constraints; The Poisson brackets for points on different hypersurfaces, to first order; The Hamiltonian formulation of the electromagnetic field in the framework of Lorentz-covariant field theory.

2831

Syracuse U., [Dept. of Physics] N. Y.

RADIATION AND OBSERVABLES, by P. G. Bergmann. [1965] [14]p. (AFOSR-66-1333) [AF AFOSR-65-789] AD 641239 Unclassified

Presented at meeting of the National Committee for the Celebration of the Fourth Centennial of the Birth of Galileo Galilei.

Also published in Atti Conv. Relatività Gen.: Probl. Energia e Onde Gravitazionale, 1965, p. 3-16.

The contents of this talk by Professor Bergmann concern the concept of observables as it has developed in general relativity and what one may learn about it from the consideration of radiative solutions of the field equations.

2832

System Development Corp., Santa Monica, Calif.

PROCEEDINGS OF THE WORKSHOP ON WORKING WITH SEMI-AUTOMATIC DOCUMENTATION SYSTEMS, Airlie Foundation, Warrenton, Va., May 2-5, 1965,

ed. by J. J. Maher [1965] 106p. incl. diagrs. refs. (AFOSR-65-1699) (AF 19(628)3418) AD 620360 Unclassified

This report contains descriptions of three semi-automatic documentation system applications now in operation: CIRC, IBM Technical Information Retrieval Center, and Douglas Aircraft's Computerized Library Program. It also contains summaries of panel discussions on techniques and methods currently used by applications people. Contents of the report include: (1) CIRC - Centralized Information and Control; (2) An Operating System: The IBM Technical Information Retrieval Center; (3) Historical Development and Present Status: Douglas Aircraft Co. Computerized Library Program; (4) Summary of Panel Discussions; Indexing and Classification, - Abstracting and Extracting, - Vocabulary Construction and Control, - Input Processing, - Request Processing, - Announcement and Dissemination, - User-System Relationships, - System Parameters and Management.

2833

System Research, Ltd., Richmond, Surrey (Gt. Brit.).

TEACHING AS A CONTROL-ENGINEERING PROCESS, [PART I], by G. Pask. [1965] [6]p. incl. illus. diagr. refs. (AFOSR-65-0583) (Sponsored jointly by Aeronautical Systems Division, Air Force Office of Scientific Research under AF 61(052)640, and Department of the Army) AD 618003 Unclassified

Also published in Control Automation Prog., v. 9: 6-11, Jan. 1965.

A review is given of the field of teaching machines with particular emphasis on adaptive teaching systems, or systems in which the teaching machine is an adaptive control mechanism. The aim is to indicate the kind of machinery that exists, the kind of work that is being done, and the results that are achieved. No attempt is made to justify the design of these systems or rationalize their performance. (Contractor's abstract)

2834

System Research, Ltd., Richmond, Surrey (Gt. Brit.).

SOME COMMENTS ON THE ORGANIZATION OF MEN, MACHINES, AND CONCEPTS, by G. Pask. [1965] [22]p. incl. diagrs. tables, refs. (AFOSR-65-2666) (Sponsored jointly by Aerospace Medical Research Laboratories; and Air Force Office of Scientific Research under AF 61(052)640) AD 628141 Unclassified

Also published in Proc. Symposium on Education for Information Science, Warrenton, Va. (Sept. 7-10, 1965), ed. by L. B. Heilprin, B. E. Markuson and F. L. Goodman. Washington, Spartan Books, 1965, p. 133-154.

Part 1 of this paper describes abstract cybernetic models for the data processing activities of organisms. In the model, an organism is regarded as reducible to minimal components that are active control systems. Part 2 of the paper discusses relevant features of several experiments in the field of man-machine interaction and provides data in support of model hypotheses. The model postulates a system composed of a pair of distinct and goal-directed individual organisms Z_α and Z_β which exist in an environment E. For purpose of data processing and problem solving aspects of Z_α and Z_β, E is a semantic environment. In metalanguage, organism Z is described as the realization of a code for a stable, goal-directed and active control system C. The Z's learn concepts about problem solving. Admissible C's are therefore restricted to a class of hierarchically organized adaptive control systems C = (C^0, C^1...) where the terms 0, 1,... denote levels of organization. System structures are considered in which Z_α and Z_β cooperatively communicate to achieve a common goal.

2835

System Research, Ltd., Richmond, Surrey (Gt. Brit.).

MAN/MACHINE INTERACTION IN ADAPTIVELY CONTROLLED EXPERIMENTAL CONDITIONS, by G. Pask. [1965] [13]p. incl. diagrs. tables, refs. (AFOSR-67-2720) (AF 61(052)640) Unclassified

Also published in Bull. Math. Biophys., Special Issue, v. 27: 261-273, 1965.

Systems in which a human subject interacts with an adaptive control mechanism through display and response facilities are reviewed. The data are discussed from the viewpoint of formulating adaptively controlled psychological experiments that can measure how a subject learns, the problem-solving procedures he adopts, and the concepts he constructs.

2836

Tasmania U. Dept. of Mathematics, Hobart (Australia).

SOME ESTIMATES OF THE COEFFICIENTS IN THE CHEBYSHEV SERIES EXPANSION OF A FUNCTION, by D. Elliott and G. Szekeres. [1965] [8]p. incl. table. (AFOSR-65-1010) (AF AFOSR-63-300) AD 618827 Unclassified

Also published in Math. Comput., v. 19: 25-32, Jan. 1965.

The function f(x) is expanded in a convergent series of Chebyshev polynomials $T_n(x)$ as $f(x) = \sum_{n=0}^{\infty} a_n T_n(x)$. This paper considers two problems. The first concerns finding an asymptotic estimate for large n of the coefficients a_n when f(z) (z = x + iy) is an integral function. The second involves the Chebyshev expansion of f(x) given its Laplace transform $\bar{f}(p)$. The Laplace transform $\bar{f}(p)$ is used either for an asymptotic evaluation of a_n or, if $\bar{f}(p)$ is sufficiently simple, to determine a_n explicitly. Examples are given of Chebyshev expansions with coefficients a_n which have been obtained in this manner.

2837

Tasmania U. Dept. of Mathematics, Hobart (Australia).

ALGORITHMS FOR THE NUMERICAL SOLUTION OF LINEAR INTEGRAL EQUATIONS OF THE SECOND KIND, by D. Elliott and W. G. Warne. Apr. 1965, 21p. (Technical rept. no. 7) (AFOSR-65-1359) (AF AFOSR-64-660) AD 621358 Unclassified

Two algorithms suitable for the solution of non-singular, linear Fredholm and Volterra integral equations of the second kind are described in detail. These algorithms make extensive use of Chebyshev series expansions. After a general statement of the algorithms and a discussion of their use, the algorithms are given as procedures written in ALGOL. (Contractor's abstract)

2838

Tasmania U. Dept. of Mathematics, Hobart (Australia).

TRUNCATION ERRORS IN TWO CHEBYSHEV SERIES APPROXIMATIONS, by D. Elliott. June 1964, 28p. incl. table, refs. (Technical rept. no. 3) (AFOSR-65-2326) (AF AFOSR-64-660) AD 628432 Unclassified

Also published in Math. Comput., v. 19 234-248, Apr. 1965.

Suppose it is required to calculate the coefficients a_r in the Chebyshev series $\sum a_n T_n(x)$ of a function f(x) in the range $-1 \leq x \leq 1$. It is well known that a convenient general method is to find the Lagrangian interpolation polynomial which coincides with f(x) at certain points. These are usually chosen to be the zeros of a Chebyshev polynomial of high degree, or alternatively the extrema of such a polynomial. The author compares the accuracies of these 2 procedures, and concludes that the latter is often to be preferred. (Math. Rev. abstract)

2839

Technical Research Group, Inc., Melville, N. Y.

COLLISION LASERS, by G. Gould. [1965] [9]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2808) [AF 49-(638)673] AD 629159 Unclassified

Also published in Appl. Opt., Suppl. 2 Chem. Lasers, p. 59-67, 1965.

Reliance on spontaneous emission to relax the lower level limits the efficiency and the power output from gas discharge lasers. The level spacing required for an untrapped radiative cascade places the laser levels well up in the energy level structure. The consequence is low quantum efficiency, a small fraction of electrons with the necessary energy for excitation, and parasitic loss through excitation of lower levels. A judicious combination of inelastic electron-atom and atom-atom collisions for excitation and relaxation can maintain a population inversion in appropriate atoms. This is possible because transfer rates between levels due to atom-atom collisions are small if the energy defect substantially exceeds the average kinetic energy. Thus collisions with other atoms can selectively relax the lower level to other nearby levels without reducing the upper level population. In favorable cases laser power of order 1 W/cm^3 is expected with an efficiency greater than 10%. Temperatures above 1000° are needed to produce a monatomic gas of most elements with suitably spaced low-lying levels. Two such elements are manganese and lanthanum. Mn can be contained in alumina tubing at 1350°; La in tantalum tubing at 1800°. Diffusion to cold windows is prevented by a noble buffer base. Apparatus for testing each of these systems has been constructed. Xenon test oscillations have been observed in the apparatus at the working temperature. Measurements of fluorescence in the prospective laser transitions are being carried out.

2840

Technical Research Group, Inc., Melville, N. Y.

PHOTODISSOCIATION OF THALLIUM BROMIDE AND CESIUM BROMIDE, by W. T. Walter and S. M. Jarrett. [1965] [4]p. incl. diagrs. table, refs. (AFOSR-65-2809) [AF 49(638)673] AD 629160 Unclassified

Also published in Appl. Opt., Suppl. 2 Chem. Lasers, p. 201-204, 1965.

Photodissociation of TlBr and CsBr by the 1850A mercury resonance line could lead to laser transitions at 5350A and 2.93 μ in Tl and Cs, respectively. The transition probabilities of Cs are such that radiative decay will maintain a population inversion between the $7\,^2P_{3/2}$ and $7\,^2S_{1/2}$ levels. Calculations indicate that

a gain of 4% per m is expected at a temperature of 890°C for photodissociation into the 7 $^2P_{3/2, 1/2}$Cs levels. In Tl, however, the 6 $^2P_{3/2}$ level is metastable. A suitable quenching gas must be found before oscillation is possible at 5350A from photodissociation into the $7\,^2S_{1/2}$ level. Nitrogen and CO_2 were tried thus far without success. (Contractor's abstract)

2841

Technical Research Group, Inc., Melville, N. Y.

RESEARCH ON PROPERTIES OF LASER DEVICES, by M. C. Newstein and N. Solimene. Final summary rept. June 1, 1959-Nov. 15, 1964. Oct. 1965, 73p. (Rept. no. TRG-134-FR) (AFOSR-66-0640) (AF 49-(638)673) AD 481501 Unclassified

The first objective of this work is to produce working models of laser devices together with the experimental and theoretical information necessary to describe and predict their performance. After the demonstration of the laser principle, emphasis was on development of lasers having improved characteristics. The work is described under 3 main topics gaseous laser media, solid-state media, and output control.

2842

Technical Research Group, Inc., Melville, N. Y.

LASER TECHNOLOGY, by R. T. Daly. [1965] [5]p. incl. illus. diagrs. tables, refs. (AFOSR-65-2969) (AF 49(638)1535) AD 628253 Unclassified

Also published in Elec. Design News, p. 120-123, 199, June 1965.

The technology of gaseous laser oscillators, homogeneous solid or liquid phase lasers, and junction of semiconductor lasers is discussed. The basic concept of laser theory is described in general terms and then extended in more detail to each of the 3 broad categories of existing lasers.

2843

Technical Research Group, Inc., Melville, N. Y.

INFRARED LASER OSCILLATION IN HBr AND HI GAS DISCHARGES, by S. M. Jarrett, J. Nunez, and G. Gould. [1965] [3]p incl. diagr. table. (AFOSR-66-1684) (AF 49(638)1535) AD 638967 Unclassified

Also published in Appl. Phys. Ltrs., v. 7: 294-296, Dec. 1, 1965

CW infrared laser oscillation has been observed in gas discharges produced in the hydrogen halides HBr and HI. Oscillation was observed at 6 wavelengths in the region between 2.2μ and 3.5μ, 3 each in HBr and HI. The oscillations have been identified with 4d-5p and 5d-6p transitions in atomic BR and I.

2844

Technical Research Group, Inc., Melville, N. Y.

PULSED LASER TRANSITIONS IN MANGANESE VAPOR, by M. Pilch, W. T. Walter and others. [1965] [2]p. incl. diagr. table. (AFOSR-66-1686) (AF 49(638)1535) AD 638389 Unclassified

Also published in Appl. Phys. Ltrs., v. 7: 309-310, Dec. 1, 1965.

A gas discharge tube containing the atomic vapor of neutral manganese has produced laser action on 5 green lines and 6 infrared lines. The gain coefficient of the strongest transition at 5341A was 37dB/m. The observed pulse width of 20 nsec implies a peak power output of 300W. This new pulsed manganese laser is similar to the pulsed laser at 7229A recently reported in the atomic vapor of neutral lead. Transient population inversions are produced by preferential electron excitation of those atomic energy levels which are both close to and optically connected with the ground level. These inversions are inherently transient because of the metastability of the lower laser level.

2845

Technion - Israel Inst. of Tech., Haifa.

LOGICAL DESIGN OF TERNARY SWITCHING CIRCUITS, by M. Yoeli and G. Rosenfeld. 1965 [11]p. incl. diagrs. tables, refs. (AFOSR-65-1361) (AF EOAR-63-65) AD 621260 Unclassified

Also published in IEEE Trans. Electron. Comput., v. EC-14: 19-29, Feb. 1965.

A logical design theory for ternary voltage switching circuits is developed. The theory is based on familiar binary switching circuit elements and simplification methods. The theory thus leads to simple electronic realization. The basic system of ternary switching elements is made function realizable by means of either diode gates or a single triode. Various simplification methods for combinational circuits are described, i.e., a map method and two algebraic methods. The first algebraic method is an adaptation of the Quine method for determining the prime implicants of a given binary function, and the second is a modification of the Scheinman binary method. (Contractor's abstract)

2846

Technion - Israel Inst. of Tech., Haifa.

TERNARY-TRANSMISSION CONTACT NETWORKS, by M. Yoeli. 1965 [4]p. incl. diagrs. table, refs. (AFOSR-66-1219) (AF EOAR-63-65) AD 639509 Unclassified

Also published in IEEE Trans. Circuit Theory, v. CT-12: 414-417, Sept. 1965.

This communication discusses multiterminal 2-

positional contact networks which include resistors and (ideal) rectifiers. Ternary transmission values are considered, namely 0 (open circuit), 1/2 (partial short circuit), and 1 (short circuit). It introduces a special binary-ternary switching algebra and demonstrates its suitability to the analysis of such ternary-transmission contact networks. This algebra is to be distinguished from the ternary algebras used e.g., in connection with ternary voltage switching circuits or for the study of static hazards of binary switching circuits.

2847

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

BUCKLING OF CIRCULAR CONICAL SHELLS UNDER COMBINED TORSION AND EXTERNAL OR INTERNAL PRESSURE, by J. Singer and M. Baruch. [1965] [24]p. incl. diagrs. tables, refs. (AFOSR-65-1234) (AF EOAR-62-61) AD 622654 Unclassified

Also published in Topics in Applied Mechanics, ed. by D. Abir, F. Ollendorff, and M. Reiner. Amsterdam, Elsevier Publishing Co., 1965, p. 65-88.

A method developed previously for the analysis of the instability of thin conical shells under external pressure is now extended to buckling under torsion and combined torsion and external or internal pressure as well as axisymmetric temperature distributions. The method is based on solution modified Donnell type stability equations, in the presence of slightly relaxed boundary conditions for the u and v displacements. Two formulations of the solution for torsion and combined loadings are given and compared. Typical examples are calculated and compared with results obtained by Seide and tests, and interaction curves for combined torsion and external and internal pressure loading are given and compared with experimental curves. For conical shells of small and medium taper ratio, the interaction curves may be approximated by the semi-empirical curve of Crate, Batdorf and Baab for cylindrical shells, but for larger taper ratio different curves are obtained. (Contractor's abstract)

2848

Technion - Israel Inst. of Tech. [Dept. of Aeronautical Engineering] Haifa.

GENERAL INSTABILITY OF STIFFENED CIRCULAR CONICAL SHELLS UNDER HYDROSTATIC PRESSURE, by M. Baruch and J. Singer. [1965] [18]p. incl. diagrs. tables, refs. (AFOSR-65-2251) (AF EOAR-62-61) AD 419706 Unclassified

Also published in Aeronaut. Quart., v. 16: 187-204, May 1965.

Donnell type equilibrium and stability equations are derived for stiffened thin conical shells. The stiffeners are considered closely spaced and are therefore assumed to be "distributed" over the whole surface of the shell. In the proposed theory the stiffeners and their spacing may vary in any prescribed manner but here only equal and equally spaced stiffeners are dealt with. The force- and moment-strain relations of the combined stiffener-sheet cross section are determined by the assumption of identical normal strains at the contact surface of stiffener and sheet. The stability equations are solved for general instability under hydrostatic pressure by the method of virtual displacements. The solution used earlier for unstiffened conical shells, which satisfies some of the boundary conditions of simple supports only approximately, is again applied here. The effect of this incomplete compliance with boundary conditions is shown to be negligible by consideration of "boundary work". The solution proposed for stiffened conical shells involves the concepts of "correcting coefficients" and minimisation of corresponding "error loads". Typical examples are analyzed and the effect of eccentricity of stiffeners is investigated. Simplified approximate formulae for the critical pressure of frame-stiffened conical shells are also proposed. (Contractor's abstract)

2849

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

BUCKLING OF UNSTIFFENED CONICAL SHELLS UNDER COMBINED TORSION AND AXIAL COMPRESSION OR TENSION, by A. Berkovits and J. Singer. [1965] [10]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1235) (AF EOAR-63-58) AD 621342 Unclassified

Presented at Seventh Israel Annual Conf. on Aviation and Astronautics, Feb. 1965.

Also published in Israel Jour. Technol., v. 3: 15-24, 1965.

A method developed previously is extended to the analysis of the instability of isotropic conical shells under combined torsion and axial compression or tension. The method is based on solution of modified Donnell type stability equations, in the presence of slightly relaxed boundary conditions for the u and v displacements. Typical examples are calculated, and theoretical interaction curves for combined loading are presented and compared with the interaction curve for cylindrical shells. An experimental program was conducted in order to determine the shape of the interaction curves for combined torsion and axial compression of isotropic conical shells. Results of combined loading tests on unstiffened aluminum alloy shells are presented. The results indicate a parabolic interaction function between torsional and compression buckling strength, similar to the empirical interaction function generally obtained for cylinders. This was to be expected in view of the similarity of the theoretical interaction curves for cones and cylinders. (Contractor's abstract)

2850

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

GENERAL INSTABILITY OF CONICAL SHELLS WITH NONUNIFORMLY SPACED STIFFENERS UNDER HYDROSTATIC PRESSURE, by M. Baruch, J. Singer, and O. Harari. [1965] [10]p. incl. diagrs. table, refs. (AFOSR-65-1236) (AF EOAR-63-58) AD 617151 Unclassified

Presented at Seventh Israel Annual Conf. on Aviation and Astronautics, Feb. 1965.

Also published in Israel Jour. Technol., v. 3: 62-71, 1965.

A method of analysis of the general instability of stiffened conical shells, developed earlier for uniform and equally spaced stiffeners, is extended to shells with non-uniformly spaced stiffeners. For hydrostatic pressure loading, rings are the most efficient stiffeners. On account of the cone geometry, equally spaced rings divide a conical shell into "sub-shells" of unequal local buckling strength. Hence unequal spacings, which result in "sub-shells" of equal local buckling strength, are the logical approach to an optimum structure. A rule for such spacings is derived and discussed. The general instability analysis is then given for conical shells with rings spaced according to rules of this type. Numerical calculations are presented and discussed, and an approximate design formula is proposed. (Contractor's abstract)

2851

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

BUCKLING OF CIRCULAR CONICAL SHELLS UNDER UNIFORM AXIAL COMPRESSION, by J. Singer. 1965 [3]p. incl. table. (AFOSR-65-2168) (AF EOAR-63-58) AD 629040 Unclassified

Also published in AIAA Jour., v. 3: 985-987, May 1965.

A new modified third stability equation in the buckling of circular conical shells under uniform axial compression is determined, under the assumption that for the buckling analysis, the prebuckling stress is represented satisfactorily by the membrane stresses. A total of N linear equations is obtained for an N-term solution, and the lowest eigenvalue η of the determinant of the coefficients of C_n yields the buckling load. However, in the case of buckling load. However, in the case of buckling under external pressure, $n = 1$ is always the basic mode, here the value of n of the basic mode is determined by the geometry of the shell and is usually larger than unity. The critical loads are calculated for 2 typical shells (one short and one long) by 1-, 2-, 3-, 4-, 5-, and 7-term solutions, and are compared with the approximate axisymmetric solution of the equation representing the buckling load. The convergence is much slower for a shell of large taper ration. The asymmetrical buckling loads are found to be very slightly below the axisymmetric ones in the examples.

2852

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

EFFECT OF ECCENTRICITY OF STIFFENERS ON THE GENERAL INSTABILITY OF STIFFENED CYLINDRICAL SHELLS UNDER TORSION, by M. Baruch, J. Singer, and T. Weller. Aug. 1965, 35p. incl. diagrs. tables, refs. (Scientific rept. no. 3; TAE rept. no. 43) (AFOSR-65-2753) (AF EOAR-63-58) AD 628174 Unclassified

A method of analysis of eccentrically stiffened cylindrical shells, developed earlier, is applied to buckling under torsion. In the calculations about 350 shells covering a wide range of shell and stiffener geometries have been considered. It is found that for long cylinders rings are the important stiffeners, and internal rings stiffen more than external rings. For short cylinders the effect is inverted, external rings yielding higher critical loads than internal rings. Stringers have little effect in long cylinders, but in short cylinders they stiffen the shell against buckling in torsion as much as rings. Outside stringers always stiffen the shell more than inside stringers. (Contractor's abstract)

2853

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

ON THE BUCKLING OF UNSTIFFENED ORTHOTROPIC AND STIFFENED CONICAL SHELLS, by J. Singer. [1965] 22p. incl. illus. diagrs. tables, refs. (AFOSR-66-0327) (AF EOAR-63-58) AD 631100 Unclassified

Presented at Seventh International Aeronautical Congress, Paris (France), June 14-16, 1965.

A linear theory developed earlier for the analysis of the instability of isotropic conical shells under external pressure is described briefly. Recent experiments with electroformed specimens are shown to be even in better agreement with theory than previous tests. Extensions of the method to other loading cases are discussed with their experimental confirmation. Results of a similar method of analysis for clamped conical shells under external pressure are presented. Boundary conditions are discussed in the light of recent conclusions as to their effect on the buckling of cylindrical shells. The extension of the method of analysis for buckling of orthotropic shells under external pressure, torsion and axial compression is then considered, and recent experimental results are described. For stiffened shells, the more accurate approach of 'distributed stiffeners', which permits consideration of the effect of eccentricity of stiffeners, is reviewed. Results for conical shells with uniformly and non-uniformly spaced stiffeners under external pressure are discussed and related to optimization studies. Recent experiments on stiffened conical shells under external pressure and

some preliminary tests under axial compression and torsion are then described. The behavior of conical shells under combined loading is then considered and interaction curves are presented for isotropic and orthotropic conical shells. (Contractor's abstract)

2854

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

FURTHER REMARKS ON THE EFFECT OF ECCENTRICITY OF STIFFENERS ON THE GENERAL INSTABILITY OF STIFFENED CYLINDRICAL SHELLS, by J. Singer, M. Baruch, and O. Harari. Aug. 1965 [27]p. incl. diagrs. tables, refs. (Scientific rept. no. 2; TAE rept. no. 42) (AFOSR-66-0569) (AF EOAR-63-53) AD 630543 Unclassified

The analysis of the general instability of stiffened cylindrical shells under hydrostatic pressure, carried out earlier, is continued in order to study the inversion of the eccentricity effect. Typical shells (250) of varying geometries are considered. The results show that for lateral pressure loading the inversion of the eccentricity effect is practically independent of the geometry of the ring but depends very strongly on the shell geometry parameter Z, whereas for hydrostatic pressure the inversion is also influenced by the bending stiffness of the rings. A range of inversion is also influenced by the bending stiffness of the rings. A range of inversion is found for both loadings. A detailed physical explanation of the cause of the eccentricity effect and its inversion is proposed.

2855

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

ON THE STABILITY OF ECCENTRICALLY STIFFENED CYLINDRICAL SHELLS UNDER AXIAL COMPRESSION, by J. Singer, M. Baruch, and O. Harari. Dec. 1965 [45]p. incl. diagrs. tables, refs. (Scientific rept. no. 4; TAE rept. no. 44) (AFOSR-66-0613) (AF EOAR-63-58) AD 630392 Unclassified

The eccentricity effect of stiffeners is studied for stiffened cylindrical shells under axial compression. Classical simple supports and clamped ends are considered. A detailed physical explanation of the causes of the eccentricity effect and its behavior is proposed and verified by computations for 350 typical shells. As for buckling under hydrostatic pressure and torsion studied earlier, the behavior of the eccentricity effect in the case of axial compression also depends very strongly on the geometry of the shell, represented by the Batdorf parameter, while the geometry of the stiffeners only influence its magnitude. Inversion of eccentricity effect occurs at very low Z, but for practical dimensions outside stringers always stiffen the shell more than inside ones. The eccentricity effect has a pronounced maximum at practical values of Z, and the behavior of the eccentricity effect is very similar for clamped and simply supported shells. Rings, which are much less effective stiffeners than stringers under axial compression, are also considered. Results are compared with those of other investigators. (Contractor's abstract)

2856

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

EQUILIBRIUM AND STABILITY EQUATIONS FOR DISCRETELY STIFFENED SHELLS, by M. Baruch. [1965] [9]p. incl. diagrs. refs. (AFOSR-66-1088) (AF EOAR-63-58) AD 632446 Unclassified

Also published in Israel Jour. Technol., v. 3: 138-146, 1965.

A method of analysis for stiffened shells is developed which considers discrete stiffeners and takes into account the eccentricity of the stiffeners. The stiffeners are concentrated along their orthogonal curvilinear coordinates with the aid of the Dirac delta function. As an example, the stability equations are developed for a cylindrical shell stiffened by equally spaced unequal rings and equally spaced equal stringers. (Contractor's abstract)

2857

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

MAGNETOGASDYNAMIC HYPERCRITICAL FLOWS WITH SHOCKS, by N. Geffen. Annual summary rept. May 1965 [29]p. incl. diagrs. refs. (TAE rept. no. 41) (AFOSR-65-1798) (AF EOAR-64-78) AD 625938 Unclassified

Two dimensional, steady, non-dissipative magnetogasdynamic flow around given slender bodies is investigated in the hypercritical (near $A^2 + M^2 = 1$) approximation. Similarity parameters are obtained by a simple method, and the flow over a double-wedge is formulated in the physical and in the hodograph planes. Two methods of solution are proposed, and a procedure for a digital computer given.

2858

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

MAGNETOGASDYNAMIC HYPERCRITICAL FLOWS WITH SHOCKS, by N. Geffen. [1965] [6]p. incl. diagrs. (AFOSR-65-2493) (AF EOAR-64-78) AD 628061 Unclassified

Presented at Seventh Israel Annual Conf. on Aviation and Astronautics, Feb. 1965.

Also published in Israel Jour. Technol., v. 3: 82-87, 1965.

Steady, aligned-fields nondisscipative

magnetogasdynamic flows around slender bodies are investigated in the hypercritical (near $A^2 + M^2 = 1$) approximation. The mathematical system is similar to the transonic one, and can be obtained from the latter by a simple transformation. The flow patterns however, include near-horizontal upstream facing shocks, and are different from ordinary gasdynamic flows. The methods used and a few of the flow patterns obtained are described in the paper.

2859

Technion - Israel Inst. of Tech. Dept. of Mechanics, Haifa.

ON THE ANALYSIS OF DEFORMATION AND THE STRAIN TENSORS, by Z. Karni. [1965] [12]p. incl. diagr. table. (AFOSR-3113) [AF EOAR-63-72] AD 616456 Unclassified

Also published in Topics in Applied Mechanics, ed. by D. Abir, F. Ollendorff, and M. Reiner. Amsterdam, Elsevier Publishing Co., 1965, p. 287-298.

A finite rotation tensor is introduced, and the effect of the rotation on the strain tensors is analyzed. (Contractor's abstract)

2860

Technion - Israel Inst. of Tech. Dept. of Mechanics, Haifa.

THE PHYSICAL TENSOR, ANALYSIS AND APPLICATIONS, by Z. Karni. Final rept. Nov. 30, 1965, 30p. (AFOSR-65-2758) (AF EOAR-64-71) AD 627697 Unclassified

The introduction of the physical tensor permits the extension of the concept of the scalar invariant of a tensor to that of tensor invariants, themselves tensors of arbitrary order. The fundamentals of the invariant theory of the physical tensor are sketched out, later applied to the invariant differential operators and the generalized relations existing between differential invariants, formed from the first and second tensor derivatives of a field vector and of a second-order tensor. (Contractor's abstract)

2861

Technion - Israel Inst. of Tech. Dept. of Mechanics, Haifa.

THE PRECESSING SYSTEM OF REFERENCE, by Z. Karni. [1965] [5]p. (AFOSR-66-0244) (AF EOAR-64-71) AD 631091 Unclassified

Also published in Israel Jour. Technol., v. 3. 147-151, 1965.

This paper discusses the integration of the vector equation of motion for the particle and for the rigid body by introducing the so-called "precessing system of reference". The examples of the spinning top and of the Foucault pendulum are used to illustrate some features of the solution of differential vector equations by vector methods. The vector solution is altogether more compact, it leans on directions in space which possess a physical meaning (any may form an oblique system of reference), and above all, in some cases there is no need to solve the equation at all since the solution is explicitly readable from the differential vector equation itself. The introduction of the precessing system of reference is a means by which the second-order differential vector equations of motion can be reduced to first order equations.

2862

Technion - Israel Inst. of Tech. [Dept. of Physics] Haifa.

SCHUMANN-RUNGE BANDS OF O_2 IN SOLID PHASES: SPECTROSCOPIC MEASUREMENT OF INTERMOLECULAR POTENTIALS, by O. Schnepp and K. Dressler. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-2547) (Sponsored jointly by Air Force Office of Scientific Research under [AF 61(052)428] and Dept. of Army) AD 628720 Unclassified

Also published in Jour. Chem. Phys., v. 42: 2482-2489, Apr. 1, 1965.

The absorption spectra of oxygen in solid solution in nitrogen and argon have been investigated in the spectral region of the Schumann-Runge bands. Eleven discrete bands have been measured in each case. The vibrational structure is very similar to that of the free molecule for low vibrational quantum numbers of the excited electronic state but the spacings deviate considerably from those of the gas for higher quantum numbers, inasmuch as their convergence is slower. Potential curves have been constructed from the data for the oxygen molecule perturbed by the solid solvent cage. The deviations of these curves from those of the free molecule have been analyzed in terms of oxygen-argon and oxygen-nitrogen pair repulsive potentials.

2863

Technion - Israel Inst. of Tech. [Dept. of Physics] Haifa.

SPECTRUM OF THE IODINE CRYSTAL. II, by O. Schnepp, J. L. Rosenberg, and M. Gouterman. [1965] [14]p. incl. illus. diagrs. tables, refs. (AFOSR-66-1269) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)428 and Public Health Service) AD 638511 Unclassified

Also published in Jour. Chem. Phys., v. 43: 2767-2780, Oct. 15, 1965.

The absorption spectrum of single and oriented crystals of iodine has been investigated in the wavelength region 7000-3000A. Four strongly polarized bands and one weakly polarized absorption band have been observed, all of which are polarized in the ac plane of the crystal.

All of the absorption bands are approximately 1000 cm^{-1} wide. The crystal-band theory for iodine given by Rosenberg has been extended, and the effects of exchange and of spin-orbit coupling have been qualitatively considered. Three models are discussed with varying relative importance of spin-orbit and crystal energies. These models are correlated, and the strong crystal force model is used to interpret the experimental observations. (Contractor's abstract)

2864

Technion - Israel Inst. of Tech. [Dept. of Physics] Haifa.

THE ABSORPTION SPECTRA OF SOLID CO AND N_2, by M. Brith and O. Schnepp. [1965] [17]p incl. illus. diagrs. tables, refs. (AFOSR-66-1559) (AF 61(052)-428) AD 638513 Unclassified

Also published in Molec. Phys., v. 9. 473-489, Apr. 1965.

The absorption spectra of CO and N_2 solids were investigated in the wavelength region 1600-1150A at temperatures ranging from 10°K to 30°K. For CO two electronic transitions were observed: $A^1\Pi - X^1\Sigma^+$, 13 vibrational bands measured between 1570A and 1250A; $d^3\Delta - X^1\Sigma^+$, 7 vibrational bands measured between 1300A and 1225A. The spectra are simply related to the molecular transitions and can be interpreted on the basis of existing theory of the excited states of molecular crystals of cubic symmetry. Davydov splitting has been clearly resolved for a number of bands of the A - X transition, and the experimental splitting energy can be quantitatively accounted for if the f-number of this transition is 0·16. The observed relative intensities of the components are in agreement with theoretical prediction. For N_2 also 2 electronic transitions have been observed. $a^1\Pi_g - X^1\Sigma_g^+$, 8 vibrational bands measured between 1460A and 1250A; $w^1\Delta_u - X^1\Sigma_g^+$, 11 bands measured between 1400A and 1170A. Here again Davydov splitting was observed but the theoretical interpretation of the splitting energy and the relative intensities of the components is complicated by the fact that the corresponding molecular transitions are dipole forbidden. The assignment of the latter transition is confirmed. (Contractor's abstract)

2865

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

NUCLEAR RESONANCE IN SHEETS AND POWDERS OF COBALT, by M. Kuznietz and A. A. Hirsch. [1965] [11]p. incl. diagrs refs. (AFOSR-66-0279) (AF EOAR-63-71) AD 629255 Unclassified

Also published in Nuclear Magnetic Resonance and Relaxation in Solids. Proc. of the Thirteenth Colloque Ampere, Leuven U (Sept. 1-5, 1964), ed. by L Van Gerven. Amsterdam, North-Holland Publishing Co., 1965, p. 122-132.

An interpretation is suggested for the NMR of Co^{59} in sheets and powders of metallic cobalt, under the assumption that 2 different effects might influence the magnitude of the NMR signal: the enhancement of the applied rf field by displacements of the Bloch walls, and the penetration of the rf field only till the "skin-depth". The measurements were carried out by a modified Hartley oscillator, in which the sweep and the modulation of the frequency are both electric. The magnitude of the signal was found to be proportional of the mass of the cobalt powder taken for its calibration. The NMR signal, in annealed sheets of cobalt of different thickness which are much higher than the "skin-depth", is proportional to the square root of the product of the electrical resistivity and the magnetocrystalline anisotropy constant. A linear relation is found between the NMR signal and the area of annealed sheets and evaporated thick films, showing that the NMR in bulk material is a surface phenomenon. The NMR signals were investigated from liquid nitrogen temperature up to 367°K. The signal in powder decreased with the increase of the temperature, while in annealed sheet it increased in accordance with the suggested interpretation. A slight cold-rolling of annealed sheet (which reduces the thickness by less than 3%) decreases the signal practically to zero, while by removal of the external surface of the sheet (chemically) the signal appears again, which shows that the cold-rolling affects mainly the layer in which are located the nuclei responsible for the NMR. (Contractor's abstract)

2866

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

DEPENDENCE OF COERCIVITY ON DRIVING FIELD IN MULTILAYER FILMS OF NICKEL, by A. A. Hirsch. 1965 [4]p. incl. illus. diagrs. (AFOSR-67-0350) (AF EOAR-63-71) AD 646950 Unclassified

Presented at INTERMAG Conf., Washington, D C., 1965.

Also published in IEEE Trans. Magnetics, v. MAG-1, 254-257, Dec. 1965.

The variation in the coercivity of magnetization loops of multilayer films of nickel was investigated as function of the rate of rise r in the applied magnetic field. The films were prepared by deposition of nickel and copper alternately in a vacuum of 2×10^{-6} mm of Hg on to substrates made of thin aluminum foils. The thickness of the nickel layers L varied in the different films from 8 to 1000A. The loops were cycled with sinusoidal or triangular waveform driving fields, with a variety of amplitudes from 1 kOe to 4 kOe, with frequencies from 0.0° to 2 cps. The measurements were performed from room down to liquid hydrogen temperatures. It was found that the coercive force could be expressed by $H_c = H_o + Q(\ln r - \ln r_o)/T^A$ for values of r changing from 1 to 5 Oe ms, where H_o, A and r_o varied slightly with temperature T. (Contractor's abstract, modified)

2867

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

QUANTITATIVE HIGH TEMPERATURE INFRARED SPECTROSCOPY, by U. P. Oppenheim. Final rept. Apr. 30, 1965, 4p. (AFOSR-65-1490) (AF EOAR-63-111) AD 623193 Unclassified

Spectral emissivity studies were made of three water vapor bands at 1.9, 2.7 and 6.3-μ. Atmospheric interference was successfully eliminated by building a hermetically sealed optical system, from which absorbing gases could be eliminated. Spectral studies with a resolution of 0.5 cm^{-1} were carried out for H_2O vapor at 1200°K in the 1.9 and 2.7-μ bands. By the use of spectral band models the band parameters and the integrated intensity of these 2 bands were determined at 1200°K. The method of "curves of growth" was also applied to atmospheric absorption by CO, N_2O and H_2O at room temperature. Total emissivity calculations were made on H_2O at 1200°K, based on the contributions of spectral band emissivities in the 1.9, 2.7 and 6.3-μ regions. The integrated intensity of the 6.3-μ band was established by measuring the intensity of a single rotational line in this band. (Contractor's abstract)

2868

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

AN INTERMEDIATE STATE BETWEEN He I AND He II, by M. Revzen, A. Ron, and I. Rudnick. [1965] [3]p. incl. diagr. refs. (AFOSR-66-2130) (AF EOAR-65-25) Unclassified

Also published in Phys. Rev. Ltrs., v. 15. 384-386, Aug. 1965.

One possible interpretation of the results of a recent experiment is that there is a discontinuity in the magnitude of the velocity of sound at the λ transition of He^4 at vapor pressure. This note is concerned with the consequences of this eventuality. It is stated that this indicates the existence of an intermediate state between He I and He II at pressures higher than the vapor pressure. The proposed phase diagram is depicted qualitatively. It is calculated that the slopes of the 2 lines differ by 1% at vapor pressure. If this difference persists to higher pressures, then one can estimate that the width of the intermediate state is less than $\frac{1}{4}\mu$ K for pressures below 10 atm. Measurements above the vapor-pressure line have defined the λ line closer than 1 μ°K. On the other hand, accuracies of 1 μ°K are possible.

2869

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

EMISSIVITY OF WATER VAPOR AT 1200 K IN THE 1.9- AND 2.7-μ REGIONS, by A. Goldman and U. P. Oppenheim. [1965] [7]p. incl. diagrs. tables, refs (AFOSR-66-0346) [AF EOAR-65-84] AD 632445 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 55: 794-800, July 1965.

The emissivities of the 2 bands of water vapor at 1.9 and 2.7μ were determined at elevated temperatures. Use was made of quartz absorption cells of various lengths, which were heated in an electrical furnace to a temperature of 1200°K. By applying the 'statistical' spectral-band model at every frequency in low-resolution spectra (8 cm^{-1}), it was possible to obtain the band parameters $2\pi\gamma^0/d$ and thus to correlate the observed spectral absorptance with the optical path length and the pressure of the gas. From absorptance measurements in the 'linear region' the absolute intensity of the bands was derived. The total emissivity was calculated as a function of path length and pressure, and good agreement was obtained with direct observations of total emissivity at 1200°K. (Contractor's abstract)

2870

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

SPECTRAL EMISSIVITY OF WATER VAPOR AT 1200°K, by U. P. Oppenheim and A. Goldman. [1965] [4]p. incl. tables, refs. (AFOSR-66-0347) [AF EOAR-65-84] AD 631098 Unclassified

Also published in Tenth Symposium (Internat'l.) on Combustion, Cambridge (Gt. Brit.) (Aug. 17-21, 1964), Pittsburgh, Combustion Inst., 1965, p. 185-188, 1965.

Results are presented of quantitative spectroscopic studies on pure water vapor in the 1.9- and 2.7-μ regions. Use was made of quartz absorption cells of various lengths, which were heated in an electrical furnace to a temperature of 1200°K. By applying the 'statistical' spectral band model at every frequency in each band, it was possible to correlate the observed spectral emissivities with the optical path length and the pressure of the gas. From emissivity measurements in the "linear region" of the 2.7-μ band it was possible to measure the absolute intensity of this band, which was found to be 198 cm^{-2} atm^{-1} at 300°K. (Contractor's abstract)

2871

Technische Hochschule. Geophysikalisches Inst., Karlsruhe (Germany).

INVESTIGATIONS ON THE NONELASTIC BEHAVIOR OF THE UPPER MANTLE, by S. Mueller and K. Fuchs. Quarterly narrative progress rept. no. 1, May 1-July 31, 1965. Aug. 15, 1965, 14p. incl. tables, refs. (AFOSR 65-2939) (AF 61(052)861) AD 628068 Unclassified

The distorting effect of the earth's crust on the spectrum

of seismic signals which are transmitted from the source through the mantle to the receiving station is discussed. In an attempt to correct for the influence of the "receiver-crust" a crustal model for the region of the Grafenberg Observatory (GGGR) near Nürnberg, Germany, has been derived. Its main features are a positive velocity gradient at the top of the crystalline basement, a low-velocity channel at a depth of about 10 km, and the possible existance of a high-velocity layer just above the MOHOROVICIC discontinuity. The presence of this layer could be detected from the spectra of body waves. (Contractor's abstract)

2872

Technische Hochschule, Inst. fur Angewandte Botanik, Munich (Germany).

PHOTOASSIMILATION OF GLUCOSE BY CHLORELLA IN MONOCHROMATIC LIGHT AND THE INHIBITION BY DCMU AND ANTIMYCIN A, by O. Kandler. Final rept. May 1, 1965, 24p. incl. diagrs. tables, refs. (AFOSR-65-2722) (AF EOAR-64-53) AD 620057 Unclassified

It was investigated whether monochromatic light beyond 700 μ can bring about light dependent glucose uptake in the absence of O_2 and CO_2. The effects of DCMU and antimycin A on photoassimilation of glucose were studied. Glucose assimilation proceeds at a high rate even beyond 700 mu. It is inhibited only about 30% by DCMU at a concentration where photosynthesis is completely inhibited. Antimycin A inhibits to 70% where photosynthesis is hardly effected. These results are strong evidence for the existence of cyclic photophosphorylation in vivo. (Contractor's abstract)

2873

Technische Hochschule. Mathematisches Inst., Munich (Germany).

ASYMPTOTIC EXPANSIONS FOR THE ERROR OF DISCRETIZATION ALGORITHMS FOR NON-LINEAR FUNCTIONAL EQUATIONS, by H. J. Stetter. [1965] [14]p. incl. table, refs. (AFOSR-65-1026) (AF EOAR-63-77) AD 619757 Unclassified

Also published in Numerische Math., v. 7, 18-31, 1965.

This note considers the converging solution of a finite algorithm and the asymptotic expansions of its discretization error. Under suitable conditions, the existence of such expansions is proven for a general class of discretization algorithms for nonlinear functional equations in Banach-spaces. Several important functional equations and their discretizations are then considered: initial and boundary value problems for both ordinary and partial differential equations, integral equations, and integrodifferential equations. Finally an example is considered of a nonlinear boundary value problem of the third kind.

2874

Technische Hochschule. Mathematisches Inst , Munich (Germany).

STABILIZING PREDICTORS FOR WEAKLY UNSTABLE CORRECTORS, by H. J. Stetter. [1965] [6]p. incl. tables. (AFOSR-65-1027) (AF EOAR-63-77) AD 619636 Unclassified

Also published in Math. Comput., v. 19 84-89, Jan. 1965.

The weak unstability occurring within algorithms used for computation of certain integral equations destroys the validity of the computation. This note demonstrates how to eliminate the cause of the weak unstability: the combination of a judiciously chosen predictor with the weakly unstable corrector constitutes a strongly stable algorithm if the corrector is not iterated.

2875

Technische Hochschule. Mathematisches Inst., Munich (Germany).

A STUDY OF STRONG AND WEAK STABILITY IN DISCRETIZATION ALGORITHMS, by H. J. Stetter. [1965] [16]p. incl. table, refs. (AFOSR-66-0389) (AF EOAR-63-77) AD 639502 Unclassified

Also published in SIAM Jour. Numer. Anal., Ser. B., v. 2, 265-280, 1965.

The author presents slightly unusual definitions of strong stability and weak instability of discrete ordinate methods for solving ordinary differential equations. He then shows that a multistep method satisfies his condition of strong stability if and only if the usual associated polynomial has a simple zero at $z = 1$ and all other zeros inside but not on the unit circle. A method would then be called weakly unstable if it is stable in the usual sense, but does not satisfy this more stringent condition. Possible extensions of the ideas to partial differential equations and to boundary value problems are also mentioned.

2876

Technische Hochschule, Vienna (Austria).

[SPACE AND TIME DEPENDENT RANDOM TEMPERATURE AND STRESS FIELDS, Part I] Örtlich und zeitlich zufällig verteilte Temperatur- und Spannungsfelder, by J. L. Zeman. [1965] [18]p. incl. diagrs. refs. (AFOSR-66-0201) (AF 61(052)645) AD 639454 Unclassified

Also published in Acta Mech., v. 1, 194-211, 1965.

The problem of determining, in the sense of correlation theory, the properties of temperature and stress in the interior of a body to which a random quantity of heat is supplied is, under certain assumptions, reduced to the problem of finding deterministic influence functions. The results are illustrated by examples.

2877

Technische Hochschule, Vienna (Austria).

[SPACE AND TIME DEPENDENT RANDOM TEMPERATURE AND STRESS FIELDS, Part II] Ortlich und zeitlich zufallig verteilte Temperatur- und Spannungsfelder, by J. L Zeman. [1965] [15]p. incl. diagrs. refs (AFOSR-66-0659) (AF 61(052)645) AD 633564 Unclassified

Also published in Acta Mech., v. 1: 371-385, 1965.

In the first part of this paper (item no. 2876) some fundamental relations were derived for temperature, stress and displacement in a body to which a space and time dependent randomly distributed quantity of heat is supplied. The results were illustrated by one example. In this second part, 2 further examples are given.

2878

Temple U. Research Inst., Philadelphia, Pa.

PLASMA JET CHEMISTRY, by C S Stokes and J. A. Cahill. Final rept. Dec. 1965, 31p. incl diagrs. tables. (Rept no. RITU 1965-40) (AFOSR-66-0607) (AF AFOSR-65-775) AD 630549 Unclassified

A plasma jet has been used as the source of energy for producing a high temperature medium for purposes of chemical synthesis The tungsten carbides (WC and W_2C) were formed in a helium plasma jet from either tungsten or tungsten trioxide (WO_3) and methane. Similarly the tantalum carbides (TaC and Ta_2C) were produced from tantalum and tantalum pentoxide (Ta_2O_5) with methane in a like manner Hydrogen sulfide was successfully synthesized from its elements in a helium plasma jet

2879

Temple U. Research Inst., Philadelphia, Pa

PLASMA JET CHEMISTRY (Abstract), by C S Stokes and A V. Grosse [1965] [2]p. (Bound with its AFOSR-65-2238) (AF AFOSR-65-775) Unclassified

The reduction of tantalum pentoxide (Ta_2O_5) to metallic tantalum has been accomplished by the use of a helium plasma jet where the oxide was carried into the jet with hydrogen. The reaction $Ta_2O_5 + 5H_2 \rightarrow 2Ta + 5H_2O$ produced yields as high as 43% tantalum. The formation of tantalum carbide was studied using 2 different approaches (1) tantalum pentoxide and methane, and (2) commercial tantalum metal powder and methane. The reactions of the above 2 methods are (1) $Ta_2O_5 + 2\ CH_4 \rightarrow Ta_2C + 5H_2O + 1\ C$ and $Ta_2O_5 + 2\ CH_4 \rightarrow 2TaC + 5H_2O + C$. (2) $2Ta + CH_4 \rightarrow Ta_2C + 2H_2$ and $Ta + CH_4 \rightarrow TaC + H_2$. The first reaction produced yields of 24% TaC and 17% Ta_2C depending on the conditions, together with some metallic tantalum. The second reaction produced 72% TaC and 27% Ta_2C as maximum under several different operating conditions. The above investigations show a gas-solid reaction producing a solid as the product. It is of interest to show a gas-solid reaction producing only a gas. For an example of this type of reaction, the synthesis of H_2S from the elements was picked. The reaction $H_2 + S \rightarrow H_2S$ was carried out in a helium-hydrogen plasma jet and yielded up to 37% H_2S based on the sulfur input. The production of H_2S has been shown to be dependent on the enthalpy of the jet.

2880

Texas A. and M. U., [Dept. of Physics] College Station.

SPIN-ROTATION CONTRIBUTION TO THE FLUORINE RELAXATION IN $C_6H_5CF_3$ (Abstract), by R. H. Faulk and M. Eisner. [1965] [1]p. [AF AFOSR-63-173] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 158, Feb. 25, 1965.

The relaxation time of the fluorine nuclei in benzotrifluoride has been measured and is found to be an only slightly varying function of temperature, ranging from 3.2 sec at -20°C to 2.4 sec at +50°C. The contributions to the relaxation time from the dipole-dipole and spin-rotation interactions have been separately calculated, and the effective spin-rotation coupling constant is calculated to be 25 ± 2 kc/sec. This coupling constant has been used to calculate the paramagnetic contribution to the chemical shift of the fluorine in $C_7H_5F_3$ relative to F_2, and yields the value, 453 ppm, which is within 10% of the observed value of 493.3 ppm for the chemical shift. Part of the difference in these quantities may be attributed to the diamagnetic contributions to the shielding constants of the fluorine nuclei in $C_7H_5F_3$ and F_2.

2881

Texas A. and M. U. [Dept. of Physics] College Station.

TRANSLATIONAL CONTRIBUTIONS TO NMR RELAXATION IN BENZENE (Abstract), by R Smith and M. Eisner. [1965] [1]p. [AF AFOSR-63-173] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman. Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 157, Feb. 25, 1965.

Temperature and concentration dependence of diffusion and proton relaxation have been measured in mixtures of C_6H_6-C_6D_6. The linear dependence of $1/T_1$ on concentration observed is used to effect a model-independent separation of rotational and translational contributions to relaxation. The temperature dependence of the translational contribution differs from that of diffusion, leading to an anomalous temperature dependence. Contrary to the suggestions that this anomalous dependence is

associated with spin-rotation interactions, it is found that the deviations from the prediction in dipole-dipole relaxation are in the translational component.

2882

Texas A. and M. U. Dept. of Physics, College Station.

THE SPECTRA OF H_2O AND D_2O IN THE VACUUM ULTRAVIOLET, by S. Bell. 1965 [9]p. incl. illus. tables, refs. (AFOSR-65-2863) (AF AFOSR-63-326) AD 628413 Unclassified

Also published in Jour. Molec. Spectros., v. 16. 205-213, 1965.

Vibrational analyses are made of 2 band systems of water vapor with origins at 1240 and 1219A. The fundamental frequencies of H_2O and D_2O are determined for the excited electronic states of both systems. Franck-Condon calculations based on estimated intensities yield increases in geometrical parameters of $\delta r = 0.055$A and $2\delta\alpha = 5.2°$ for the 1240A system, and $\delta r = 0.067$A and $2\delta\alpha = 8.5°$ for the 1219A system. (Contractor's abstract)

2883

Texas A. and M. U. [Dept. of Physics] College Station.

DOUBLE-MINIMUM POTENTIAL FUNCTIONS IN EXCITED ELECTRONIC STATES OF SO_2 AND NO_2 (Abstract), by J. B. Coon and F. A. Cesani. [1965] [1]p. [AF AFOSR-63-326] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys Soc., Series II, v. 10· 157, Feb. 25, 1965.

Additional examples of double-minimum potential functions in the excited states of bent triatomic molecules are found. This extends previous work. A new vibrational analysis of the 3700-A system of SO_2 has been made. Calculated intensities of all bands involving only the symmetrical modes of vibration agree well with the observed intensities. However, 4 nontemperature-sensitive bands that cannot be accounted for by the symmetrical modes are interpreted as involving a double-minimum potential in the Q_3' coordinate. These bands are given the assignments (011^+), (021^+), (101^+), and (111^+). The last two are strong bands whose relative intensities and observed interval (1^+-0^+) of 1201 cm^{-1} are used to calculate a double-minimum potential function. The barrier height is roughly 1500 cm^{-1}. The weak bands (011^+) and (021^+) lead to a barrier height significantly lower. Similar calculations are made for the 2491-A system of NO_2. For this molecule, $(1^+-0^+) = 713$ cm^{-1} and the barrier height is approximately 800 cm^{-1}.

2884

Texas Instruments. Inc., Dallas.

DIRECT CONFIRMATION OF THE A-CENTER MODEL IN ZnS BY OBSERVATION OF HYPERFINE STRUCTURE IN EPR SPECTRA, by J. Schneider, A. Räuber and others. [1965] [3]p. incl. diagr. table. (AFOSR-65-1180) (AF 49(638)1250) AD 621297 Unclassified

Also published in Jour. Chem. Phys., v. 42· 1839-1841, Mar. 1, 1965.

Electron paramagnetic resonance (EPR) studies are made of Ga-, Br-, and I-doped ZnS. EPR spectra of the self-activated center show resolved hyperfine structure with the impurity, thereby providing direct proof that the center responsible for the blue self-activated luminescence in ZnS is an associate of a zinc vacancy with a substitutional impurity from Group III or Group VII.

2885

Texas Instruments, Inc., Dallas.

ELECTRON PARAMAGNETIC RESONANCE OF Cr^{2+} IN 4- AND 8-COORDINATED CRYSTALS (Abstract), by M. Dewit, A. R. Reinberg and others. [1965] [1]p. [AF 49(638)1250] Unclassified

Presented at meeting of the Amer. Phys Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10· 329-330, Mar. 24, 1965.

Electron paramagnetic resonance attributed to distorted isolated substitutional Cr^{2+} has been observed in 4-coordinated CdS and ZnSe, and 8-coordinated CaF_2 and CdF_2. In 4-coordination, the distortions occur along ⟨100⟩ axes, in 8-coordination along ⟨110⟩ axes. The centers are characterized by given parameters, where A is the zero-field splitting. Superhyperfine structure is observed in CdS with ~9 Cd nuclei, in the fluorides with 8 F nuclei, and in ZnSe with 4 Se nuclei. Applying stress to CdS at 1.3 K causes the centers to redistribute among the equivalent directions, strongly suggesting a distortion and not defect association.

2886

Texas Instruments, Inc , Dallas.

ELECTRON PARAMAGNETIC RESONANCE OF FLUORINE IN SINGLE-CRYSTAL BERYLLIUM OXIDE (Abstract), by A. R. Reinberg and T. L Estle [1965] [1]p [AF 49(638)1250] Unclassified

Presented at meeting of the Amer Phys Soc., New York, Jan. 27-28, 1965.

Published in Bull. Amer Phys Soc , Series II, v. 10 57, Jan. 28, 1965.

EPR spectra for irradiated fluorine-doped BeO powders above 77 °K have recently been reported. Similar spectra

in single crystals from 1.3° to 300°K have been observed. As for the powders, a large fluorine hyperfine interaction (775 G for H C) and a superhyperfine structure (shfs) due to nearest-neighbor beryllium ions are observed. At the lowest temperature and for H C, the shfs consists of 7 equally spaced lines, suggesting interaction with two beryllium nuclei (I = 3/2). Above about 30°K, it changes to a 10-line pattern with the same over-all splitting. The low-temperature spectrum is interpreted in terms of a deep donor made up of 3s and 3p functions centered on the substitutional fluorine and 2s and 2p functions centered on 2 of the nearest-neighbor basal beryllium ions. The high-temperature spectrum results when the electron hops among the 3 equivalent directions that lie in the basal plane. Line shapes predicted on the basis of the hopping model are consistent with observations in the intermediate-temperature region.

2887

Texas Instruments, Inc., Dallas.

PARAMAGNETIC RESONANCE SPECTRA OF Fe-Cu ASSOCIATES IN ZnS (Abstract), by W. C. Holton, M. Dewit and others. [1965] [1]p. [AF 49(638)1250] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 330, Mar. 24, 1965.

An EPR spectrum arising from a spin 5/2 in orthorhombic symmetry has been studied in single crystals of of cubic ZnS containing Fe and Cu. The hyperfine structure of Fe^{57}, Cu^{63}, and Cu^{65} and the angular dependence of the spectrum with respect to crystal orientation in the magnetic field lead to the model of a neutral defect in which the charged impurities Fe^{3+} and Cu^{+} are associated at 2 nearest zinc sites. The $3d^5$ configuration of Fe^{3+} in orthorhombic symmetry leads to 3 Kramer's doublets. The transitions within the lowest 2 doublets have been observed and the results at 1.3°K and 9.2 Gc sec are $g_x = 9.66$, $g_y = 1.265$, $g_z \simeq 0.3$ for the lowest doublet and $g_x = 4.06$, $g_y = 4.53$, $g_z = 4.36$ for the middle doublet. The axes are $x \simeq [331]$, $y = [110]$, $z \simeq [116]$ with the x axis rotated 3.6° away from [331] toward [111]. The main features of the spectrum can be explained with a spin Hamiltonian $= g\beta H \cdot S + E(S_x^2 - S_y^2) + DS_z^2$ with $S = 5/2$, E comparable to the microwave quantum, and $D \gg E$. The middle doublet has also been observed at 77°K in single crystals and powders and corresponds to the $g = 4.29$ lines of Fe^{3+} previously observed in glasses and biological materials. Similar centers have been observed in single crystals of ZnSe and ZnTe. This association of Fe and Cu in ZnS furnishes a possible explanation of the "killer" action of Fe on the ZnS:Cu luminescence.

2888

Texas Instruments, Inc., Dallas.

SUPERHYPERFINE STRUCTURE OF IRON-GROUP IMPURITIES IN II-VI COMPOUNDS (Abstract), by T. L. Estle and W. C. Holton. [1965] [1]p. [AF 49(638)-1250] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 57, Jan. 28, 1965.

Superhyperfine structure (shfs) of EPR spectra has been reported for several iron-group impurities in II-VI compounds. All reported observations have been explained as an interaction of the substitutional impurity with the nearest zinc or cadmium nuclei. No observations attributed to the still-nearer negative ions have been reported. The failure to observe O^{17} or S^{33} shfs may result from the low relative abundance of these isotopes. In cadmium compounds, the intense Cd^{111} and Cd^{113} shfs would make observation of the negative-ion shfs difficult. However, if ZnSe and ZnTe the Se^{77} and Te^{125} shfs should be easily observed if they are resolved. We have observed shfs in ZnSe:Cr^{+}, ZnSe:Mn^{2+}, ZnSe:Fe^{3+}, ZnFe:Cr^{+}, and ZnTe:Fe^{+} arising from Se^{77} or Te^{125}. The Cr^{+} shfs, originally attributed to Zn^{67}, and the Fe^{+} and Mn^{2+} shfs result from the two closest shells of negative ions. Only the nearest shell shfs has been observed for Fe^{3+}. No resolved Zn^{67} shfs has yet been observed in ZnSe or ZnTe. Quantitative results are reported.

2889

Texas Instruments, Inc. Science Services Div., Dallas.

BASIC RESEARCH IN CRUSTAL STUDIES, by S. J. Laster, M. M. Backus and others. Final rept. Sept. 1, 1963-Nov. 30, 1965. Dec. 31, 1965, 1v. incl. illus. diagrs. tables, refs. (AFOSR-[illegible]0577) (AF 49(638)-1244) AD 628385 Unclassified

The work falls into 4 tasks: (1) single-layer models; (2) multilayer models; (3) models with layer thickness variation; and (4) experimental studies using field data. The single-layer studies included theoretical investigation of normal and leaking modes, studies of the practical aspects of frequency-wavenumber analysis and investigation of mode separation by multichannel filte ing. Theoretical and analog model investigations for 2 layers over a half-space showed the difficulty in directly observing an intermediate velocity layer using frequencies of 0.5 cps or less. Analog model investigations of a model having a dipping M-discontinuity showed a wide range of phase velocities for ray events, as predicted. Experimental studies of field data showed the usefulness of velocity filtering as an interpretive aid. Correlation statistics for small events showed that only about 50% of the energy arriving between the first arrival and surface waves is predictable. For events at small distance

(Δ ~ 30 km), Rayleigh-mode dispersion curves were measured. These suggested low near-surface velocities extending to a depth of 1/2-km. It was found that receiving arrays in line with the shot are necessary for adequate dispersion measurements.

2890

Texas Instruments, Inc. [Science Services Div.] Dallas.

NUMERICAL EXPERIMENTS IN THE ESTIMATION OF FREQUENCY WAVENUMBER SPECTRA OF SEISMIC EVENTS USING LINEAR ARRAYS, by A. F. Linville and S. J. Laster. [1965] 36p. incl. illus. diagrs. tables. (AFOSR-67-1201) (Bound with its AFOSR-66-0577; AD 628385) (AF 49(638)1244)
AD 652973 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 56. 1337-1355, Dec. 1966.

Studies in the measurement of frequency-wavenumber spectra of transient events have been conducted using theoretical and analog model data recorded along a 21-element, inline array. Straight-forward numerical transformation, assuming space stationarity, gives good definition of the dominant (Rayleigh) mode, but little information concerning higher modes. The presence of spatial nonstationarity due primarily to cross correlation between modes complicates the fine structure of the spectral estimate. Averaging over redundant space lags is necessary to remove this. Additional difficulties arise from side lobes due to use of the finite length array. The amplitude of the side lobes can be reduced by using a space lay window. In the present case this gives indications of the higher modes, but these indications are so ill-defined as to be useless for determining dispersion. The effects of amplitude deviations between channels are also studied. (Contractor's abstract)

2891

Texas Instruments, Inc. [Science Services Div.] Dallas.

NEAR-SURFACE DISPERSION STUDIES AT TONTO FOREST SEISMOLOGICAL OBSERVATORY, by A. F. Linville and S. J. Laster. [1965] 66p. incl. illus. diagrs. tables. (AFOSR-67-2090) (Bound with its AFOSR-66-0577; AD 628385) (AF 49(638)1244)
AD 658274 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 57. 311-340, June 1967.

Four local seismic events digitally recorded on a crossed-linear array have been analyzed to evaluate the representation of wave propagation in inhomogeneous earth models in terms of "local" dispersion. The analysis techniques studies are based primarily on the correlation properties of the signals at various receivers. Frequency-wavenumber spectra are computed for the events by various methods, and a comparison of the results indicates that the best method is a combination using averaged correlations computed from prewhitened data. The utility of computing dispersion curves from an estimation of the "transfer function" has been evaluated. The studies show the necessity of recording data directly "inline" in areas of rough topography between source and array if "local" dispersion is to be measured. Multichannel prediction studies indicate that the signals are highly nonstationary in space.

2892

Texas Instruments, Inc. [Science Services Div.] Dallas.

ANALOG MODEL STUDIES OF WAVE PROPAGATION IN A CRUST WITH A DIPPING INTERFACE, by S. J. Laster and A. F. Linville. [1965] 36p. incl. illus. diagrs. tables (Bound with its AFOSR-66-0577, AD 628385) (AF 49(638)1244) Unclassified

Analogue model studies of a single layer with dipping interface upon a half-space show that the most striking prediction of ray theory is the production of a multiplicity of phase velocities for compressional refracted events, as opposed to the single phase velocity found in parallel layered models. An attempt is made to determine the true refractor velocity and dip from measured velocities associated with particular ray paths. For low frequencies the chief prediction of mode theory is a dependence of the dispersion curves on horizontal distance, as a result of their dependence on layer thickness. An attempt is made to measure the leaking mode dispersion curves for comparison with theory.

2893

Texas Instruments, Inc. [Science Services Div.] Dallas.

APPLICATION OF MULTICHANNEL FILTERING FOR THE SEPARATION OF DISPERSIVE MODES OF PROPAGATION, by S. J. Laster and A. F. Linville. [1965] [70]p. incl. illus. diagrs. (Bound with its AFOSR-66-0577, AD 628385) (AF 49(638)1244) Unclassified

Presented at Forty-sixth Annual Meeting of the Amer. Geophysical Union, Washington, D. C.

This paper discusses the results of multichannel mode separation studies using both theoretical and analog model seismograms. Unlike conventional velocity filtering, the mode separation technique makes use of the fact that for dispersive modes the phase velocity is frequency dependent. Other information, such as modal amplitude and the relation between horizontal and vertical components of motion, can be included in the filter design. In the present study 2 processors are considered. One, having 9 channels, makes use of only the frequency-velocity relationships, while a second (6 channels) also uses two component information. A description of the filter design and the results obtained from applying these filters to the data are given (Contractor's abstract)

2894

[Texas Instruments, Inc. Science Services Div., Dallas]

MULTICHANNEL PROCESSING APPLIED TO THE ANALYSIS OF REFRACTION SEISMOGRAMS RECORDED AT TONTO FOREST SEISMOLOGICAL OBSERVATORY, by T. W. Harley, R. B. Hofmann, and S. J. Laster. [1965] 58p. incl. illus. diagrs. tables. (Bound with its AFOSR-66-0577, AD 628385) (AF 49(638)1244) Unclassified

A group of experimental crustal seismograms from the Tonto Forest Seismological Observatory have been selected which show a large number of coherent, pulse-like events. These include both recordings of nuclear devices detonated in Nevada and shots recorded during the 1964 USGS calibrations program. The nuclear records have been subjected to wideband velocity filtering and the results clearly illustrate the P_n and P_g arrivals, with little indication of P^*_n. The similarity in velocity between P_n and the P_n multiples suggests that dip of the discontinuity under Tonto Forest is very small or absent. The USGS shots indicate a significant difference between the crust to the north of the array as compared to the crust south of the array. P_g is observed on all records, but P_n is observed only from shots in the north, while a lower velocity event, perhaps P^*_n, is seen from shots in the south. Well-developed surface waves are also more common from shots in the north, presumably due to greater thickness of sedimentary cover. The seismometer to seismometer predictability of a shot from the Bylas shotpoint and of a quarry blast from near the Clarkdale shotpoint are investigated. Significant pulse-shape changes across the array are observed in the raw data, and it is found that only about 50 % of the energy is predictable from one seismometer to the next. (Contractor's abstract, modified)

2895

Texas Instruments, Inc. [Science Services Div.] Dallas.

THEORETICAL INVESTIGATION OF MODAL SEISMOGRAMS FOR A LAYER OVER A HALF-SPACE, by S. J. Laster, J. G. Foreman, and A. F. Linville [1965] [26]p. incl. illus. diagrs. table. (AF 49(638)-1244) Unclassified

Presented at Thirteenth Annual Internat'l. Meeting of the Society of Exploration Geophysicists, Los Angeles, Calif., Nov. 19, 1964.

Published in Geophysics, v. 30 571-596, Aug. 1965.

The use of normal modes to represent the propagation of elastic waves at large horizontal offset is well known. By addition of the relevant leaky modes, the mode theory is shown to be useful for representation of the seismograms at shorter range. A theoretical model consisting of a 2-cm brass layer over a steel half-space is considered. Dispersion curves and excitation functions are computed for the first 4 normal modes and the first 3 PL modes. Attenuation as a function of frequency also is computed for the PL modes. A suite of seismograms is computed for the distance range 50-70 cm, showing each mode individually and their sum (the total seismogram). It is found that, for the distances used, the individual modes do not approximate transients with a definite "arrival" time. Only their sum is required to exhibit this physical behavior. In addition, at short distances, the dispersion of a single mode is not visually obvious although the dispersion curve may be recovered by use of Fourier transform methods. Determination of the dispersion curves from the total seismogram is more difficult and requires some separation of the modes, as they overlap in frequency and velocity. This work shows the preponderance of the leaky modes in the early part of the seismogram and indicates their importance in the later part of the seismogram for short horizontal offset. (Contractor's abstract)

2896

Texas Technological Coll. Dept. of Chemistry, Lubbock.

THE THERMAL DECOMPOSITION OF METAL ETHYLENEDIAMINE OXALATE COMPLEXES, by J. M Haschke and W. W. Wendlandt. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-1217) (AF AFOSR-63-23) AD 622847 Unclassified

Also published in Anal. Chim. Acta, v. 32: 386-393, 1965.

The thermal dehydration and deamination of some ethylenediamine complexes of Zn, Cd, Cu, Ni, and Co oxalate were studied by thermogravimetry, differential thermal analysis, differential scanning calorimetry, high temperature reflectance spectroscopy, and gas evolution. The tris(ethylenediamine) complexes deaminated to mono(ethylenediamine) compounds which then decomposed directly to the metal oxide. The kinetics and heats of dehydration and deamination of several of the complexes were determined.

2897

Texas Technological Coll. Dept. of Chemistry, Lubbock.

THE SOLID STATE REACTION BETWEEN TRIS(ETHYLENEDIAMINE)CHROMIUM(III) COMPLEXES AND ALKALI METAL HALIDES AND THIOCYANATES, by W. W. Wendlandt and C. H. Stembridge. [1965] [7]p. incl. diagrs. tables. (AFOSR-65-1218) [AF AFOSR-63-23] AD 622840 Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 27: 575-581, 1965

Various tris(ethylenediamine) complexes, $[Cr(en)_3]X_3$ ($X = Cl^-$, Br^-, I^-, and SCN^-), were heated with large excesses of ammonium and alkali metal halides and thiocyanates. The tris → bis deamination reaction was followed by high temperature reflectance spectroscopy and by dynamic reflectance spectroscopy from ambient to 225 C. The reaction product, in most cases, was cis-$[Cr(en)_2Y_2]X$, where Y and X are the same or different anions, depending upon the matrix material employed. In an ammonium salt matrix the ease of

anion coordination was: $F^- > SCN^- > Cl^- > Br^-$, in an alkali metal salt matrix, the order was: $SCN^- > F^- > Cl^- > Br^-$. These orders hold regardless of whether the coordinated anion is initially ionically bound in the complex or the matrix salt anion. The thermal matrix method appears to be a potentially useful technique for the preparation of bis(ethylenediamine)chromium(III) complexes.

2898

Texas Technological Coll. Dept. of Chemistry, Lubbock.

THE THERMAL DISSOCIATION OF SOME BIS AND TETRAKIS (PYRIDINE) METAL COMPLEXES, by W. W. Wendlandt and S. I. Ali. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-1650) (AF AFOSR-63-23) AD 624332 Unclassified

Also published in Zeitschr. Anorg. und Allgem. Chem., v. 337: 6-13, 1965.

The thermal dissociation of 16 pyridine complexes of the general formulas, $M(py)_4X_2$ and $M(py)_2X_2$, where M is Cu, Ni, Mn, Cd, Zn, and Co and X is SCN, Cl, Br, I and 1/2 C_2O_4, was studied by thermogravimetry and differential thermal analysis. The thermal transitions involved were mainly the depyridination reaction to lower pyridine content complexes. Such reactions as tetrakis(pyridine) → bis(pyridine) and bis(pyridine) → mono(pyridine) complexes are observed. The depyridination reactions for the complexes are discussed in detail. (Contractor's abstract)

2899

Texas Technological Coll. Dept. of Chemistry, Lubbock.

ION RADICALS. VI. PHENOXATHIIN AND PHENOXATHIIN 5-OXIDE IN SULFURIC ACID, by H. J. Shine and R. J. Small. 1965 [5]p. incl. diagrs. tables, refs. (AFOSR-65-2391) (AF AFOSR-63-23) AD 725592 Unclassified

Also published in Jour. Org. Chem., v. 30: 2140-2144, July 1965.

The reactions of phenoxathiin (I) and phenoxathiin 5-oxide (III) in acidic solutions have been studied by ultraviolet, visible, and e.s.r. spectroscopy. It has been shown that in 82, 96, and 100% sulfuric acid III is converted to the phenoxathiin cation radical (II). The conversion of III to II has been followed by changes in the absorption and e.s.r. spectra. A second cation radical (V) is also formed in the 96% sulfuric acid solutions—that of 3-hydroxyphenoxathiin. It is proposed that in acidic solution III is in equilibrium with protonated III(IV) and the phenoxathiin dication (VI); that the formation of the cation radical II occurs by loss of hydroxyl from IV, and that the hydroxyl is stored either as hydrogen peroxide or a peroxysulfuric acid; and that the reactions which eventually lead to V include, first, a hydroxylation of the aromatic ring by attack of water on either of the cations, IV or VI. A hydroxyphenoxathiin 5-oxide (VII) has been isolated from solutions of III in 96% sulfuric acid. The reactions of VII in 96% sulfuric acid have been investigated briefly. The e.s.r. spectrum of a solution of VII in 96% sulfuric acid is attributed to V. (Contractor's abstract)

2900

Texas Technological Coll. Dept. of Chemistry, Lubbock.

ION RADICALS. V PHENOTHIAZINE, PHENOTHIAZINE 5-OXIDE, AND PHENOTHIAZONE-3 IN ACID SOLUTIONS, by H. J. Shine and E. E. Mach. 1965 [10]p. incl. diagrs. tables, refs. (AFOSR-65-2392) (AF AFOSR-63-23) AD 625593 Unclassified

Also published in Jour. Org. Chem., v. 30 2130-2139, July 1965.

The reactions of phenothiazine (I), phenothiazine 5-oxide (II), and phenothiazone-3 (III) in acidic solutions have been studied by ultraviolet, visible, and e.s.r. spectroscopy. Solutions of II in 96% sulfuric acid are stable, it is proposed that they contain the protonated phenazothionium ion (VI). Similarly, solutions of III in 96% sulfuric acid are stable, and it is proposed that they contain the protonated hydroxyphenazothionium ion (XIII). Solutions of I in 96% sulfuric acid contain the phenothiazine cation radical (IV) which, in time, is further oxidized to VI. It is shown that III in 59% sulfuric acid is converted to the hydroxyphenothiazine cation radical (XI). It is also shown that in 4 aqueous sulfuric acid II is converted not only to the cation radical IV but also to XI. Mechanisms are proposed for these reactions. It is proposed that in aqueous sulfuric acid II is in equilibrium with protonated II(VIII) and with the phenazothionium ion (V) arising from dehydration of VII. (Contractor's abstract, modified)

2901

Texas Technological Coll. Dept. of Chemistry, Lubbock.

ION RADICALS. VII. THE REACTIONS OF THIANTHRENE OXIDE IN HYDROCHLORIC ACID, by H. J. Shine and C. F. Dais. 1965 [4]p. incl. diagrs. refs. (AFOSR-65-2393) (AF AFOSR-63-23) AD 625590 Unclassified

Also published in Jour. Org. Chem., v. 30 2145-2148, July 1965.

The reaction of thianthrene monoxide with concentrated hydrochloric acid gave thianthrene and 2-chlorothianthrene. The thianthrene cation radical was also formed. Chlorine was detected above the surface of the reaction solution. The same reaction in the presence of phenol gave p-chlorophenol, thianthrene, and the monohydrate of p-hydroxyphenylthianthrenylium chloride, no 2-chlorothianthrene was formed. Attempts to chlorinate thianthrene suspended in hydrochloric acid with chlorine and hypochlorous acid failed. The products were thianthrene oxides. The reductive chlorination is therefore regarded as not arising from reduction to thianthrene followed by electrophilic chlorination. Instead, nucleophilic substitution by chloride ion on the hydroxysulfonium cation is proposed. The formation of chlorine in the reductive chlorination is regarded as

coincident with, but not responsible for the formation of 2-chlorothianthrene. A nucleophilic substitution is also applied to interpreting the chlorination of thianthrene in dry chloroform. (Contractor's abstract)

2902

Texas Technological Coll. Dept. of Chemistry, Lubbock.

THERMODILATOMETRIC ANALYSIS. SOME CHEMICAL APPLICATIONS, by W. W. Wendlandt. [1965] [4]p. incl. diagrs. refs. (AFOSR-65-2394) (AF AFOSR-63-23) AD 625589 Unclassified

Also published in Anal. Chim. Acta, v. 33 98-101, 1965.

Some applications of thermodilatometric analysis to several new chemical systems are discussed. The technique may be used for the determination of solid-solid phase transitions and decomposition reactions. An inexpensive automatic recording dilatometer is described.

2903

Texas Technological Coll. Dept. of Chemistry, Lubbock.

THE THERMAL DECOMPOSITION OF METAL COMPLEXES. XVI. POTASSIUM TRIS(OXALATO)-COBALTATE (III) TRIHYDRATE, by W. W. Wendlandt and E. L. Simmons. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-64-2762) (AF AFOSR-63-23) AD 627831 Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 27: 2317-2323, 1965.

The thermal decomposition of $K_3[CO(C_2O_4)_3]\cdot 3H_2O$ in the solid-state, was studied by thermogravimetry, high temperature reflectance spectroscopy, differential thermal analysis, mass spectrometry, gas evolution analysis, and by magnetic techniques. The stoichiometry of the decomposition reaction was determined and a mechanism is proposed to explain the reaction. The ultraviolet photolysis of the compound, in the solid-state, was also determined. The photolysis and thermal decomposition reactions did not involve exactly the same products. (Contractor's abstract)

2904

Texas Technological Coll. Dept. of Chemistry, Lubbock.

THE THERMAL DECOMPOSITION OF METAL COMPLEXES. XVII. POTASSIUM TRIS(OXALATO)MANGANATE(III) TRIHYDRATE, by E. L. Simmons and W. W. Wendlandt. [1965] [5]p. incl. diagrs. (AFOSR-65-2763) (AF AFOSR-63-23) AD 627832 Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 27: 2325-2329, 1965.

The photochemical and thermal dissociation of $K_3[Mn(C_2O_4)_3]\cdot 3H_2O$ was determined. On exposure to ultraviolet radiation or heating to 85°C, the compound yields $K_2[Mn(C_2O_4)_2]$, $K_2C_2O_4$, CO_2, and H_2O. The kinetics of the photolysis reaction was determined with $k = 52.7/min$ at 25°C. The above reactions are compared with the analogous reactions of $K_3[Co(C_2O_4)_3]\cdot 3H_2O$ (see item no. 2903).

2905

Texas U. [Computation Center] Austin.

ON THE SUBDIFFERENTIABILITY OF CONVEX FUNCTIONS, by A. Brondsted and R. T. Rockafellar. [1965] [7]p. (AFOSR-66-0666) [AF AFOSR-63-467] AD 632888 Unclassified

Also published in Proc. Amer. Math. Soc., v. 16: 605-611, Aug. 1965.

Let E be a locally convex vector space and $f: E \to (-\infty, \infty]$ a convex function, $f \not\equiv \infty$. The function f is said to be subdifferentiable at x in E if there exists a continuous linear functional x^* on E such that $f(y) \geq f(x) + (y-x, x^*)$ for all y in E. (Equivalently, there exists a nonvertical supporting hyperplane at the point (x, f(x)) to the convex supergraph $\{(y, r): r \geq f(y)\}$ of f in E x R.) The set of all such x is denoted by dom ∂f, while $\{x: f(x) < \infty\}$ is denoted by dom f. By modifying a lemma due to Bishop and Phelps (Proc. Symp. Pure Math., v. 7, 27-35, 1961), the authors prove (Theorem 2) that if f is lower semi-continuous and E is a Banach space, then dom ∂f is dense in dom f and f is equal to the supremum of the continuous affine functions on E whose graphs support the supergraph of f. Stronger results of a similar nature are obtained for the convex function f^* dual to f, and some examples are given. These and related results improve theorems of J. J. Moreau (Faculté des Sciences de Montpellier, Séminaires de Mathématiques, Université de Montpellier, Montpellier, 1963). (Math. Rev. abstract)

2906

Texas U. Computation Center, Austin.

HELLY'S THEOREM AND MINIMA OF CONVEX FUNCTIONS, by R. T. Rockafellar. [1965] [17]p. incl. refs. (AFOSR-66-0669) (AF AFOSR-63-467) AD 632889 Unclassified

Also published in Duke Math. Jour., v. 32: 381-398, Sept. 1965.

This paper proves an existence theorem (which is, in effect, an extension of the classical theorem of Helly, according to which an infinite collection of compact convex sets in R^n has a nonempty intersection if every $n + 1$ of the sets have a point in common) for solutions to a very general class of constrained and unconstrained minimization problems involving convex functions on R^n. This theorem is not limited to collections of convex functions on a bounded convex set, and hence can be used both in the compact case and in the theory of convex programming, where compactness is usually too severe a restriction. The principle device used is to replace

compactness by "asymptotic regularity conditions' which restrict benavior alorg certain infinite ravs which might be present. Besides applying the existence theorem to ordinary convex nrograms, results are derived from it in the theory of inequalities and Lagrange multipliers complementary to those in Proc. Amer. Math. Soc., v. 8: 617-622, 1957. A new general version of von Neumann's minimax theorem, not requiring compactness, is also deduced.

2907

Texas U. [Computation Center] Austin.

AN ELEMENTARY PROOF OF JACKSON'S THEOREM ON MEAN-APPROXIMATION, by E. W. Cheney. [1965] [3]p. (AFOSR-66-0040) [AF AFOSR-64-467] AD 641741 Unclassified

Also published in Math. Mag., v. 38: 189-191, Sept. 1965.

An elementary proof is given of Jackson's theorem: let P be a Haar subspace of C (a, b). Then each f in C (a, b) possesses at most one best approximation-in-the-mean from P.

2908

Texas U. Dept. of Chemical Engineering, Austin.

THE PHASE EQUILIBRIA AND CRYSTAL CHEMISTRY OF THE RARE EARTH GROUP VI SYSTEMS. II. ERBIUM-TELLURIUM, by D. J. Haase, H. Steinfink, and E. J. Weiss. 1965 [3]p. incl. diagrs. tables. (AFOSR-65-1382) [AF AFOSR-62-237] AD 622647 Unclassified

Also published in Inorg. Chem., v. 4: 541-543, 1965.

In a continuation of the investigation of the binary phase diagrams of the rare earth-group VI elements, the erbium-tellurium system was developed. The phases occurring in the erbium-tellurium system are: (1) the solid solution series $ErTe$-Er_2Te_3, orthorhombic, Fddd, a = 12.096A, b = 8.553Å, c = 25.659A, the lattice constants vary throughout the solid solution series, mp 1525-1460°C, and (2) $ErTe_3$, orthorhombic, Cmc2, a = 4.31A, b = 25.45A, and c = 4.31A, peritectic at 575°C. A eutectic is observed at approximately 13 atom % tellurium and 1270°C. The influence of the ionic ratio on the stability of the structures is discussed. (Contractor's abstract, modified)

2909

Texas U. Dept. of Chemical Engineering, Austin.

THE PHASE EQUILIBRIA AND CRYSTAL CHEMISTRY OF THE RARE EARTH GROUP VI SYSTEMS. I. ERBIUM-SELENIUM, by D. J. Haase, H. Steinfink, and E. J. Weiss. 1965 [3]p. incl. diagr. tables. (AFOSR-65-1383) [AF AFOSR-62-237] AD 622648 Unclassified

Also published in Inorg. Chem., v. 4: 538-540, Apr. 1965.

The phase equilibrium relations in the binary system erbium-selenium were investigated as part of a program of research on compounds formed between rare earth and group VI elements. The phases occurring in the system are (1) ErSe, fcc, a = 5.662A, mp 1630 C, (2) the solid solution series Er_2Se_3-Er_3Se_4, orthorhombic, Fddd, a = 11.38A, b = 8.09A, c = 24.20A, mp 1400-1440°C, (3) γ-$ErSe_2$, orthorhombic, Cmma, a = 16.22A, b = 15.80A, c = 11.88A, transition to β-$ErSe_2$ at 890°C, and (4) β-$ErSe_2$, orthorhombic, Immm, a = 4.061A, b = 5.571A, c = 13.16A, peritectic at 1010°C. Two eutectics were observed at approx 3 at-% selenium and 1310°C and approx 55.5 at-% selenium and 1370°C. (Contractor's abstract, modified)

2910

Texas U. Dept. of Chemical Engineering, Austin.

THERMOELECTRIC AND ELECTRICAL MEASUREMENTS IN THE La-Te SYSTEM, by T. H. Ramsey, H. Steinfink, and E. J. Weiss. [1965] [6]p. incl. diagrs. table, refs. (AFOSR-65-1384) [AF AFOSR-62-237] AD 621261 Unclassified

Also published in Jour. Appl. Phys., v. 36: 548-553, Feb. 1965.

An evaluation of the electrical conductivity and Seebeck coefficient of the compounds in the La-Te system has indicated values of ρ from 0.1 Ω-cm to 20 x 10^3 Ω-cm. The bonding, based on earlier crystal-chemical studies and supported by this evaluation, indicates a variation from almost pure metallic in LaTe to metallic with a substantial ionic component in La_2Te_3. An evaluation of the Seebeck coefficient has further differentiated between the purely metallic and semiconducting nature of the various compounds. The evaluation was conducted on polycrystalline pressed-powders or sintered materials, and the energy-gap measurements are believed to be a measure of surface phenomena activation processes rather than an indication of true intrinsic character.

2911

Texas U. Dept. of Chemical Engineering, Austin.

THE PHASE EQUILIBRIA AND CRYSTAL CHEMISTRY OF THE RARE EARTH—GROUP VI SYSTEMS. IV LANTHANUM-TELLURIUM, by T. H. Ramsey, H. Steinfink, and E. J. Weiss. 1965 [4]p. incl. diagr. table, refs. (AFOSR-65-1925) (AF AFOSR-62-237) AD 627938 Unclassified

Also published in Inorg. Chem., v. 4: 1154-1157, Aug. 1965.

The intermediate phases occurring in the lanthanum-tellurium system are LaTe, fcc, a = 6.436A, mp 1720°C; a solid solution series La_3Te_4-La_2Te_3 which has the Th_3P_4-type structure, the cubic lattice constant for the 2 end members are a = 9.628 and 9.619A,

respectively, and they melt at 1515° and 1485°C; a solid solution series $LaTe_{2.0}$-$LaTe_{1.7}$, the tetragonal unit cell for $LaTe_{2.0}$ has dimensions a = 4.506A, c = 9.13A and melts incongruently at 1450°C, and finally the phase $LaTe_3$, orthorhombic, with a pseudotetragonal cell a=b=4.41A, c = 26.1A, which melts incongruently at 835°C. These compounds were produced and investigated as part of a study on a particular stoichiometry Ln_yX_z, where Ln represented a series of rare earth elements and X was an element of group VI of the periodic table. (Contractor's abstract, modified)

2912

Texas U. Dept. of Chemical Engineering, Austin.

THERMOELECTRIC AND ELECTRICAL MEASUREMENTS IN THE Er-Se SYSTEM, by D. J. Haase and H. Steinfink. [1965] [6]p. incl. diagrs. refs. (AFOSR-66-0272) (AF AFOSR-62-237) AD 629173 Unclassified

Also published in Jour. Appl. Phys., v. 36 3490-3495, Nov. 1965.

An evaluation of the electrical conductivity and thermoelectric power for compounds in the Er-Se system shows that they are degenerate semiconductors. In order to explain the observations in the intrinsic region the number of carriers must be considered as a function of the concentration of the erbium atoms in the compound. Two temperature-dependent processes take place, the activation of impurity levels and the high-temperature activation of localized energy levels associated with the number of erbium atoms present. (Contractor's abstract)

2913

Texas U. Dept. of Chemical Engineering, Austin.

THE PHASE EQUILIBRIA AND CRYSTAL CHEMISTRY OF THE RARE EARTH GROUP VI SYSTEMS. III. NEODYMIUM-TELLURIUM, by W. Lin, H. Steinfink, and E. J. Weiss. 1965 [5]p. incl. diagrs tables, refs. (AFOSR-65-2539) [AF AFOSR-65-806] AD 628455 Unclassified

Also published in Inorg. Chem., v. 4. 877-881, June 1965.

The phases occurring in the neodymium-tellurium system are: NdTe, fcc, a = 6.278A, mp 2040°C; A solid solution series Nd_3Te_4–Nd_2Te_3 which has a high temperature, Th_3P_4-type structure, whose cubic lattice constant varies from 9.434 to 9.424A, respectively; a phase transition occurs at 1000° to an orthorhombic modification, Pbnm, a = 11.94A, b = 12.24A, c = 4.407A, Nd_3Te_4 melts at 1680° and Nd_2Te_3 melts at 1620°C. A solid solution series exists over the composition range $NdTe_{1.74}$ to $NdTe_2$, the tetragonal unit cell for $NdTe_2$ has dimensions a = 4.419A, c = 9.021A, space group $P4/nmm$, and the compound melts at 1270°C. The phase Nd_2Te_5 is orthorhombic, pseudotetragonal, a = b = 4.380A, c = 44.0A, space group Bmmb, and melts incongruently at 910°C. $NdTe_3$ is orthorhombic, Bmmb, and the dimensions of the pseudotetragonal cell are a = 4.350A, c = 25.8A. The compound melts incongruently at 830°C. (Contractor's abstract)

2914

Texas U. Dept. of Chemistry, Austin.

OXIDATION OF AROMATIC COMPOUNDS BY ELECTRON TRANSFER, by M. J. S. Dewar. Final rept. Oct. 1, 1961-Dec 31, 1965, 12p. incl. diagrs. tables. (AFOSR-66-0714) (AF AFOSR-64-528) AD 632268 Unclassified

The work carried out under this project has been concerned with a general survey of reactions involving the oxidation of aromatic compounds by electron transfer, the oxidizing agents being derivatives of metals in high valence states. An extensive qualitative survey suggested that many aromatic compounds undergo oxidation by such reagents, by mechanisms in which the key step is indeed an electron transfer. A number of these reactions lead to products different from those given by other oxidizing agents and it seems likely that procedures of this kind may prove to be of value in synthesis. Several of these reactions have been studied in detail, their kinetics seem to indicate very clearly that the first step is indeed the production of an ion-radical by abstraction of an electron from the aromatic substrate. Apart from possible practical applications, reactions of this kind may help to throw light on the nature of the electron transfer process. As a byproduct of this work, a number of metal coordination polymers which serve as electron transfer agents and possible semiconductors were prepared and found to show semiconduction properties. (Contractor's abstract, modified)

2915

Texas U. Dept. of Chemistry, Austin.

THE PHOTOCHEMISTRY OF KETENE. THE METHYLENE RADICAL, by S.-y. Ho, I. Unger, and W. A. Noyes, Jr. Mar. 20, 1965, 5p. (AFOSR-67-0637) (AF AFOSR-65-778) AD 648665 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 2297-2298, May 20, 1965.

Recent evidence indicates that both singlet and triplet methylenes are produced when ketene is irradiated at 3200A. This behavior is intermediate between that of 2700A and 3700A. The primary photochemical process shifts from the production of singlet methylene at the shorter wave lengths to the production of singlet and triplet methylenes at longer wave lengths.

2916

Texas U. Dept. of Electrical Engineering, Austin.

SOME EFFECTS OF THE MARTIAN ATMOSPHERE ON ELECTROMAGNETIC RADIATION FROM MARINER IV, by H. D. Cubley and A. H. LaGrone. [1965] [2]p. incl. diagrs. table. (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office, and Office of Naval Research] under AF AFOSR-65-765) Unclassified

Published in IEEE Trans. Antennas and Propagation, v. AP-13: 983-986, Nov. 1965.

The 2300-mc/s channel provides a means of directly investigating the atmosphere of Mars. This method requires that the trajectory of the spacecraft be such that the spacecraft pass through or very near the occultation zone of Mars. The assumed trajectory of the Mariner IV spacecraft is, in fact, such a trajectory. The path of this trajectory is to be a gradual curve that passes within 8750 km of Mars at closest approach. This trajectory then continues past Mars and enters the occultation zone approx 20,000 km behind the planet. The radio signal from the spacecraft will experience diffraction effects due to the planet and any atmosphere that may exist. The Martian ionoshphere was considered and found to have negligible effects. Reflections of the 2300-mc/s signal from the Martian surface and effects due to polarization were also neglected. Based on these assumptions and the two proposed atmospheres of Mars, the field strength observed on Earth due to the occultation of Mariner IV by Mars was solved analytically. Results of this computation are shown for both the upper and lower extremes of the Martian atmosphere and for the case of an airless Mars. It should be noted that the Martian atmosphere bends the rays in such a manner that the edge of the planet appears to be displaced. This causes the familiar Fresnel diffraction pattern to be shifted a significant distance below the geometrical edge of the planet, the amount of shift being a function of the index of refraction profile of the assumed atmosphere. The second effect is a divergence effect that reduces the strength of the signal. These effects can be used to help deduce the composition of the atmosphere of Mars or of other planets as probes similar to Mariner IV are sent to explore outer space.

2917

Texas U. [Dept. of Engineering Mechanics] Austin.

A NEW METHOD FOR THE PREPARATION OF SUCCESSIVE REPLICAS FOR USE IN ELECTRON MICROSCOPY, by M. A. Wilkov. [Jan. 1965] 15p. (AFOSR-65-1071) (AF AFOSR-64-560) AD 616340 Unclassified

A new method is described for making negative carbon platinum replicas of a selected area. Location of the area to be replicated is accomplished with a micrometer mechanical stage on an optical microscope. A collodion matrix is then formed on a replica grid and the entire assembly is dry stripped with tape. This process does not disturb the specimen surface, even after many replications, which enables the method to be used in the study of the changes in surface structure during mechanical deformation. Several examples of the process are given by the micrographs of the surface damage of aluminum single crystals and 4340 steel specimens subjected to a fatigue stress.

2918

Texas U. [Dept. of Engineering Mechanics] Austin.

MECHANISM OF FATIGUE IN METALLIC CRYSTALS, by M. A. Wilkov and R. Shield. [Jan. 1965] [39]p. (AF AFOSR-64-560) AD 616341 Unclassified

The origin and progressive growth of cracks on the surface of (112) and (123) oriented single crystals of aluminum subjected to cyclic deformation at 77°K and 300°K were observed with a JEM 150 electron microscope. A negative carbon platinum replication technique was used which allowed a successive examination of the surface changes in a selected area on the surface of a specimen at given intervals of load application. Changes in crystallographic orientation or temperature did not appear to have any effect on the basic mode of crack formation, only the density and rate of crack growth. A tentative explanation of the mechanism of fatigue is proposed based on this work and other previous investigations.

2919

Texas U. [Dept. of Physics] Austin.

SOME EXCITED STATES OF THE HELIUM MOLECULE. I. THE LOWEST $^1\Sigma_{u+}$ AND $^3\Sigma_g{}^+$ STATES AND THE FIRST EXCITED $^1\Sigma_g{}^+$ STATES, by J. C. Browne. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-65-2802) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-215 and National Aeronautics and Space Administration) AD 644862 Unclassified

Also published in Jour. Chem. Phys., v. 42: 2826-2829, Apr. 15, 1965.

Some theoretical potential curves for the $^1\Sigma_u{}^+$ (2s, ^{1}So), $^1\Sigma_g{}^+$ (2s, ^{1}So), $^1\Sigma_g{}^+$ (2po, ^{1}So), $^3\Sigma_g{}^+$ (2s, $^3S_1$), and $^3\Sigma_g{}^+$ (2po, $^3S_1$) states of the helium molecule are reported. It has been found that by using a two-term wavefunction with a mixed basis of Slater-type orbitals and elliptic orbitals, the $^1\Sigma_u{}^+$ potential curve has a maximum of about 0.174 ev at R = 5.0ao and a minimum at R = 2.07ao with a rationalized binding energy, E_B = E (calc. R_e) - E (calc., R = ∞) of E_B = 1.9 ev. In agreement with the recent suggestions of R. S. Mulliken, the lowest bound state of the helium molecule of symmetry $^3\Sigma_g{}^+$ and the first bound excited state of symmetry $^1\Sigma_g{}^+$ arise from the interactions He(^{1}So, $1s^2$) + He(^{3}So, 1s2s), $^3\Sigma_g{}^+$ (2s, $^3S_1$), and He(^{1}So, $1s^2$) + He(^{1}So, 1s2s), $^1\Sigma_g{}^+$ (2s, ^{1}So), respectively. The $^1\Sigma_g{}^+$ (2s, ^{1}So) and $^3\Sigma_g{}^+$ (2s, $^3S_1$) states were also found

to have maxima in their computed potential curves. The computed maxima are: $^1\Sigma_g^+$ - 0.7 ev, R = 4.5ao. $^3\Sigma_g^+$ - 0.8 ev, R = 3.75ao.

2920

Texas U. [Dept. of Physics] Austin.

SOME EXCITED STATES OF He_2^{++}: MIXED BASIS-SET CALCULATIONS, by J. C. Browne. [1965] [4]p. incl. diagrs. tables, refs. (AFOSR-66-2797) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-215 and National Aeronautics and Space Administration) AD 644861 Unclassified

Also published in Jour. Chem. Phys., v. 42 1428-1431, Feb. 15, 1965.

Quantum-mechanical calculations have been made which yield approximate potential curves for the lowest $^1\Sigma_u^+$, $^3\Sigma_u^+$, and $^3\Sigma_g^+$ states and the first excited $^1\Sigma_g^+$ state of He_2^{++}. The $^3\Sigma_g^+$ and $^3\Sigma_u^+$ states exhibit no minima in their computed potential curves, but the $^1\Sigma_u^+$ and $(^1\Sigma_g^+)^*$ states are bound. Rigorous lower bounds of 0.29 and 0.24 ev are found for D_e of $^1\Sigma_u^+$ and $(^1\Sigma_g^+)^*$, respectively. The probable errors in these D_e are less than 0.1 ev.

2921

[Texas U. Dept. of Physics, Austin]

QUANTUM MECHANICAL POTENTIAL ENERGY CURVES FOR THE $^1\pi_u$ AND $^3\pi_u$ STATES OF THE He_2 AND THE $^1\pi_g$ AND $^3\pi_g$ STATES OF H_2, by J. C. Browne. [1965] [3]p. incl diagrs. tables, refs. (AFOSR-66-2801) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-215 and National Aeronautics and Space Administration) AD 646122 Unclassified

Also published in Phys. Rev., v. 138 A9-A11, Apr. 5, 1965.

There are reported here calculated potential curves for the $^1\pi_u$ and $^3\pi_u$ states of He_2 and for the $^1\pi_g$ and $^3\pi_g$ states of H_2. In each case the potential curve shows a pronounced maximum before descending into a bound state. These maxima are shown to result from interactions of potential curves originating from a normal atom and a second quantum excited atom with curves which originate in a normal atom plus a third quantum excited atom. The computed maxima are $^1\pi_u(He_2)$ 0.5 ev, R 3.5A_0, $^3\pi_u(He_2)$ - 0.6 ev, R 3.0A_0, $^1\pi_g(H_2)$ 0.43 ev, R 4.0A_0, $^3\pi_g(H_2)$ 0.57 ev, R 4.0A_0. These maxima were predicted earlier by Mulliken on semitheoretical grounds. The wave function used for each calculation was a three term function of the generalized valence-bond type. All used Slater-type orbitals for a basis set.

2922

Texas U. [Dept. of Physics] Austin.

A REMARKABLE PROPERTY OF PLANE WAVES IN GENERAL RELATIVITY, by R. Penrose. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-1015) (AF AFOSR-63-454) AD 618617 Unclassified

Also published in Rev. Modern Phys., v. 37: 215-220, Jan. 1965.

The complete general-relativistic plane wave space-times are examined in relation to the focusing effect they exert on null cones. The following remarkable property is then obtained. No spacelike hypersurface exists in the space-time which is adequate for the global specification of Cauchy data. As a consequence, it is not possible to imbed a plane wave globally in any hyperbolic normal pseudo-Euclidean space. (Contractor's abstract)

2923

Texas U. [Dept. of Physics] Austin.

ZERO REST-MASS FIELDS INCLUDING GRAVITATION: ASYMPTOTIC BEHAVIOR, by R. Penrose. [1965] [45]p. incl. diagrs. refs. (AFOSR-65-1016) (Sponsored jointly by Aeronautical Research Laboratory, and Air Force Office of Scientific Research under AF AFOSR-63-454) AD 619637 Unclassified

Also published in Proc. Roy. Soc. (London), v. 284A. 159-203, Feb. 23, 1965.

A zero rest-mass field of arbitrary spin s determines, at each event in space-time, a set of 2s principal null directions which are related to the radiative behavior of the field. These directions exhibit the characteristic peeling-off of Sachs. Part I of this paper is concerned with an independent derivation of this property for fields of any spin in special relativity by means of an inductive spinor argument which depends ultimately on the appropriate asymptotic behavior of a simple Hertz-type complex scalar potential. Part II describes a general technique for discussing asymptotic properties of fields in curved space-times, which is applicable to all asymptotically de Sitter space times. The technique affords a covariant approach to the definition of radiation fields in general relativity. Further applications of the technique are also indicated

2924

Texas U., Dept. of Physics, Austin.

10 EXACT GRAVITIONALLY-CONSERVED QUANTITIES, by E. T. Newman and R. Penrose. [1965] [3]p. incl. refs. (In cooperation with Pittsburgh U. and Birkbeck College, London) (AF AFOSR-63-454) AD 641682 Unclassified

Published in Phys. Rev. Ltrs., v 15: 231-233, Aug. 9, 1965.

The paper is concerned with a discussion of 10 exact gravitationally conserved quantities. In ordinary electromagnetic theory, total charge remains exactly constant for any system surrounded by source-free space. This is a direct consequence of Maxwell's equations for the free-space region, whereas dipole and higher moments can be carried away by electromagnetic radiation. In gravitational theory, analogs of this conserved charge would at first sight appear to be mass, momentum, and angular momentum, as they are indeed exactly conserved in the linearized Einstein theory for regions surrounded by empty space. However, in the full nonlinear theory mass and momentum can be changed by gravitational radiation. It has therefore been commonly believed that there are no exactly conserved gravitational quantities in general relativity. But it is found out quite unexpectedly, that there is a set of 10 geometrical quantities, defined for asymptotically flat space-times, which have a quadrupole structure and whose values cannot be altered in any way by gravitational radiation.

2925

Texas U. Dept. of Physics, Austin.

THE PHYSICS OF METASTABLE SYSTEMS, by W. W. Robertson. Final rept. Feb. 1, 1964-Jan 31, 1965, 10p. (AFOSR-65-1052) (AF AFOSR-64-273) AD 619100 Unclassified

The work of this project has been concerned with the mechanisms whereby long-lived metastable states of the rare gases are formed and decay. Work completed included a method of titration for He^+, He_2^+, $He(2^3S)$ whereby the concentrations were proportional to the intensity of selectively excited spectra of admixed gases in a burner arrangement where the fuel consisted of the excited species in a helium stream. Absorption and emission spectra in a pulsed discharge with time resolved techniques enabled the $He(2^1S)$, $He(2^3S)$, He^-, He_2^+ and He_2^* concentrations to be monitored. Abstracts of papers that have been published in journals and references to the journal articles are given.

2926

Texas U. Dept. of Physics, Austin.

ATOMIC AND MOLECULAR EMISSION IN THE NEGATIVE GLOW OF A HELIUM DISCHARGE, by W. B. Hurt and W. W. Robertson. Aug. 1964 [5]p. incl. diagrs (AFOSR-65-1429) (AF AFOSR-64-273) AD 622627 Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Also published in Jour. Chem. Phys., v. 42 556-560, Jan. 15, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10 192, Feb. 25, 1965.

The spatial distribution of helium atomic and molecular radiation has been investigated in the negative glow of a dc discharge. The atomic radiation peaks sharply at the cathode edge of the negative glow, the molecular radiation less sharply at a greater distance from the cathode. Microwave quenching indicates that most of the atomic and all of the molecular radiation results from electron-ion recombination processes. The decrease in atomic radiation reflects the decrease in atomic ion concentration which is controlled primarily by diffusion away from the cathode and by three-body conversion to molecular ions. The molecular ions are lost by diffusion and by collisional-radiative recombination to the neutral molecule, with collisional processes predominating. The negative glow can be characterized as a plasma steady in time but with a 1-dimensional spatial decay away from the cathode. (Contractor's abstract)

2927

Texas U. Dept. of Physics, Austin.

TEMPERATURE DEPENDENCE OF THE RATE OF CONVERSION OF He^+ INTO He_2^+, by F. E. Niles and W. W. Robertson. [1965] [4]p. incl. diagrs refs. (AFOSR-65-2506) (AF AFOSR-64-273) AD 628447 Unclassified

Also published in Jour. Chem. Phys., v. 42 3277-3280, May 1, 1965.

Measurement of the decay of atomic and molecular emissions in the early helium afterglow for temperatures from 77° to 449°K and pressures from 3.76 to 9.93 Torr, together with the known value for the ambipolar diffusion of He^+, have shown that the temperature dependence of the conversion frequency for the reaction $He^+ + 2He \rightarrow He_2^+ + He$ goes as T^{-1}. When the conversion frequency is expressed as βp^2, the quantity βT^3 is independent of temperature and pressure with an average value of 2.97×10^9 K^3 $sec^{-1} \cdot Torr^{-2}$. When the conversion frequency is expressed as $k_R[He]^2$, the quantity $k_R T$ is independent of temperature and pressure with an average value of 3.19×10^{-29} $K \cdot cm^6$ $atoms^{-2}$ sec^{-1}. Theoretical considerations confirm that the temperature dependence of the conversion frequency goes as T^{-1}. (Contractor's abstract)

2928

Texas U. Dept. of Physics, Austin.

COLLISIONAL RADIATIVE RECOMBINATION OF He_2^+ INTO DISSOCIATIVE STATES, by W. W. Robertson. [1965] [7]p. incl. diagrs. (AFOSR-65-2507) (AF AFOSR 64-273) AD 628448 Unclassified

Also published in Jour. Chem. Phys., v 42 2064-2070, Mar. 15, 1965.

Spectroscopic investigation of a flowing helium afterglow revealed the presence of strong 10 830-A atomic helium emission corresponding to the $2^3P \rightarrow 2^3S$ transition, which could be quenched by the application of a weak microwave field to the afterglow. An examination of the axial variation and pressure dependence of the

concentration of 2^3P atoms established that it resulted primarily from the ion-electron recombination of He_2^+, rather than He^+, at the higher pressures examined. An extension of the theory of collisional-radiative recombination of molecular ions to include dissociating states is postulated to explain these observations. (Contractor's abstract)

2929

Texas U. [Dept. of Physics] Austin.

DISSOCIATION OBSERVED IN A HELIUM AFTERGLOW (Abstract), by C. B. Collins, Jr. and W. W. Robertson. [1965] [1]p. [AF AFOSR-64-273] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 186, Feb. 25, 1965.

Spectroscopic observations conducted on a flowing helium afterglow at an electron density of the order of 2×10^{12} cm^3 and a temperature of 1800 K revealed the emission of the 10 830-A ($2^3P - 2^3S$) helium line at a higher intensity than could be expected as the result of cascading from the higher levels populated by the collisional-radiative recombination of He^+. The emission was found to be quenched upon application of a weak microwave field to the afterglow. An examination of the pressure dependence of the 10 830-A intensity and ion concentrations established that the anomalously high 2^3P population was the result of the ion-electron recombination of He_2^+. The axial variation of the intensity revealed a dependence that was first order on He_2^+ concentration and first order on electron density. Mechanisms are discussed.

2930

Texas U. [Dept. of Physics] Austin.

MEASUREMENT OF THE TEMPERATURE DEPENDENCE OF THE RATE OF CONVERSION OF He^+ INTO He_2^+ IN THE HELIUM AFTERGLOW (Abstract), by F. E. Niles, C. B. Collins, Jr., and W. W. Robertson. [1965] [1]p. [AF AFOSR-64-273] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 186, Feb. 25, 1965.

Previous work yielded the rate of conversion at room temperature of He^+ into He_2^+ by the reaction $He^+ + 2He \rightarrow He_2^+ + He$ from the observed decay of the atomic and molecular emission in the early helium afterglow and the known rate of diffusion of He^+. Similar measurements have been carried out over the temperature range 77 –443 K. These measurements show that the temperature dependence of the rate of conversion β^2 goes as T^{-1} and, consequently, that the temperature dependence of β goes as T^{-3}. These results seem to be consistent with the theoretical predictions of the temperature dependence of termolecular reactions.

2931

Texas U. [Dept. of Physics] Austin.

OBSERVATIONS ON THE VISIBLE AND NEAR-INFRARED ARGON CONTINUUM (Abstract), by J. F. Prince and W. W. Robertson. [1965] [1]p. [AF AFOSR-64-273] Unclassified

Presented at meeting of the Amer. Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965

Published in Bull. Amer. Phys. Soc., Series II, v. 10 170-171, Feb. 25, 1965.

Spectroscopic observations have been made on the visible and nearinfrared (3500-8000 A) argon continuum. For these studies, the continuum was examined in the positive column of a dc, high-purity argon discharge. The continuum intensity has been measured as a function of wavelength at constant currents for pressures of about 5-50 Torr and at constant pressures for currents of 2.5-10 mA. Ratios of relative line intensity to continuum intensity as a function of pressure and discharge current is also reported. The heavily structured argon continuum, which was observed in the present experiments, is compared to the results of previous workers with allowance made for the many differences in experimental conditions. The present results are examined under the current theory that the primary sources for the visible and infrared argon continuum are free-free and free-bound transitions in the argon plasma.

2932

Texas U. Dept. of Physics, Austin.

SPECTROSCOPIC INVESTIGATION OF THE HELIUM-NEON MOLECULE, by W. R. Henderson, F. A. Matsen, and W. W. Robertson. [1965] [6]p. incl. diagrs. refs. (AF AFOSR-64-273) Unclassified

Presented at meeting of the Amer Phys. Soc., Oklahoma U., Norman, Feb. 25-27, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10 186, Feb. 25, 1965.

Published in Jour. Chem Phys., v. 43 1290-1295, Aug. 15, 1965.

When a discharge is excited in a helium-neon mixture a band spectrum appears that is absent in the spectra of the separate gases. This spectrum has been attributed to the HeNe molecule. Although investigated here under fairly high resolution, the spectrum was not completely analyzed However, substitution of ^3He for ^4He resulted in isotopic shifts in agreement with those calculated for the rotational structure of a diatomic HeNe molecule. Investigation of the spatial distribution of intensity of the atomic and molecular radiation in the

cathode region of a dc discharge in a helium-neon mixture and of its behavior under a superimposed microwave field yielded an indication of the origin of the molecular spectrum. The molecular ion $HeNe^+$ is evidently formed by the reaction $He^+ + Ne + X \cdot HeNe^+ + X$ and then recombines partially into bound states. The molecular radiation observed is thus attributed to transitions between weakly bound states of the neutral molecule HeNe populated from above by electron-ion recombination. (Contractor's abstract)

2933

[Texas U. Dept. of Physics, Austin]

ROTATING FLUID MASSES IN GENERAL RELATIVITY, by R. H. Boyer. [1965] [4]p. (AFOSR-66-1412) (AF AFOSR-64-454) AD 641681 Unclassified

Also published in Proc. Cambridge Philos. Soc., v. 61: 527-530, 1965.

Some properties of the gravitational field of an isolated, axially symmetric, uniformly rotating mass of perfect fluid in a steady state according to the general theory of relativity are derived. Several exact models describing rotating fluids are known in Newtonian mechanics, the Maclaurin and Jacobi ellipsoids being perhaps the most interesting. In general relativity, no such exact solution is known in its entirety, although Kerr has exhibited a certain vacuum solution possessing features that one might expect of a space-time exterior to some rotating body. Having Kerr's solution in mind, the question of whether a perfect fluid interior can be matched to any given exterior field is considered. The main results exhibit the class of all possible fluid boundaries, given the exterior field, and some relations between the pressure, density, 4-velocity, and interior metric tensor.

2934

Texas U. [Dept. of Physics] Austin.

GRAVITATIONAL COLLAPSE IN A RELATIVISTIC POLYTROPIC GAS (Abstract), by R. W. Lindquist. [1965] [1]p. (Sponsored jointly by Aerospace Research Laboratories, Air Force Office of Scientific Research under [AF AFOSR-64-454, and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 48, Jan. 27, 1965.

An exact solution of the relativistic equations for spherically symmetric collapse for a perfect fluid that satisfies a polytropic equation of state with $\gamma > 2$, is presented. The solution obtained describes a fluid of infinite extent in which the density falls off as r^{-}, it is thus not directly applicable to a collapsing star with a finite boundary. Nevertheless, the dynamical features of the collapse are qualitatively similar to those observed in numerical solutions for more realistic models if a certain dimensionless ratio GM_0/c^2R_0 (M_0 and R_0 being two parameters of the solution with dimensions of mass and distance, respectively) is greater than unity, each spherical element of fluid collapses to a minimum radius and then expands, while if $GM_0/c^2R_0 \cdot 1$ the solution contracts indefinitely, much like the $p = 0$ case of Oppenheimer-Snyder. Behavior of light rays and the nature of the Schwarzschild surface for this solution are discussed.

2935

Texas U. Dept. of Physics, Austin.

SOME USES OF HYPERBOLIC VELOCITY SPACE, by L. H Boyer. [1965] [7]p. incl. diagrs. refs. (Sponsored jointly by Aeronautical Research Laboratories, and Air Force Office of Scientific Research under AF AFOSR-64-454) Unclassified

Published in Amer. Jour. Phys., v. 33: 910-916, Nov. 1965.

This paper deals with the definition and properties of the velocity space of special or general relativity. The metric naturally induced by the enveloping space-time is that of a space of constant negative curvature which is referred to here as a 3-dimensional Lobachevsky space. The purpose is to show how this notion can simplify or reinterpret ideas of relativistic kinematics. Supplementing the more familiar applications, 3 others are given here which make essential use of the curvature, namely to the derivations of aberration, Thomas precession, and the forms of relativistic collision invariants. (Contractor's abstract)

2936

Texas U. Dept. of Physics, Austin.

CONVERSION OF ATOMIC IONS TO MOLECULAR IONS FOR THE NOBLE GASES, by F. E. Niles and W W. Robertson. [1965] [2]p. incl. tables. (AF AFOSR-65-273) Unclassified

Published in Jour Chem. Phys., v 43: 1076-1078, Aug. 1, 1965.

The reaction rate k_r for $X^+ + 2X \cdot X_2^+ + X$, where X represents a noble gas was calculated. Expressed as $k_r T$] K-cm^6 atom^{-2} sec^{-1} ($\times 10^{29}$)], the values are He 3.07, Ne 0.43, Ar 2.06, Kr 1.33, and Xe 1 22 The conversion frequency of the atomic ion to molecular ion, ρ (sec^{-1} torr^{-2}), is He 190, Ne 15, Ar 7., Kr 46, and Xe 42

2937

Texas U. [Dept. of Physics] Austin

RELATIVISTIC ASTROPHYSICS A REPORT ON THE SECOND TEXAS SYMPOSIUM, by I. Robinson, A Schild, and E. L. Schucking. [1965] [8]p incl illus diagr. table. (AFOSR-65-2771) [AF AFOSR-65-725] AD 629842 Unclassified

The second symposium continued the discussion of quasistellar sources and reported on the progress made in the preceding year. Half of the symposium was devoted to the new maps of the sky, to x-ray, gamma-ray, and cosmic-ray astronomy, to the search for cosmic neutrinos and to the possible large-scale implications of the breakdown of CP-invariance. The next sessions were devoted to the exploration of the skies through the observation of relativistic particles and high-energy radiation. The symposium concluded with a seminar on gravitational collapse.

2938

Texas U. [Dept. of Psychology] Austin.

ATTRACTION AS A LINEAR FUNCTION OF PROPORTION OF POSITIVE REINFORCEMENTS, by D. Byrne and D. Nelson. [1965] [5]p. incl. diagrs. tables, refs. (AF AFOSR-63-261) Unclassified

Published in Jour. Personality and Social Psychol., v. 1, 659-663, June 1965.

In various investigations of the effects of the similarity of a stranger's attitude on attraction toward him, the proportion of similar attitudes has not been distinguished from the number of similar attitudes. In a 4 x 3 factorial design, 4 levels of proportion and 3 levels of number were employed. Each of 168 Ss was asked to read an attitude scale purportedly filled out by an anonymous stranger and to evaluate him on a number of variables including attraction toward him. As hypothesized, analysis of variance indicated that attraction was significantly ($p < .001$) affected only by proportion. Utilizing these and other data for a total of 790 Ss, the functional relationship between proportion of similar attitudes and attraction was found to be a linear one. The conceptualization of attitude similarity as constituting positive reinforcement was strengthened by the finding of a linear relationship in McDonald's data between proportion of high creativity ratings given to 192 Ss and their attraction toward the rater. (Contractor's abstract)

2939

Texas U. [Dept. of Psychology] Austin.

MAGNITUDE OF POSITIVE AND NEGATIVE REINFORCEMENTS AS A DETERMINANT OF ATTRACTION, by D. Byrne and R. Rhamey. [1965] [6]p. incl. diagr. tables, refs. (AF AFOSR-64-261) Unclassified

Published in Jour. Personality and Social Psychol., v. 2, 884-889, Dec. 1965

It was hypothesized that positive and negative reinforcements concerning personal attributes are of greater magnitude and hence exert a greater effect on attraction than reinforcements involving attitude and similarity-dissimilarity with respect to impersonal topics. In a 4 x 3 factorial design, 4 levels of attitude similarity (1.00, .67, .33, and .00) and 3 types of evaluation conditions (positive, negative, and control) were employed. Each of 180 Ss was asked to read an attitude scale purportedly filled out by an anoymous stranger and to evaluate him on a number of variables, including attraction. In the positive and negative conditions, Ss also received information concerning the stranger's evaluation of them. Analysis of variance indicated that attraction was significantly influenced by both independent variables ($p < .01$). The effect of the personal evaluation items was found to be greater than that of the impersonal items ($p < .001$). It was suggested that the equation for the law of attraction should include a weighting factor to designate the effect of reinforcement magnitude. (Contractor's abstract)

2940

Texas U. Labs. for Electronics and Related Science Research, Austin.

TEXAS BIANNUAL OF ELECTRONICS RESEARCH, by A. A. Dougal. Oct. 1, 1964-Mar. 31, 1965. May 15, 1965, 145p. incl. illus. diagrs. tables, refs. (Rept. no. 1) (AFOSR-65-1715) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 620913 Unclassified

This semiannual report is a compilation of brief summaries of research topics in the areas of biomedical electronics, information sciences, physical, quantum, and plasma electronics; and space, atmospheric, and earth radio sciences. Definitive results recently obtained, research in progress, and future plans are presented. A bibliography of meeting papers, publications, and reports by faculty and staff is included.

2941

Texas U. Labs. for Electronics and Related Science Research, Austin.

AN ADAPTIVE PATTERN CLASSIFICATION SYSTEM, by J. D. Patterson and B. F. Womack. Aug. 16, 1965, 87p. incl. diagrs. table, refs. (Technical rept. no. 9) (AFOSR-66-0514) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766; and Texas Instruments, Inc.) AD 489328 Unclassified

Also published in IEEE Trans. Systems Sci. Cybernetics, v. SSC-2, 62-67, Aug., 1965.

Adaptive pattern classification is the assignment of patterns to classes based on typical patterns or training samples which are used by the system to determine the decision procedure. An adaptive pattern classification system is described that does not require a prior knowledge of the probability density of the pattern vectors for each class, as do the classical statistical techniques. Any decision rule that consists of a discriminant function that is a linear combination of arbitrary scalar functions of the pattern vector may be chosen on the basis of a priori knowledge about the classes, engineering judgement, and economic considerations. The system

optimizes itself by adjustment of the decision parameters according to a weighted mean-square-error performance criterion, using a multivariable search technique. (Contractor's abstract, modified)

2942

Texas U., Labs. for Electronics and Related Science Research, Austin.

A STUDY OF NONLINEAR NEGATIVE CAPACITANCE, by C. L. Wright, Jr. and C. O. Harbourt. Aug. 16, 1965, 110p. incl. refs. (Technical rept. no. 5) (AFOSR-66-0516) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 489325 Unclassified

An analytical study is made of the behavior of a certain class of RLC networks which contain a theoretical nonlinear negative capacitance along with various possible combinations of constant parasitic elements that are certain to be present in any physical realization of this type of capacitance. The theoretical capacitor is defined in terms of its charge-voltage relationship. This study is directed toward an evaluation of the usefulness of a nonlinear negative capacitance in a network to accomplish either amplification or oscillation or switching. In order for a network to be useful as an amplifier, its small-signal model must be stable. Therefore, for this part of the study the nonlinear capacitor is represented by a linear, negative capacitance. Singular point-analysis discloses that any of the defined networks may have 2 stable equilibrium points. This is the basic criterion for a bistable device, so the conclusion is that nonlinear capacitance, like nonlinear resistance, can be used effectively to construct a switching circuit. It is proven by phase plane methods that none of the second order systems can support a sustained oscillation. A nonlinear negative capacitance has been realized by means of a transistor negative impedance converter circuit. (Contractor's abstract, modified)

2943

Texas U. Labs. for Electronics and Related Science Research, Austin.

TRAINING-ADJUSTED DECISION SYSTEMS FOR PROCESS CONTROL, by C. L. Kettler and B. F. Womack. Aug. 16, 1965, 122p. incl. refs. (Technical rept. no. 11) (AFOSR-66-0518) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 489330 Unclassified

Methods for the control of discrete product manufacturing processes are developed. Emphasis is placed on the end requirement for economical physical implementation of an adaptive controller with analog circuits. The proposed process controller is capable of making pass/reject decisions (classifications) at each of the manufacturing stations comprising the process for each discrete unit of manufacture. The process controller is capable of estimating control parameters at future manufacturing stations, or at final test. The minimum average risk classification operator is explored where the required conditional probability densities are multivariate symmetric. A search procedure is developed for determining the quadratic classification operator, which does not require exact prior knowledge of the (possibly different) functional forms of the conditional probability densities. The individual search algorithms are shown to converge for finite training sets. The derived value will converge in probability with increasing size of the sample set to the required value, which is shown to be median-unbiased. Implementation of the translation, rotation, and dilation algorithms with analog circuits is considered as an approach to realizing the slave classification operator. (Contractor's abstract, modified)

2944

Texas U., Labs. for Electronics and Related Science Research, Austin.

THE USE OF ELECTROMAGNETIC RADIATION IN THE STUDY OF PLANETARY ATMOSPHERES AND SURFACES, by H. D. Cubley and A. H. LaGrone. Aug. 15, 1965, 100p. incl. refs. (Technical rept. no. 7) (AFOSR-66-0519) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 489327 Unclassified

Various techniques employing electromagnetic radiation are presently being used in the study of planetary atmospheres and surfaces. These techniques generally make use of either thermal radiation from the planet itself or solar radiation that is reflected and scattered from the surface and atmosphere of the planet. Such measurements are made from earth-based observation points. Radio astronomy uses radio techniques to measure such quantities as the surface temperature of the planet and the polarization of any nonthermal radiation from the planet. Radar astronomy uses both pulsed and continuous wave radar. These radars can be used to study the surface roughness of a planet, its rotation rate, and the density of its ionosphere. Infrared astronomy is used in the study of the emission and absorption bands in a planetary atmosphere. Visual astronomy enables the observation of surface features such as clouds and haze. Close-up observations are possible when a spaceprobe such as Mariner 4 is occulted by a planet and its atmosphere. (Contractor's abstract, modified)

2945

Texas U Labs. for Electronics and Related Science Research, Austin.

THE CATHODE RAY STORAGE TUBE IN ADAPTIVE DECISION SYSTEMS, by J. H. Seamon and B. F. Womack Aug. 10, 1965, 107p. incl. refs. (Technical rept. no. 10) (AFOSR-66-0531) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 489329 Unclassified

The Cathode Ray Storage Tube (Scan-Converter Tube) is investigated for storage of an array of adaptive weights for an Adaptive Decision System. The advantages and limitations of the Tube are investigated. The significant advantage of the Tube is the low cost per weight. This low cost is due to the large number of weights available, and to electron beam scanning which eliminates the need for connectors to individual weights. The most serious limitation of the Tube is the lack of a greater dynamic range. The realization of an Adaptive Decision System using the Tube is proposed. The logical structure is that of a 2-layer machine with the first layer adaptive. Both layers use threshold logic. The interconnections of the layers are such that the System consists of parallel committees, and can be trained by the Committee Training Procedure. The fixed increment training rule is used. The logic used is (1,0), which offers advantages in adapting the weights in the Tube. A Modified Training Procedure is proposed to reduce the complexity and cost of the System.

2946

Texas U. Labs. for Electronics and Related Science Research, Austin.

THEORY AND MEASUREMENT OF DIELECTRIC PROPERTIES OF ALKALI HALIDE CRYSTALS AT CRYOGENIC TEMPERATURES, by D. Grisson and W. H. Hartwig. Aug. 16, 1965, 90p. incl. refs. (Technical rept. no. 6) (AFOSR-66-0532) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 483326 Unclassified

The Born expression, $E \sim r + \beta/r^n$, for the energy of interaction between 2 ions is used to derive a new expression for the ionic polarizability of the alkali halides. The new expression for the ionic polarizability, based upon dielectric constant measurements, gives values of the repulsive exponent n, in the Born energy relation, which agree well with values obtained from compressibility studies. The dielectric losses in a perfect crystal are examined in detail. It is assumed that there are 3 mechanisms which may contribute to the losses in a perfect crystal: radiation damping, quantum absorption, and collision broadening. Calculations show the losses due to radiation and quantum effects to be too small to measure. A new theory of collision broadening, as applied to dielectric losses, is offered. The thermal energy of the crystal lattice produces an rms ion displacement from the equilibrium position. Experimental dielectric loss measurements in the VHF-UHF range show the actual losses to be much larger than those calculated for perfect crystals. The observed losses in NaCl and KCl are shown to be of the same nature as Debye relaxation, which are associated with crystal defects. For NaCl, a loss peak near 300 mc/sec has an activation energy of .0011 ev and has a fractional defect density of approximately 5×10^{-10}. (Contractor's abstract, modified)

2947

Texas U. Labs. for Electronics and Related Science Research, Austin.

KERR CELL PHOTOGRAPHY OF A DYNAMICAL DEUTERIUM PLASMA PRODUCED IN A 30 KILOJOULE THETA PINCH, by H. N. Roberts, R. F. Gribble, and A. A. Dougal. Jan. 15, 1965, 60p. incl. refs. (Technical rept. no. 3) (AFOSR-66-0534) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 800738 Unclassified

A 0.1 μs Kerr cell shutter was employed in a photographic investigation of the space and time history of the luminous ring characteristic of the plasma current sheath in a high temperature, pure, dense, deuterium plasma formed in the "theta pinch" geometry. Only one photograph could be taken per discharge. Repeatability is found to be a reasonable assumption. Generation of the plasma is accomplished in a 4 stage process. A method is proposed for obtaining rough estimations of relative electron densities from a photographically recorded light intensities. The effect that different bias field intensities have on the beginning of the initial inward sweep of the luminosity is correlated with simple theory providing an indication that the current sheath and luminous ring are coincident during the initial inward sweep. Snowplow model energy calculations performed with the slope of the initial inward sweep from position vs time plots indicate ion energies from 40 to 100 ev agreeing with 10% to computer calculations based on the theoretical considerations employed by the Hain-Roberts code. The noted dependence of the initial minimum radial position on reverse bias field is "trapped" by the current sheath. A comparison of theoretical and experimental position vs time plots indicates that the leading edge of the observed luminosity is essentially the position of maximum particle density during the initial inward sweep. (Contractor's abstract, modified)

2948

Texas U. Labs. for Electronics and Related Science Research, Austin.

TEXAS BIANNUAL OF ELECTRONICS RESEARCH, by A. A. Dougal. Final rept. Apr. 1, 1965-Sept. 30, 1965. Nov. 15, 1965, 168p. incl. illus. diagrs. table, refs. (Rept. no. 2) (AFOSR-66-0612) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 479817 Unclassified

This second biannual report is a compilation of summaries of research topics in the areas of biomedical electronics, information sciences: physical, quantum, and plasma electronics, and space, atmospheric, and earth radio sciences. Definitive results recently obtained, research in progress, and future plans are presented. A bibliography of meeting papers, publications, and reports by faculty and staff is included.

2949

Texas U. Labs. for Electronics and Related Science Research, Austin.

MICROWAVE EMISSION FROM BULK n-TYPE INDIUM ARSENIDE, by D. K. Ferry and A. A. Dougal. [1965] [2]p. incl. diagrs. (AFOSR-66-1061) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 643321 Unclassified

Also published in Appl. Phys. Ltrs., v. 7: 318-319, Dec. 15, 1965.

The observation of microwave emission from n-type indium arsenide in the presence of applied electric and magnetic fields at liquid nitrogen temperatures is reported. Radiation is observed when the electric field (E) exceeds a threshold value which is dependent on the magnetic field (B). The threshold E is observed to be 135 v/cm at 8.5 kg; the emission is observed for B as low as 5 kg.

2950

Texas U. [Labs. for Electronics and Related Science Research] Austin.

CONTINUOUS MICROWAVE EMISSION FROM INDIUM ANTIMONIDE, by D. K. Ferry, R. W. Young, and A. A. Dougal. [1965] [1]p. incl. diagrs. (AFOSR-67-0818) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-65-766) AD 650027 Unclassified

Also published in Jour. Appl. Phys., v. 36: 3684-3685, Nov. 1965.

Observation is made of the continuous microwave emission from InSb with dc electric and magnetic fields applied. This continuous operation was obtained at 77°K with the magnetic field oriented perpendicular to the electric field. The threshold electric and magnetic fields were observed to be 6 v/cm and 3000 G, respectively. Several attempts were made to obtain continuous emission with the magnetic field oriented parallel to the electric field. However, the increased current in this mode again led to thermal problems and no emission was observed. The threshold in electric field for continuous emission is similar to that for pulsed emission. This occurrence of continuous emission must be considered in proposed theories of the effect. The low electric field required is insufficient to cause impact ionization, and rules out avalanche breakdown and pinch effects as the basis. This, coupled with the continuous emission observation, points toward a more fundamental process as the basis of the microwave emission.

2951

Texas U. [Labs. for Electronics and Related Science Research] Austin.

A 16-FOOT DIAMETER MILLIMETER WAVELENGTH ANTENNA SYSTEM, ITS CHARACTERISTICS AND ITS APPLICATIONS, by C. W. Tolbert, A. W. Straiton, and L. C. Krause. Aug. 1964, 8p. incl. illus. diagrs. table. (AFOSR-66-1052) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-66-766], National Aeronautics and Space Administration, and National Science Foundation) AD 643214 Unclassified

Also published in IEEE Trans. Antennas and Propagation, v. AP-13: 225-229, Mar. 1965.

This paper describes the characteristics of the 16-ft diam millimeter wavelength antenna system at the Electrical Engineering Research Laboratory, University of Texas, Austin. Aperture efficiencies of the antenna at the frequencies of 35, 70 and 94 Gc are 59%, 55% and 52%, respectively, corresponding to gain and beamwidths of 62.5 dB and 0.118° at 35 Gc/s, of 68.5 dB and of 70.9 dB and 0.048° at 94 Gc/s. First sidelobes and other sidelobes over the 35- to 94-Gc/s frequency interval are -18 dB and -25, respectively. The 70-Gc/s radiation temperatures of Jupiter and the earth's moon have been measured. The brightness temperature of Jupiter was found to be 112 ± 22°K and the maximum brightness temperature contour of the moon was 270°K. Relatively higher emission temperatures were observed from the maria and the craters of Copernicus and Tycho than from surrounding lunar areas.

2952

Texas U. Labs. for Electronics and Related Science Research, Austin.

INVESTIGATION OF TAU A AND SGR A MILLIMETER WAVELENGTH RADIATION, by C. W. Tolbert and A. W. Straiton. [1965] [4]p. incl. illus. diagr. tables, refs. (AFOSR-66-1053) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [AF AFOSR-66-766]) AD 643213 Unclassified

Also published in Astron. Jour., v. 70: 177-180, Mar. 1965.

The techniques of investigating the position and flux density of 35 and 70 Gc Tau A radiation and 35 and 94 Gc Sgr A radiation are described. Tau A (35 Gc) and Sgr A (35 Gc) flux densities were 420 ± 60 x 10^{-26} cps^{-1} and 290 ± 100 x 10^{-26} W m^{-2} cps^{-1}, respectively. The flux density of Tau A (70 Gc) interpreted from an antenna temperature signal to noise ratio of approximately 2 to 1 was 790 ± 50 x 10^{-26} W m^{-2} cps^{-1}. Observations at 94 Gc of Sgr A, having a calculated antenna temperature standard deviation of 0.2°C, revealed no source of radiation at the central position of Sgr A (35 Gc). The 35 Gc position of Tau A and Sgr A coincided, within the limits of the measuring accuracy ± 3^s R.A. and ± 1' Dec., with lower frequency source positions. (Contractor's abstract)

2953

Texas U. [Labs. for Electronic and Related Science Research] Austin.

FIELD EQUATIONS IN CYLINDRICAL COORDINATES FOR GYROELECTRIC MEDIA WITH SOURCES, by R. K. Likushi. [1965] [2]p. (AFOSR-66-1054) [AF AFOSR-66-766] AD 643215 Unclassified

Also published in IEEE Trans. Microwave Theory and Techniques, v. MTT-13. 881-882, Nov. 1965.

Transverse field equations are developed for gyroelectric media with sources. These equations are developed from first principles for materials characterized by a tensorial relative permittivity of the form

$$\bar{\bar{K}} = \begin{bmatrix} K_{11} & jK_{12} & 0 \\ -jK_{12} & K_{11} & 0 \\ 0 & 0 & K_{33} \end{bmatrix}$$

By making a transformation from a gyroelectric medium to a gyromagnetic medium the equations reduce to those obtained by Rosenbaum and Coleman, "Cerenkov Radiation in Anisotropic Ferrites", IEEE Trans. Microwave Theory and Tech., v. MTT-11: 302-311, Oct. 1963.

2954

Texas U. Labs. for Electronics and Related Science Research, Austin.

MILLIMETRE WAVE-LENGTH SPECTRA OF THE CRAB AND ORION NEBULAE, by C. W. Tolbert. [1965] [4]p. incl. refs. (AFOSR-66-1055) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and National Science Foundation under AF AFOSR-66-.06, and National Aeronautics and Space Administration) AD 643015 Unclassified

Also published in Nature, v. 206: 1304-1307, June 25. 1965.

Measurements of 35, 70, and 94 Gc radiation from the crab and orion nebulae were conducted during the period December 1964-February 1965 to establish more accurately and over a wider frequency interval the nebulae's millimeter spectral index. Measurements to determine the 35 and 94 Gc flux densities of the Orion Nebula were also made during the same time period. The observing period was selected to permit optical confirmation of the millimeter telescope pointing at reasonably early night hours. This period also coincided with the season of minimum atmospheric water vapor density the principal atmospheric obscurant of 35 and 94 Gc radiation.

2955

Texas U. Labs. for Electronics and Related Science Research, Austin.

TEMPERATURE DEPENDENCE OF R. F. RESIDUAL LOSSES IN SUPERCONDUCTORS, by C. R. Haden and W. H. Hartwig. [1965] [2]p. incl. diagr. (AFOSR-66-1057) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [AF AFOSR-66-766] and National Science Foundation) AD 642999 Unclassified

Also published in Phys. Ltrs., v. 17: 106-107, July 1, 1965.

A theoretical model, and an experimental verification of it, is developed to describe the residual r.f. losses in superconductors. This temperature dependent loss is shown to be due to flux-trapping of the r.f. magnetic field. It occurs in both type I and type II materials and can be accounted for by a simple model for trapping centers in the surface.

2956

Texas U. Labs. for Electronics and Related Science Research, Austin.

MAGNETOTELLURIC MICROPULSATIONS AT WIDELY SEPARATED STATIONS, by A. S. Orange and F. X. Bostick. [1965] [7]p. incl. diagrs. table. (AFOSR-66-1069) (Sponsored jointly by Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under [AF AFOSR-66-766]) AD 642952 Unclassified

Also published in Jour. Geophys. Research, v. 70: 1407-1413, Mar. 15, 1965.

Magnetotelluric micropulsations were recorded simultaneously at Texas, Puerto Rico, and Trinidad, West Indies, during October 1962. Analysis of several data samples yielded information concerning the power spectrums of micropulsation activity and the coherency of signals recorded at the 3 locations. No frequency variation with latitude or longitude was observed. No significant diurnal frequency variation was noted, although a wide change in peak frequency was seen from day to day. The coherency analysis indicated that the signals at the 3 locations were consistently very similar and at times were nearly identical. (Contractor's abstract)

2957

Texas U. Labs. for Electronics and Related Science Research, Austin.

IMPULSE RESPONSE OF THE MAGNETOSPHERIC COLUMN, by C. F. Prince, Jr., F. X. Bostick, and H. W. Smith. [1965] [8]p. incl. diagrs. (AFOSR-66-1071) (Sponsored jointly by Air Force Office of Scientific

Research, Army Research Office (Durham), and Office of Naval Research under [AF AFOSR-66-766])
AD 643216 Unclassified

Also published in Jour. Geophys Research, v. 70, 4901-4908, Oct. 1, 1965

The transmission characteristics of a plane stratified model of the earth's magnetospheric to plane hydromagnetic waves incident at the uppermost layer interface have been computed. The computations, performed as a function of the angular frequency of the wave, are used to obtain the ratio of the amplitude of the tangential magnetic fields in the specified incident waves to the magnetic field amplitudes computed at the layer interface representing the earth's surface. This steady-state transfer function is then Fourier-transformed to obtain simulated time records of the magnetic field at the earth's surface excited by impulsive inputs at the top of the magnetospheric column. Models representing both daytime and nighttime atmospheres during conditions of sunspot minimum are considered. The simulated time records are compared with experimental recording of the geomagnetic field obtained by other investigators. (Contractor's abstract)

2958

Texas U., Labs. for Electronics and Related Science Research, Austin.

SYNTHESIS OF A LINEAR TIME-VARIABLE PARAMETER CONTROL SYSTEM, by B. F. Womack. [1965] [19]p. incl. illus. diagrs. table. (AFOSR-66-1073) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-66-766] and Southern Fellowship Foundation) AD 643016 Unclassified

Presented at Southwest Inst. of Electrical and Electronic Engineers Conference, Apr. 22-24, 1964.

Also published in Internat'l. Jour. Control, v. 1, 55-73, Jan. 1965.

The modified adjoint system has been utilized by other researchers in the analysis of time-varying parameter (TVP) systems whose input signal is a stationary random variable corrupted with noise (Laning and Battin 1956). The modified adjoint system will be developed in this paper as a synthesis tool for final-value systems. The system error is to be a minimum at time t T. The technique is applicable to systems which can be represented by ordinary linear differential equations with deterministic functions as coefficients. The modified adjoint system is advantageous since it yields the optimum system, in a mean-square sense, and provides a set of integral equations which makes compensation an easier task than is possible with the original system (Womack 1963). An experimental system and a random signal generator were constructed to test the synthesis procedure. The performance of the experimental system incorporating conventional compensation is compared with the performance of the system including a compensator designed by using the modified adjoint system. Results indicate the latter system to be superior in a mean-square sense. (Contractor's abstract)

2959

Texas U. Labs. for Electronics and Related Science Research, Austin.

BREAKDOWN MINIMA DUE TO ELECTRON-IMPACT IONIZATION IN SUPER-HIGH PRESSURE GASES IRRADIATED BY A FOCUSED GIANT-PULSE LASER, by D. H. Gill and A. A. Dougal. [1965] [3]p. incl. diagrs. (AFOSR-67-0762) (Sponsored jointly by [Air Force Office of Scientific Research, Army Research Office (Durham), and Office of Naval Research under AF AFOSR-66-766] and National Science Foundation) AD 649602 Unclassified

Also published in Phys. Rev. Ltrs., v. 15, 845-847, Nov. 29, 1965.

Minima in the curves of threshold electric field vs pressure for ionization of superhigh-pressure helium, argon, and nitrogen using a focused giant-pulse ruby laser are reported. These minima are characteristic of electron impact ionization. Definitive experimental data are presented which are indicative of electron impact ionization where the heating of electrons occurs through energy transfer from the light wave to the electrons undergoing collisions with neutrals. The presence, pressure, and sharpness of these minima are predicted by a simple electron-impact ionization theory, and these predictions agree with the experimental data presented here.

2960

Texas U. Medical Branch. Dept. of Pharmacology, Galveston.

THE EFFECTS OF GANGLIONIC BLOCKADE UPON THE PRESSOR RESPONSE ELICITED BY ELEVATION OF THE CEREBRAL SPINAL FLUID PRESSURE (Abstract), by J. G. Hilton and M. Steinberg. [1965] [1]p. (AFOSR-66-1468) (AF AFOSR-63-391) AD 641527 Unclassified

Also published in Proc. Internat'l. Union of Physiological Sciences, Twenty-third Internat'l. Cong., Tokyo (Japan) (Sept. 1-9, 1965), Amsterdam, Excerpta Medica Foundation, v. 1 478, 1965.

The sensitivity of the ganglia to stimulation by the cholinergic agents neostigmine and pilocarpine after blocking drugs has led to a study of the effects of ganglionic blocking drugs upon a variety of vasomotor reflexes. This report concerns the effects of the reflex vasopressor response elicited by elevation of the cerebral spinal fluid pressure. Dogs were anesthetized with sodium pentobarbital and the arterial pressure was recorded from the brachial and femoral arteries, the venous pressure was recorded from the femoral vein. Alterations in vasomotor tone were measured using a modification of the major vessel occlusion technique of Bartelstone. Cerebral spinal fluid pressure was

elevated via a needle placed directly into the cisterna magna. Vasomotor tone and blood pressure were measured in the absence and presence of an elevated cerebral spinal fluid pressure during the control period and after the intravenous injection of 1 mg/kg of the ganglionic blocking drug chlorisondamine chloride. The results of this study showed that chlorisondamine chloride did not completely block either the alteration in vasomotor tone or the alteration in blood pressure produced by elevation of cerebral spinal fluid pressure. This alteration was blocked by the production of total spinal anesthesia or by the administration of small doses of atropine or similar parasympatholytic agents.

2961

Texas U. Medical Branch. Dept. of Pharmacology, Galveston.

CAROTID SINUS OCCLUSION RESPONSE IN THE PRESENCE OF CHLORISONDAMINE AND ATROPINE (Abstract), by M. Steinberg and J. G. Hilton. [1965] [1]p. (AFOSR-66-1470) (AF AFOSR-65-391) AD 641064 Unclassified

Also published in Texas Rept. Biol. Med., v. 23: 667, 1965.

Classical ganglionic blocking agents such as chlorisondamine (1 mg/kg) fail to block completely the pressor response of carotid sinus occlusion in dogs. The pressor response is obliterated by the injection of 1 mg/kg of atropine after the chlorisondamine (Ecolid) has been given. Systemic blood pressure is lowered when chlorisondamine is injected and further reduced after the administration of the atropine. Piperocaine hydrochloride, 1.5% (20 cc introthecally) given after the 2 above mentioned agents significantly lowered the post blockade blood pressure. A major vessel occlusion was performed caudal to the renal arteries (Hilton modification of Bartelstone, Circ. Res., v. 8: 1059, 1960). Blood pressure was monitored from the femoral artery, brachial artery and femoral vein, using a Statham Transducer and a Grass Polygraph. Results indicate that there is a component of the ganglia which is "muscarinic" in response, which agrees with recent publications. This report is a part of a study of vasopressor reflexes under the influence of autonomic agents.

2962

Thiokol Chemical Corp. Reaction Motors Div., Denville, N. J.

RESEARCH STUDY OF LIGHT EMISSION CAUSED BY PRESSURE FLUCTUATIONS IN ROCKET ENGINES, by B. Hornstein. Final rept. Jan. 1-Dec. 31, 1964, May 1965, 66p. incl. illus. diagrs. tables, refs. (Rept. no. RMD 5516-F) (AFOSR-65-1208) (AF 49-(638)1279) AD 622524 Unclassified

Simultaneous high frequency measurements of light emission and pressure were made in an oscillating premixed methane-air rocket engine in order to gain knowledge concerning important pressure-combustion interactions. With transverse oscillations, no corresponding emission fluctuations were observed, but longitudinal pressure oscillations were always found to be accompanied by emission fluctuations of the same frequency. Visible spectra were photographically recorded and showed similarity to previous laboratory spectra of flames as a function of pressure. These spectra and the high frequency photomultiplier data are interpreted to show that the CH and OH emission fluctuations are indicative of pressure response in the early chain-branching phase of reaction.

2963

Thiokol Chemical Corp. Reaction Motors Div., Denville, N. J.

AFOSR COMBINED CONTRACTORS MEETING ON COMBUSTION DYNAMICS RESEARCH: ABSTRACTS [Patrick Air Force Base, Fla.] (June 1-4, 1965) [1965] 71p. (AFOSR-65-0590) [AF 49(638)1505] AD 623186 Unclassified

Abstracts are presented of papers presented at the meeting in various fields of combustion dynamics, including supersonic combustion, steady-state rocket combustion, jet mixing, liquid rockets, plasmas, light emission and thermal radiation, shock initiation, liquid rocket injectors, and resonant combustion. Special emphasis is placed on combustion instability and solid propellants.

2964

[Thompson Ramo Wooldridge, Inc., Canoga Park, Calif.]

COMPUTER PROCESSING AND CULTURAL DATA: PROBLEMS OF METHOD, by P. L. Garvin. [1965] [20]p. incl. diagrs. refs. (AFOSR-65-2263) (AF 49-(638)1128) AD 625069 Unclassified

Also published in The Use of Computers in Anthropology, ed. by D. Hymes. London, The Hague, Mouton and Co., 1965, p. 120-139.

The paper considers some crucial aspects of problems connected with the processing of cultural data on computing equipment. Questions arise which are more closely related to the characteristics of computer applications than to the nature of the problems that are to be studied. One set of questions concerns the use of the computer as a tool for information processing, and more particularly, with the input and output problems that it raises. (1) what type of information is required to make the use of the equipment possible, i.e., what is needed to make a problem computable? (2) what type of information can be expected as the result of computer use? Limited experience exists on the use of computers for the study of culture, and these questions can at present only be considered in the abstract and in the most general terms. A variety of possibilities are examined and relevant questions are posed for future research.

2965

Thompson Ramo Wooldridge, Inc., Canoga Park, Calif.

LINGUISTIC AND ENGINEERING ASPECTS OF AUTOMATIC SPEECH RECOGNITION, by P. L. Garvin and S. Bertram. [1965] [3]p. (AFOSR-66-0416) (AF 49(638)1128) AD 632108 Unclassified

Also published in Phonetica, v. 13: 37-39, 1965.

This brief note comments on 3 problem areas associated with automatic speech recognition: (1) distortions occurring in the acoustic environment under ordinary circumstances; (2) dependence of recognition on context; and (3) selection of a form of analysis that yields parameters most nearly invariant to characteristics independent of message recognition.

2966

Thompson Ramo Wooldridge, Inc., Canoga Park, Calif.

SOME COMMENTS ON ALGORITHM AND GRAMMAR IN THE AUTOMATIC PARSING OF NATURAL LANGUAGES, by P. L. Garvin. [1965] 7p. (AFOSR-65-1386) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1516 and Rome Air Development Center) AD 621159 Unclassified

Presented at Internat'l. Conf. on Computational Linguistics, May 19-21, 1965, New York.

The repeated assertion regarding the efficiency of a simple parsing algorithm combinable with a variety of different grammars written in the form of appropriate tables of rules is examined. The question is raised of the increasing complexity of the tables when more than the most elementary natural-language conditions are included, as well as the question of the ordering of the rules within such nonelementary tables. It is concluded that the structuring of the parsing program as an executive routine with appropriate subroutines is a satisfactory separation of grammar and algorithm.

2967

Thompson Ramo Wooldridge, Inc. Space Technol. Labs., Redondo Beach, Calif.

GENERATION AND DIAGNOSIS OF SYNTHESIZED PLASMA STREAMS, by J. M. Sellen, Jr., W. Bernstein, and R. F. Kemp. [1965] [7]p. incl. diagrs. refs. (AFOSR-65-1807) (AF 49(638)886) AD 625992 Unclassified

Also published in Rev. Scient. Instr., v. 36: 316-322, Mar. 1965.

A contact-ionization source is described which generates a cesium ion stream characterized by a high degree of order in the ion motion. Electrons are added to form a quiescent, collisionless plasma stream. Diagnostic instruments are described for demonstrating the properties of the plasma streams. Ion densities range from 5×10^7 to 1×10^{11} ions/cm^3 in the source region, at accelerating voltages from 100 v to a few thousand volts, depending on the experimental application. Conical expansion of the beam reduces the densities in downstream regions. Electron temperatures in the beams range downward from the ~ 2500 °K emissive wire temperature. Means are described for increasing electron temperatures to several times this value, with resultant increase in beam divergence. (Contractor's abstract)

2968

Thompson Ramo Wooldridge, Inc. Space Technol. Labs., Redondo Beach, Calif.

PROPERTIES OF ACCELERATED PLASMAS (Abstract), by C. L. Dailey. [1965] [1]p. (Bound with AFOSR-65-1266; AD 622527) (AF 49(638)1210) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

An inductive pulsed plasma accelerator has been operated with sufficient pre-ionization to produce a diamagnetic discharge on the first half-cycle. The accelerator circuit is well coupled to the plasma for a few tenths of a μ-second while the plasma current builds up in a thin layer close to the accelerator coil. It then propagates at a nearly constant velocity producing complete ionization and accelerating the plasma to a velocity comparable to the current layer velocity. The propagating current layer possesses an initial sharp front in which occur the maximum values of the axial electric field, the plasma current density and the slope of the radial magnetic field. This front is followed by a layer of ion current in the region of the shoulder of the magnetic field disturbance. Upon passage of the current layer, the ions execute a half-cycle gyration and are ejected axially from the region of influence of the accelerator coil. The ion current corresponds to the azimuthal component of this velocity; the time required for this acceleration determines the scale of the current layer.

2969

Thompson Ramo Wooldridge, Inc. Space Technol. Labs., Redondo Beach, Calif.

RESEARCH ON INTERACTION OF PLASMA STREAMS WITH MAGNETIC FIELDS (Abstract), by J. M. Sellen, Jr., W. Bernstein, and R. F. Kemp. [1965] [1]p. (Bound with AFOSR-65-1266; AD 622527) (AF 49(638)-1538) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

The interaction of a collisionless Cs^+ plasma stream with a transverse dipole-like magnetic field has been examined. It was noted that the plasma was unstable whenever the plasma stream penetrated or traversed a magnetic field in excess of some critical value. This instability was manifested by both high frequency

(10-100 mc) and low frequency (100 kc) oscillations. More recent studies have related to the low frequency oscillations. At least two modes of this oscillation have been observed. A second area of study is the generation of dense, slowly moving plasma streams. These plasmas are to be utilized in the examination of streaming instabilities between this directed ion flow and a thermal plasma. A third area of study is the oscillation in the virtual source region of dense, unneutralized ion streams. This unipolar flow region duplicates that portion of the Chapman-Ferraro interaction in which the ion stream is reflected. While the Chapman-Ferraro description of this reflection is of a steady-state, non-time-varying potential structure, the actual behavior is oscillatory with a characteristic period of the order of the total ion time-of-flight in the sheath region.

2970

Toronto U. Inst. for Aerospace Studies (Canada).

RAREFIED GAS DYNAMICS: PROCEEDINGS OF THE FOURTH INTERNATIONAL SYMPOSIUM, Toronto U. (Canada), July 14-17, 1964, ed. by J. H. de Leeuw. New York, Academic Press, 1965 [714]p. incl. illus. diagrs. tables, refs. (Advances in Applied Mechanics Suppl. no. 3) (Sponsored jointly by Air Force Office of Scientific Research, National Aeronautics and Space Administration, and Office of Naval Research) Unclassified

From the scope of topics covered by the papers and abstracts presented during the meeting and the number of participants, a clear indication of the interest and active research in the area of rarefied gas dynamics was evident. The areas covered were: transition flow, experimental techniques and apparatus, surface interactions, kinetic theory, molecular beams, internal flow, and rarefied plasmas and shock structure.

2971

Toronto U. Inst. for Aerospace Studies (Canada).

ON THE LATERAL INSTABILITIES OF AIRCRAFT DUE TO PARAMETRIC EXCITATION, by M. Masak. Jan. 1965 [65]p. incl. illus. diagrs. table, refs. (UTIAS technical note no. 86) (AFOSR-65-0625) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-222 and National Research Council) AD 457979 Unclassified

Lateral instabilities of aircraft due to parametric excitation are studied. A theoretical discussion involving asymptotic approximations to the state transition matrix and a Liapunov stability analysis are presented first. This is followed by an analogue computer study to observe the actual phenomenon. Both high-aspect-ratio swept-wing and slender delta-wing jet transports are considered. (Contractor's abstract)

2972

Toronto U. Inst. for Aerospace Studies (Canada).

OPERATING BOUNDARIES FOR STEADY HYPERSONIC FLIGHT ON A MINOR CIRCLE, by A. M. Drummond. [1965] 8p. incl. diagrs. refs. (AFOSR-65-2345) (AF AFOSR-64-222) AD 629043 Unclassified

Also published in Canad. Aeronaut. and Space Jour., v. 11: 1-8, Jan. 1965.

An analysis is presented of steady flight at constant altitude on minor-circle paths about a spherical, non-rotating earth. Calculations determining the altitude-speed domain available for flight are made and the limitations imposed on the domain by lift, thrust and temperature bounds are shown. The principal conclusion is that minor-circle flight is possible at speeds up to and slightly beyond circular speed at an average altitude of 160,000 ft. The performance is mainly thrust limited, though increased allowable skin temperatures would result in an increase in performance. The highest possible value of the quantity C_L S/W is desirable to achieve a high operating altitude. (Contractor's abstract)

2973

Toronto U. Inst. for Aerospace Studies (Canada).

SPIN DECAY OF A CLASS OF SATELLITES CAUSED BY SOLAR RADIATION, by B. Etkin and P. C. Hughes. July 1965 [51]p. incl. illus. diagrs. table. (UTIAS rept. no. 107) (AFOSR-66-0725) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-222 and Defence Research Telecommunications Establishment) AD 631934 Unclassified

A study is presented of the interaction with the solar radiation field of a spinning satellite having long flexible rods. The dynamics of thermal bending of the rods is analyzed, including the effect of vehicle rotation, and the shape, amplitude and phase are calculated. The radiation pressure on the periodically bent rods produces a net average despin torque that depends critically on the phase lag of the thermal bending. The theory is compared with flight data from the Alouette I and S48 satellites, and the agreement indicates that the mechanism studied is the primary cause of despin of these vehicles.

2974

Toronto U. Inst. for Aerospace Studies (Canada).

THE DESIGN OF A FACILITY FOR THE MEASUREMENT OF HUMAN PILOT DYNAMICS, by L. Reid. June 1965, 68p. (UTIAS technical note no. 95) (AF AFOSR-64-222) AD 627570 Unclassified

The report describes the modification of the UTIAS CF-100 flight simulator and the development of a data analysis technique in order to study human operators in a realistic flight environment. The operator forms

part of a closed loop system which may consist of one or two degrees of freedom. A method of analyzing data obtained from short record runs is presented which is similar to the well known cross-correlation, cross-power spectral density method.

2975

Toronto U. Inst. for Aerospace Studies (Canada).

SPIN DECAY OF A FLEXIBLE SATELLITE BY STRUCTURAL DISSIPATION OF ENERGY, by B. Etkin. Mar. 1965, 34p. (UTIAS rept. no. 105) (AF AFOSR-64-222) AD 475737 Unclassified

This report analyzes the coupling of the rigid-body and elastic modes of motion of a spinning satellite under 2 conditions of motion: (1) wobbling, in which the direction of the spin vector is appreciably different from that of a principal axis of inertia and (2) quasi-steady spin, in which the spin vector nearly coincides with the principal axis of maximum inertia. In the former case, elastic modes are excited into periodic motion, with consequent energy dissipation, even in the absence of an external force field. In the latter case, the elastic mode excitation is caused by, and requires the presence of, the external gravity-gradient field. Order-of-magnitude estimates of the rate of energy dissipation and spin decay are presented for both cases for the Alouette 1 satellite. It is concluded that the mechanism studied is not the principal one causing the spin decay of Alouette 1 satellite.

2976

Toronto U. Inst. for Aerospace Studies (Canada)

REFRACTION OF SOUND BY JET FLOW OR JET TEMPERATURE, by J. Atvars, L. K. Schubert and others. May 1965 [28]p. incl. illus. diagrs. refs. (UTIAS technical note no. 109) (AFOSR-66-0332) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-223, National Aeronautics and Space Administration, and National Research Council of Canada) AD 623867 Unclassified

The heart-shaped pattern of subsonic-jet noise normally peaks somewhere between 15° and 45° from the axis, depending on conditions, falling off sharply as the axis is approached. Conflicting explanations of this directivity pattern appear in the literature. The present investigation suggests that the deep cleft in the pattern can be attributed mainly to refraction of the sound out of the jet by the velocity and temperature fields. The evidence lies in measurements made of the sound field of a harmonic 'point' source placed within a 3/4" diam air jet. The source is the orifice of a tube about 1/16" i. d. driven through a conical coupling of a horn-type loudspeaker driver; this radiates sound essentially omnidirectionally up to about 15,000 cps. The experiment established the formation of an axial intensity minimum, which appears to be mainly due to refraction. The depth of the refraction valley increases with jet velocity, jet temperature, and sound frequency; a depth corresponding to an intensity reduction of the order of 35 db is attained at M - 0.9 for 3000 cps.

2977

Toronto U. Inst. for Aerospace Studies (Canada).

FREE-MOLECULE FLOW THROUGH AXI-SYMMETRIC TUBES, by S. J. Townsend. Mar. 1965 [114]p. incl. diagrs. table, refs. (UTIAS rept. no. 106) (AFOSR-65-0749) (AF AFOSR-64-276) AD 616615 Unclassified

The properties of the flow field of a gas passing through an internally reflecting, axi-symmetric tube are calculated. The major assumptions are: (1) that the mean free path of molecules in the external gas is large compared with the tube dimensions, (2) that molecules incident on the internal surface undergo complete energy accommodation, (3) that there is no accumulation or ablation at the wall, and (4) that the boundary distribution functions for the gases are Maxwellian. Expressions for convection of mass, axial momentum and kinetic energy through the tube are derived. Radical distributions of these flow quantities across the inlet and exit planes are treated. Integrations over the inlet and exit planes give the total quantities convected through the tube. It is shown that the properties can be calculated directly in terms of tube geometry and wall temperatures Results also show that it is possible to develop a net thrust on an internal flow system under free-molecule flow conditions.

2978

Toronto U. Inst. for Aerospace Studies (Canada).

FLOW VISUALIZATION USING A TRAVERSING ELECTRON BEAM, by D. E. Rothe. [1965] [2]p. incl. illus. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-276 and Defence Research Board of Canada) Unclassified

Published in AIAA Jour., v. 3: 1945-1946, Oct. 1965.

A study is made to show the advantages of a flow visualization technique which makes use of a thin high-energy electron beam that can be moved with respect to the flow. With this method it is said to be possible to obtain a quantitative correct record of the density distribution in a low-density gas flow. For comparison, an outline is given of other visualization techniques which have been applied to rarified gas flows.

2979

Toronto U. [Inst. for Aerospace Studies] (Canada).

FREE-MOLECULE FLOW THROUGH CONICAL TUBES, by S. J. Townsend, G. N. Patterson, and S. R. M. Sinclair. [1965] [12]p. incl. diagrs. (AF AFOSR-64-276) Unclassified

Also published in Rarefied Gas Dynamics; Proc. Fourth Internat'l. Symposium, Toronto U. (Canada) (July 14-17, 1964), ed. by J. H. de Leeuw. New York Academic Press, v. 1: 641-652, 1965.

The transport of mass, axial momentum, and energy

through axially symmetric tubes in free-molecule flow is considered. The dependence upon wall temperature of the axial momentum and energy flows in the exit plane is outlined. The resultant transport equations are presented along with representative numerical solutions. Extensions of these flow distributions to the case of arbitrary speed ratio can be carried out. The problem of an optimum free molecule "scoop" for orbital vehicles is also considered. Optimum wall angles for convergent cones can be found, resulting in maximum mass flow passed by the scoop.

2980

Toronto U. Inst. for Aerospace Studies (Canada).

THE DETERMINATION OF SPATIALLY NON-UNIFORM ELECTRON DENSITY DISTRIBUTION, by K. A. Graf. Apr. 1965 [120]p. incl. illus. diagrs. tables, refs. (UTIAS rept. no. 106) (AFOSR-65-0935) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-366 and Defence Research Board of Canada) AD 616614
Unclassified

Electron densities have been measured in the subsonic portion of a free-expansion argon jet by microwave and Langmuir probe methods. The electron density in the jet had a Gaussian radial distribution; along the axis of the jet the density fell off approximately exponentially. Microwave measurements were made by traversing the microwave beam across the jet. This allowed the spatial variation of electron density to be determined. The data were analyzed with a ray-tracing technique. Langmuir probe measurements were made with cylindrical and flaw probes under essentially collison free conditions and over a range of probe radius to Debye length rations of about 10 to 50. Both electron and ion collection were measured and analyzed. Two methods are considered for interpreting the electron part of the characteristic, the deviation-from-linearity method and the 2-tangent-intercept method. The latter method is found to give values 2 or 3 times higher than the former method. This difficulty is overcome by analyzing the data with the aid of theoretical particle-collection curves calculated by Laframboise. In these calculations, the ratio of ion and electron temperatures, and the ratio of probe radius to Debye length are taken into account. Using this procedure, the probe data agree very well with the microwave data. (Contractor's abstract)

2981

Toronto U. Inst. for Aerospace Studies (Canada).

AERODYNAMICALLY GENERATED SOUND, by H. S. Ribner. Final rept. Dec. 1965 [15]p. incl. diagrs. (AFOSR-65-2714) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-672, National Aeronautics and Space Administration, and National Research Council of Canada) AD 627897
Unclassified

This research relates turbulence to the noise-generating features of the UTIAS 4-in. low-speed jet more directly than in prior work, with a minimum of simplifying assumptions. The design and calibration techniques of the aerofoil probe anemometer have been refined further and some illustrative applications have been explored. The research on refraction of pure tones injected into a jet via hypodermic tube has thrown further light on jet noise directionality. In measurements with extremely cold nitrogen jets (-180°C), the sound was found to be refracted inward to produce a large enhancement along the jet axis. Similar behavior, with quantitative agreement, has been found with filtered jet noise. The convection of a vortex through a plane shock gives rise to a weak S-shapes distortion of the shock together with a cylindrical sound wave. The theory for the sound wave (UTIAS rept. no. 61, 1959) has been extended to predict the shape of the shock distortion to within upper and lower bounds. Good qualitative agreement with the experimental shape is found.

2982

Toronto U. Inst. for Aerospace Studies (Canada).

A TURBULENCE PROBE UTILIZING AERODYNAMIC LIFT, by T. E. Siddon. June 1965 [32]p. incl. illus. diagrs. refs. (UTIAS technical note no. 88) (AFOSR-66-0615) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-672 and National Research Council of Canada) AD 627572
Unclassified

The concept of a new-type of anemometer for measuring the cross-stream or "v"-component of turbulent velocity is presented. Basic theory concerning the response characteristics of the so-called "aerofoil probe" is discussed. Steps in the development of a satisfactory prototype of the "aerofoil probe" are outlined. Various problems concerning resonant frequencies, accelerometric effects, low-frequency response fall-off, and the effect of finite aerofoil size were encountered, and these are described in detail. A method of dynamic calibration employing a square-wave turbulence simulator is outlined. Various experimental data accumulated from measurements in a low-speed turbulent air jet are presented. These include velocity measurements, frequency spectra, autocorrelations, and 2 point space-time correlations. Comparisons with hot-wire data are made wherever possible. Conclusions are drawn as to feasibility of using the aerofoil probe in preference to hot-wire techniques for turbulence measurements. Limitations of both techniques are compared.

2983

Toronto U. Inst. for Aerospace Studies (Canada).

DESIGN, INSTRUMENTATION AND PERFORMANCE OF THE UTIAS 4-in. x 7-in. HYPERSONIC SHOCK TUBE, by A. G. Boyer. May 1965 [164]p. incl. illus. diagrs. tables, refs. (UTIAS rept. no. 99) (AFOSR-65-1400) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-365 and Defence Research Board of Canada) AD 621447
Unclassified

A detailed account is presented of the research and

development, design, calibration, and performance of the UTIAS 4-in. x 7-in. hypersonic shock tube, which is used as a modern aerophysical research facility for dissociated and ionized gas flows. The component design and construction features, operating and control systems, safety features, and the diaphragm techniques employed, are described. The instrumentation for monitoring tube performance and operation is also discussed. The operating characteristics, including theoretical and observed performance, are presented. An account of various problems which arose during the development and operation of this facility, and the corrective measures taken, is included. (Contractor's abstract)

2984

Toronto U. Inst. for Aerospace Studies (Canada).

INSTRUMENTATION AND CALIBRATION OF UTIAS 11-in. x 15-in. HYPERSONIC SHOCK TUNNEL, by Y. Y. Chan, R. F. Mason, and N. M. Reddy. June 1965 [92]p. incl. illus. diagrs. table, refs. (UTIAS technical note no. 91) (AFOSR-66-0002) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-365, Defence Research Board of Canada, and National Research Council) AD 631933 Unclassified

An outline of the problems encountered in the calibration of the UTIAS 11 in. x 15 in. Hypersonic Shock Tunnel and some of the solutions are presented. An impulsively heated tungsten-wire technique was successfully developed to obtain detonation-free, smooth, and very repeatable combustion by burning stoichiometric mixtures of oxygen and hydrogen, diluted with helium. It was found that tailored shock Mach numbers as high as $M_s = 9.5$ were achieved. A test section flow calibration was done by measuring wall static pressures, pitot pressures and stagnation point heat-transfer rates. Qualitative pressure-time histories of static and pitot pressures obtained from theoretical considerations were used to interpret the experimental data as well as the nozzle starting time and testing times. Schlieren pictures of the flows over a flat plate and a right circular cylinder are also presented. Methods of predicting the test-section flow quantities in the different flow regimes are indicated. Nozzle starting processes are explained by utilizing available theories. The reservoir and test section conditions were usually P_o - 30 atmospheres to 90 atmospheres; T_o - 3000° to 4500°K; $Z_o = 1.00$ to 1.35; p_∞ - 0.003 to 0.02 psi, p_t - 0.1 to 0.8 psi, $M_\infty = 8.0$ to 13.8, Re/ft = 1.5×10^4 to 3.82×10^3 (based on flow field behind the shock). (Contractor's abstract)

2985

Training Center for Experimental Aerodynamics, Brussels (Belgium).

NEAR FREE MOLECULE BEHAVIOR OF GASES WITH FINITE INFINITE COLLISION CROSS SECTION, by J. J. Smolderen. [1965] [18]p. incl. table. (AF EOAR-63-38) Unclassified

Published in Rarefied Gas Dynamics; Proc. Fourth Internat'l. Symposium, Toronto U. (Canada) (July 14-17, 1964), ed. by J. H. de Leeuw, New York, Academic Press, v. 1: 277-295, 1965.

The paper deals with the behavior, at large Knudsen numbers, of solutions of the Boltzmann equation in the realistic case of molecular interactions with infinite range. So far, most of the applications of the Boltzmann equation to the treatment of transitional or near free molecule flow problems have been based on simple molecular models with finite range of interaction, such as the rigid sphere model, or the BGK model, which can be treated as a finite range interaction. The present paper deals essentially with 1-dimensional problems such as Couette flow and heat conduction between parallel plates, and power law type interactions are considered, although the results could be extended to arbitrary laws, at the cost of considerable mathematical complications. The full Boltzmann equation is replaced by a reduced linear integro-differential equation exhibiting the same singular behavior, caused essentially, by the divergence of the collision integral if the distribution function becomes discontinuous. It is then shown that the gas-kinetic boundary value problem for this linear integro-differential equation may be reduced to the solution of an integral equation of a rather complicated and singular type. The essential practical result from these mathematical developments is the nature of the Knudsen number dependence of the dominant term of the near free molecule corrections, which turns out to be $K^{-(s-1)/(s+1)}$, s being the exponent in the interaction force law. Numerical treatment is briefly outlined for the case of hyperthermal Couette flow, assuming a rather rough estimate for the solution of the integral equation. (Contractor's abstract)

2986

Tufts U. Dept. of Biology, Medford, Mass.

[ULTRASONIC INTERACTION BETWEEN SPECIES] by K. D. Roeder. Summary rept. June 1, 1964-Aug. 31, 1965, 4p. (AFOSR-65-2223) (AF AFOSR-64-671) AD 625034 Unclassified

Certain families of moths have ears capable of detecting the ultrasonic pulses emitted by the sonar system of insect-hunting bats. Among other maneuvers, these moths turn and fly directly away from a source of faint ultrasonic pulses. This report covers 2 phases of an attempt to analyze the physiological mechanisms of this system. Working with microelectrodes, interneurons have been found that are driven by the acoustic receptors, and whose properties suggest that they are directly concerned in the evasive behavior. The acoustic sensitivity of the receptors has been found to be 0.02-0.03 dyne/cm^2 between 20 and 50 kHz. The range of the tympanic organ for the cries of hunting bats has been found to be 32 to 40 meters. Work is in progress on the significance of the ultrasonic clicks emitted by certain moths when molested or exposed to an artificial source of ultrasonic pulses.

2987

Tufts U. Dept. of Chemistry, Medford, Mass.

TEMPERATURE DEPENDENCE OF CHLORINE NQR FREQUENCIES AND PI BONDING, by T. E. Haas and E. P. Marram. [1965] [5]p. incl. diagrs. table, refs. (Contribution no. 333) (AFOSR-66-1740) (AF AFOSR-65-859) AD 641544 Unclassified

Also published in Jour. Chem. Phys., v. 43: 3985-3989, Dec. 1, 1965.

A theory is presented for the anomalous temperature dependence of Cl^{35} NQR frequencies observed for certain transition-metal-chloride compounds. The basic feature of the theory is a break down of π bonding due to bending vibrations, and a consequent increase in the electron population in chlorine 2p π orbitals, causing in turn an increase in the observed NQR frequency. An approximate separation of lattice-motion effects and intramolecular effect is made for the series of compounds K_2MCl_6; M = W, Re, Os, Ir, Pt, and it is shown that the predicted magnitude and behavior of the intramolecular effects agree well with the observed values. (Contractor's abstract)

2988

Tufts U. [Inst. for Psychological Research] Medford, Mass.

EFFECTS ON HAND-EYE COORDINATION OF TWO DIFFERENT ARM MOTIONS DURING COMPENSATION FOR DISPLACED VISION, by S. J. Freedman, S. B. Hall, and J. H. Rekosh. [1965] [3]p. incl. table. (AFOSR-65-1365) (AF 49(638)12??) AD 621187 Unclassified

Also published in Perceptual and Motor Skills, v. 20: 1054-1056, 1965.

Comparisons were made between the compensations produced by sagittal arm motion, a swift extension of the arm from its resting position in the lap to an approximately straight ahead position, and by transverse arm motion, the fully extended arm starting from a position at 45° to the body midline at shoulder height and moving parallel to the surface of the table until approximately straight ahead. Eight right-handed male college students were tested with both types of arm motion, 4 wearing base right prisms and 4 wearing base left. Effects of exposure with sagittal motion generalize more to transverse than vice versa. The differences may be related to the greater precision of body midline judgments with sagittal motion.

2989

[Tufts U. Inst. for Psychological Research] Medford, Mass.

EXPERIMENTAL DEAFFERENTATION IN MAN, by S. J. Freedman. [1965] [10]p. incl. refs. (AFOSR-65-2678) (AF 49(638)1282) AD 628717 Unclassified

Also published in Proc. Symposium; Bel-Air II-Desafferentation Experimentale et Clinique, Geneva (Switzerland) (1965), Geneva, Georg and Cie, 1965, p. 79-88.

In this discussion on human sensory deprivation, selected aspects of experimental work with adults are considered. Comments are made on hallucinatory phenomena and perceptual findings. The study of sensory deprivation may be approached by searching for a solution to a problem, for relevant variables, and for explanatory principles.

2990

[Tufts U. Inst. for Psychological Research] Medford, Mass.

REMARKS ON THE RELATION BETWEEN PERCEPTION AND MOTION, by S. J. Freedman. [1965] [9]p. incl. diagr. refs. (AFOSR-65-2679) (AF 49(638)1282) AD 629300 Unclassified

Also published in Proc. Symposium ; Bel-Air II-Desafferentation Experimentale et Clinique, Geneva (Switzerland) (1965), Geneva, Georg and Cie, 1965, p. 298-306.

Experiments (auditory-motor and visual-motor) over the last 10 yr in several different laboratories have implicated the necessity of self-produced movements for either the compensatory adaptation or the deterioration of perceptual-motor performance to occur. Whether the change in the nature of motor-sensory relationships is systematic or asystematic, whether it is time-independent or time-varied, there has been no significant alteration of perception and perceptual-motor performance, unless the observer is permitted free movement. The experiments imply that the stability of spatial perception and spatially-oriented behavior depends upon continued contact with the customary sense-stimulating environment. The processes which are described appear also to play a critical role in the development of effective perceptual-motor coordination, and may be related conceptually to Piaget's concepts of assimilation, accommodation and alimentation in the development of the sensory-motor schemata which he considers requisite to intelligence.

2991

Tulane U. [Dept. of Physics] New Orleans, La.

NUCLEAR-SPIN LATTICE RELAXATION IN PURE AND PARAMAGNETICALLY DOPED CaF_2 FROM 4.2° TO 195°K (Abstract), by R. A. Laing and J. Cass. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-592] and National Aeronautics and Space Administration) Unclassified

Presented at meeting of the Amer. Phys. Soc., Chattanooga, Tenn., Nov. 5-7, 1964.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 258, Feb. 25, 1965.

In an effort to understand the interaction between the nuclear-spin system and the lattice via dilute concentrations of paramagnetic impurity in ionic crystals, the nuclear spin-lattice relaxation time has been measured as a function of magnetic field, temperature, and orientation for three different samples of CaF_2. One of the "pure" samples contained trace amounts of rare-earth ions. The other "pure" sample contained trace amounts of transition ions, and the third sample had been doped with 1 part in 10^5 of Mn^{2+}. The results showed that the nuclear spin-lattice relaxation process was diffusion-limited above 77°K for the two "pure" samples, although the relaxation process of the Mn^{2+}-doped sample was rapid diffusion up to temperatures of at least 90°K. The sample containing trace amounts of transition-metal ions was studied at 4.2°K and the relaxation process was found to be in the rapid-diffusion limit. In all samples, in the liquid-nitrogen temperature range, it appeared that both the direct and Raman processes were competing in the relaxation of the paramagnetic ions. The results indicate that the concentration and type of paramagnetic impurity affect not only the magnitude of the nuclear spin-lattice relaxation time but also the nature of the relaxation process. Additional measurements in the liquid-helium temperature region are being made and are reported on in the paper.

2992

Turin U. [Dept. of Physics] (Italy).

ANGULAR CORRELATIONS IN NUCLEAR DIRECT ELECTRODISINTEGRATION, by E. Napolitano and G. Ponzano. [1965] 5p. (AFOSR-65-1351) (AF EOAR-62-101) AD 622015 Unclassified

Also published in Nuovo Cimento, Series X, v. 35: 279-283, Jan. 1, 1965.

The single-particle shell model of the nucleus is used to calculate the angular correlations between the inelastically scattered electrons and the nucleons emitted via the direct electromagnetic interaction induced by the impinging electrons. General results are established and summarized. (Contractor's abstract)

2993

Turin U. Dept. of Physics (Italy).

THE SHORT-WAVELENGTH APPROXIMATION TO THE SCHRODINGER EQUATION, by L. Bertocchi, S. Fubini, and G. Furlan. [1965] 34p. incl. diagrs. refs. (AFOSR-65-1847) [AF EOAR-64-33] AD 626093 Unclassified

Also published in Nuovo Cimento, Series X, v. 35: 599-633, Jan. 16, 1965.

The short-wavelength approximation to the Schrodinger equation is studied in the presence of 1 and 2-turning points. Two methods are presented which allow the evaluation of the higher corrections to an elementary approximation method first originated by Wentzel.

The first method, the real method, employs higher transcendental functions; the second one uses complex integration techniques. (Contractor's abstract)

2994

Turin U. Dept. of Physics (Italy).

ON THE THEORY OF SCATTERING BY SINGULAR POTENTIALS, by L. Bertocchi, S. Fubini, and G. Furlan. [1965] 11p. incl. refs. (AFOSR-65-1848) [AF EOAR-64-39] AD 625697 Unclassified

Also published in Nuovo Cimento, Series X, v. 35: 633-643, Jan. 16, 1965.

Some characteristic features of the scattering by singular potentials are discussed both for the low- and the high-energy limit. The discussion is limited to repulsive potentials of the form g^2/r^n. It is also shown how the results can be extended to more general cases.

2995

Turin U. [Dept. of Physics] (Italy).

ON THE RACAH ALGEBRA FOR THE GROUP R_4, by G. Ponzano. [1965] 3p. incl. diagr. (AFOSR-65-1849) (AF EOAR-64-39) AD 625698 Unclassified

Also published in Nuovo Cimento, Series X, v. 35: 1231-1233, Feb. 16, 1965.

The 6j-symbol for the group R_4 is explicitly calculated and the properties of the Racah algebra of compact simply reducible groups are verified. Owing to the isomorphism $R_4 \sim R_3 \times R_3$, it is expected that R_4 invariants can be expressed in terms of the corresponding ones for R_3. From the R_4 Wigner coefficient, the 3nj-symbols for R_4 are given by the product of two R_3 3nj-symbols of the same type with different arguments. The result is illustrated with graphical representations.

2996

Turin U. [Dept. of Physics] (Italy).

A CONTRIBUTION TO THE STUDY OF 2$\mathcal{L}$-j COEFFICIENTS, by G. Ponzano. [1965] 7p. incl. diagrs. (AFOSR-65-1850) (AF EOAR-64-39) AD 625699 Unclassified

Also published in Nuovo Cimento, Series X, v. 36: 385-391, Mar. 16, 1965.

Relative to the recoupling of several angular momenta, 8 different kinds of 2$\mathcal{L}$-j symbols are considered. Their graphical representations and symmetries are studied in detail, and expressions in terms of lower-order symbols are given. (Contractor's abstract, modified)

2997

Turin U. Dept. of Physics (Italy).

RENORMALIZATION EFFECTS FOR PARTIALLY CONSERVED CURRENTS, by S. Fubini and G. Furlan. [1965] [19]p. incl. refs. (AFOSR-65-1851) [AF EOAR-64-39] AD 625700 Unclassified

Also published in Physics, v. 1: 229-247, 1965.

It is shown how to obtain, through the use of suitable commutation relations, sum rules for the renormalization ratios between bare and dressed coupling constants. The method is completely general and it can be applied to any broken symmetry. As an illustration, the cases of the weak vector current, both strangeness-conserving and strangeness-changing, are considered. (Contractor s abstract, modified)

2998

Turin U. Dept. of Physics (Italy).

SINGULAR POTENTIALS WITH SHORT RANGE, by H. Cornille and E. Predazzi. [1965] 34p. incl. diagrs. table, refs. (AFOSR-66-1717) (AF EOAR-64-39) AD 638060 Unclassified

Also published in Nuovo Cimento, Series X, v. 35: 879-912, Feb. 1, 1965.

Previous works have shown the properties and the possibility of useful approximate methods for the Jost functions, and the radial wave functions in the case of Yukawa generalized potentials, less or equally singular than the centrifugal term. Some of these results are extended to a larger class of short-range potentials which, near the origin, can be represented as a finite superposition of inverse powers of the radial variable; namely, the most singular term is repulsive with a.. arbitrary inverse-power behavior. For simplicity, the degrees of the other terms are obtained from one of the leading terms by the decreasing of unities. The key (as for the inverse power-square case) is to find a singular factor removing the singular part near the origin of the outgoing (ingoing) waves, and keeping unaltered the symptotic character of the outgoing (ingoing) waves. After this, the analysis follows, as closely as possible, the usual development. By investigating the asymptotic behavior of the Laplace transform, the existence of the Jost function is proved. The definition of the Jost function as a series, whose p-th term comes from the contribution of the iteration of order p of the inverse Laplace transform is divergent. A method is presented for evaluating the Jost function by means of convergent sequences, which allow the calculation of approximations which are always convergent without any arbitrary cut-off or hard-core procedures. All the above formalism is given for the $\ell = 0$ case. (Contractor's abstract)

2999

Turin U. Dept. of Physics (Italy).

THE PROJECTIVE GROUP AS A REALIZATION OF THE SU(N,1) GROUP, by A. Giovannini and F. Gliozzi. [1965] 6p. incl. refs. (AFOSR-66-1721) (AF EOAR-64-39) AD 639546 Unclassified

Also published in Nuovo Cimento, Series X, v. 40: 881-886, Dec. 1, 1965.

The dynamical group of the N-dimensional harmonic oscillator is a realization in terms of creation and destruction operators of the projective group of linear fractional transformations. A suitable contraction on this group yields the group SU_n as the degeneracy group of the system. (Contractor's abstract)

3000

Turin U. Dept. of Physics (Italy).

DIFFERENTIAL PROPERTIES OF FEYNMAN AMPLITUDES, by V. De Alfaro, B. Jaksic, and T. Regge. [1965] [10]p. incl. diagrs. (AFOSR-66-1723) (In cooperation with Princeton U., N. J.) (Sponsored jointly by Air Force Office of Scientific Research under AF EOAR-64-39 and National Science Foundation) AD 639549 Unclassified

Also published in High Energy Physics and Elementary Particles: Lectures Presented at a Seminar, International Centre for Theoretical Physics, Trieste (Italy) (May 3-June 30, 1965). Vienna, International Atomics Energy Agency, 1965, p. 263-272.

A new approach to the study of the analytical properties of Feynman amplitudes is described in this paper. The differential properties of each term in the relativistic expansion of scattering amplitudes are investigated. By differential properties is meant the existence of ordinary differential equations for each variable appearing in the term, such equations being a suitable substitute for the integral representation when coupled with simple boundary conditions.

3001

Turin U. Dept. of Physics (Italy).

THEORY OF CORRECTIONS TO UNITARY SYMMETRY FORMULAE, by G. Furlan, F. Lannoy and others. [1965] 33p. incl. diagrs. refs. (AFOSR-66-1725) [AF EOAR-64-39] AD 639550 Unclassified

Also published in Nuovo Cimento, Series V, v. 40: 597-629, Nov. 21, 1965.

A systematic analysis of the equal-time commutation relations of the generators of an algebra with certain physical operators is made. A method is then introduced whereby considering matrix elements of such commutators between physical one-particle states and using completeness and invariance under space-time

translations, corrections to broken symmetry group-theoretical formulae are obtained. Several applications to weak, electromagnetic and strong interactions are then made. (Contractor's abstract)

3002

Turin U. Dept. of Physics (Italy).

A DISPERSION THEORY OF SYMMETRY BREAKING, by S. Fubini, G. Furlan, and C. Rossetti. [1965] 23p. incl. refs. (AFOSR-66-1726) [AF EOAR-64-39] AD 639545 Unclassified

Also published in Nuovo Cimento, Series X, v. 40: 1171-1193, Dec. 21, 1965.

A new relativistic approach to the problem of broken symmetries is proposed. This is the covariant generalization of the non-relativistic sum rules obtained in previous investigations. The result is in the form of dispersion sum rules where the pole term represents the group-theoretical answer and the cut the breaking correction. The method is applied to SU_3 and chiral $SU_3 \times SU_3$ leading to very satisfactory results and predictions. (Contractor's abstract)

3003

Turin U. [Dept. of Physics] (Italy).

A NEW APPROACH TO SCATTERING BY SINGULAR POTENTIALS, by S. Fubini and R. Stroffolini. [1965] 5p. (AFOSR-66-2716) [AF EOAR-64-39] AD 644091 Unclassified

Also published in Nuovo Cimento, Series X, v. 37: 1812-1816, June 16, 1965.

The problem of giving an unambiguous mathematical meaning to the solutions of nonrenormalizable field theories has been the object of several investigations. One possible line of attack is to consider simple models given by singular nonrelativistic or relativistic potential scattering equations as a guide to obtain new ideas and techniques to be generalized to the field-theoretical case. A discussion is given of a new point of view in the study of singular potentials, which allows a systematic treatment of a large class of potentials. The approach proposed is essentially based on the study of the polydromy of the wave function $\psi(r)$ in the r variable. The important point is that both singular and regular potentials exhibit very simple and general features in this framework.

3004

[Turin U. Dept. of Physics (Italy)]

SINGULAR LOGARITHMIC POTENTIALS IN COORDINATE SPACE, by H. Cornille and E. Predazzi. [1965] [11]p. (AF EOAR-64-39) Unclassified

Published in Jour. Math. Phys., v. 6: 1730-1740, Nov. 1965.

In previous works study was made of the problem of the determination of the Jost function for singular repulsive potentials behaving near the origin like inverse powers. The key was to define "new Jost solutions" which, still being asymptotically ingoing (or outgoing) waves, tend to constant (Jost functions) near the origin. It was shown from the perturbation expansion in coordinate space of these "new Jost solutions" that construction of the Jost functions can be made by connecting the radial coordinate r and the order of the perturbation expansion p. More precisely, if introduction is made of an r(p) dependence, the Jost function is the limit of convergent sequences provided r(p) goes to zero less rapidly than a given limiting dependence $r_L(p)$. In this paper, working in coordinate space, the same method is extended for two other families of singular potentials: (1) consideration is given to the case in which the most singular part of the potentials behaves like $G^2(\log r^{-1})^{\beta} r^{-2n}$, ($n \geq 1$, β arbitrary) near the origin; (2) study is made of exponentially singular repulsive potentials of finite range. It is found that the most singular is supposed to be the potential, the higher becomes the available limiting dependence. (Contractor's abstract)

3005

United Aircraft Corp. Research Labs., East Hartford, Conn.

VARIATIONAL APPROACH TO PERTURBATION THEORY. I. APPLICATION TO THE CALCULATION OF ATOMIC POLARIZABILITIES, by H. J. Kolker and H. H. Michels. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-0065) (AF 49(638)1133) AD 632226 Unclassified

Also published in Jour. Chem. Phys., v. 43: 1027-1035, Aug. 1, 1965.

A variational approach to perturbation theory is derived which establishes the relationship between variational and conventional approaches that utilize expansions in terms of atomic or molecular eigenfunctions. This approach is based upon the observation that the variational approach to perturbation theory is formally equivalent to a variational method for constructing a special set of excited-state wavefunctions. A mathematical demonstration of this equivalence has been formulated. With the use of this new approach to perturbation theory, both the static and dynamic polarizabilities of the two-electron helium isoelectronic series, H^-, He, and Li^+ and a four-electron system represented by the beryllium atom have been calculated. Multiconfiguration open-shell wavefunctions were employed. These flexible wavefunctions permit a quantitative analysis of the near-degenerate s-p orbital mixing in the ground state of the beryllium atom. The inclusion of this orbital degeneracy effect results in a substantial reduction in the calculated polarizability. (Contractor's abstract)

3006

United Aircraft Corp. Research Labs., East Hartford, Conn.

NON-EQUILIBRIUM IONIZATION USING ELECTROSTATIC PROBING TECHNIQUES, by R. H. Bullis. Final rept. Mar. 1, 1963-Feb. 28, 1965, Apr. 26, 1965. [37]p. incl. diagrs. refs. (Rept. no. D-920072-6) (AFOSR 65-1241) (AF 49(638)1221 AD 621276 Unclassified

Research was conducted to determine the electron energy distribution in the cesium plasma in an arc-mode thermionic converter and to determine the changes in this distribution produced by the presence of a highly inert gas background pressure. Electrostatic probes were used to measure various plasma properties, such as electron energy distribution, electron number density, and plasma potential. Calculations were made of the plasma production and loss rates. A bibliography of the publications resulting from this work and reprints of the most recent papers covering portions of the research are included. (Contractor's abstract modified)

3007

United Aircraft Corp. Research Labs., East Hartford, Conn.

EFFECTS OF INERT GAS OVERPRESSURE ON ARC CHARACTERISTICS, by R. H. Bullis, W. J. Wiegand, and D. W. Bell. [1965] [12]p. incl. diagrs. refs. (AFOSR 65-2500) (Also bound with its AFOSR 65-1241; AD 621276) (AF 49(638)1221) AD 628024

Presented at Twenty Fifth Annual Conf. of Physical Electronics, Mass. Inst. of Tech., Mar. 24-26, 1965.

To determine the effect of the presence of an inert gas on the properties of the nonequilibrium cesium plasma which exists in the interelectrode space of an arc-mode thermionic converter, detailed electrostatic probe measurements have been made of electron temperature, electron number density, and the plasma potential over a wide range of inert gas pressures. By employing electrostatic probe techniques to measure the properties of the nonequilibrium cesium plasma, direct assessment has been made of the effects of an overpressure of inert gas on the plasma properties without having to include extraneous effects such as changes in the work functions of the emitter and collector produced by the interaction of the inert gas with these surfaces. In addition, spectroscopic measurements have been made to determine the behavior of the atomic and molecular excited state populations with changes in inert gas pressure, converter output and maximum electron density in the neutralization plasma. The range of inert gas pressure over which volume ionization processes can be sustained in the nonequilibrium neutralization plasma in the converted with argon used as the inert gas has been determined from these measurements.

3008

United Aircraft Corp. Research Labs., East Hartford, Conn.

CHARACTERISTICS OF THE NEUTRALIZATION PLASMA IN THE ARC-MODE THERMIONIC CONVERTER, by R. H. Bullis and W. J. Wiegand. [1965] 12p. incl. diagrs. (Bound with its AFOSR 65-1241; AD 621276) (AF 49(638)1221) Unclassified

Further detailed measurements of the properties of the nonequilibrium plasma existing in the interelectrode space of arc-mode converters have been made with coaxial electrostatic Langmuir probes. Previous probe measurements have detected the existence of a small retarding sheath in the immediate vicinity of the emitter as well as a variation in the plasma potential which is accelerating for electrons and which extends over distances from the emitter surface corresponding to 20 to 30% of the interelectrode spacing. Detailed studies have been made to determine the behavior of the potential distribution for variations in emitter temperature,

cesium pressure, converter spacing, and output. From these studies the position of the minimum point in the potential well, which is accelerating for electrons, has been found to be strongly affected by changes in emitter temperature and cesium pressure. The over-all potential drop in the electron accelerating region near the emitter appears to be independent of the energy required to excite a cesium atom from the ground state to the $6P_{1/2}$, $6P_{3/2}$ first excited states. The average fields found to exist in this region range from 300 to 1500 v/m. The small retarding sheath near the emitter surface has been found to be strongly influenced by the production rate of ions at the emitter surface. A strong correlation has been observed between several of the parameters of the plasma and the output characteristics of the arc-mode converter. The observed variations in electron number density and electron energy distribution with position in the interelectrode space determined from probe measurements correlate well with spectroscopically determined electron densities and electron temperatures. (Contractor's abstract)

3009

United Aircraft Corp. Research Labs., East Hartford, Conn.

STUDIES OF NON-EQUILIBRIUM IONIZATION (Abstract), by R. H. Bullis and W. J. Wiegand [1965] [2]p. (Bound with AFOSR 65-1266; AD 622527) (AF 49(638)1221) Unclassified

Presented at Eighth AFOSR Contractors' meeting on Ion and Plasma Propulsion Research, Los Angeles, Calif., Apr. 29-30, 1965.

Investigations of the effects of cathode-anode spacing and of the presence of a relatively high inert gas background pressure on the properties of the non-equilibrium cesium plasma generated in the arc-mode thermionic plasma diode have been made using coaxial electrostatic probe and spectroscopic techniques. From detailed coaxial electrostatic probe studies of the nonequilibrium cesium arc, it has been established that an accelerating region for electrons exists in the plasma immediately adjacent to the cathode surface. Correlations of potential drop and position of the minimum point of the potential well, which extends from the cathode surface several thousand Debye lengths into the plasma, have been made with variations in emitter temperature, cesium pressure, and cathode-anode spacing. Studies have been conducted to determine the effects of the presence of an inert gas background pressure on the properties of the non-equilibrium arc. Spectroscopic observations of the arc characteristics indicated that the population of cesium molecules in excited states was drastically reduced with increasing argon background pressure. These results will be correlated with electron number densities determined by probe techniques and the mechanisms postulated for the production of the enhancement in the degree of ionization observed in the non-equilibrium arc.

3010

United Aircraft Corp. Research Labs., East Hartford, Conn.

AN ASYMPTOTIC SOLUTION FOR OPTIMUM POWER-LIMITED ORBIT TRANSFER, by T. N. Edelbaum, Oct. 1965, 10 p. (AFOSR 65-2002) (AF 49(638)1239) AD 623170 Unclassified

A complete first-order asymptotic solution was obtained for optimum power-limited transfer between coplanar elliptic orbits of arbitrary size, eccentricity, and orientation. The solution was obtained by the averaging method of Bogoliubov and Mitropolsky and corresponds to what is called 'the improved first approximation' including both secular and short-period terms. The problem for which the solution is presented corresponds to miminum-fuel transfer in fixed time of a low-thrust rocket operating at constant power and variable thrust. The average acceleration of the rocket is assumed small in relation to the acceleration of gravity. Analytic expressions were derived for the orbit elements, the payoff, and the optimum control.

3011

United Aircraft Corp. Research Labs., East Hartford, Conn.

OPTIMUM POWER-LIMITED ORBIT TRANSFER IN STRONG GRAVITY FIELDS, by T. N. Edelbaum. [1965] [5]p. incl. diagrs. refs. (AFOSR 65-2328) (AF 49(638)1239) AD 629302 Unclassified

Presented at AIAA/JON Astrodynamics Guidance and Control Conf., Aug. 24-26, 1964, Los Angeles, Calif.

Also published in AIAA Jour., v. 3: 921-925, May 1965.

Analytic solutions are obtained for optimum transfer between arbitrary coplanar or coaxial ellipses in strong central gravitational fields. Fuel consumption is minimized for fixed transfer times with powerlimited propulsion. The first-order secular solution obtained is valid only if many revolutions are made about the primary body during the transfer. The necessary conditions of Euler, Weierstrass, and Jacobi are satisfied so that the solutions actually furnish a local minimum. Multiple solutions are obtained for large changes in inclination or argument of perigee. The analysis shows which of these solutions furnishes an absolute minimum. It is found that all extremals violate the Jacobi condition and cease to be minimizing solutions if they are followed far enough. (Contractor's abstract)

3012

[United Electrodynamics, Inc., Alexandria, Va.]

DATA PROCESSING TECHNIQUES FOR THE DETECTION AND INTERPRETATION OF TELESEISMIC SIGNALS, by C. B. Archambeau, J. C. Bradford and others. [1965] [6]p. incl. diagrs. table. (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under AF 49(638)-1117, and Air Force Technical Applications Center) Unclassified

Published in Proc. IEEE, v. 53: 1860-1865, Dec. 1965.

This paper is a collection of six papers describing recent developments in automated detection and identification of teleseismic earthquakes and explosions in a seismic noise background. The first paper evaluates the assumption that the outputs of seismometer arrays can be added since the signals will reinforce while the noise is cancelled. The second paper describes a method utilizing orthogonal expansions of the Kautz type in an effort to determine spectral and temporal differences between both types of signals and noise. The third pacer describes a thermal equilibrium analogy to estimate the noise energies in each mode to account for the observed depth and frequency behavior. The use of multiple and partial coherence functions for resolving noise backgrounds into their propagation components is described in the fourth paper. Compressional, shear, and surface wave components of signals can be separated from seismic noise backgrounds by recognizing their differing polarization properties, as shown in the fifth paper. The source mechanisms can theoretically be identified from their radiation patterns provided instrument and travel path distortions are removed. A final paper describes this theory and how these various methods of detecting and isolating the signals can be integrated into an automated signal analysis system. (Contractor's abstract, modified)

3013

United States Industrial Chemicals Co., Cincinnati, Ohio.

PROTONATION OF ORGANOCYANOCOBALTATE(III) COMPLEXES: A NEW SYNTHESIS OF NITRILES, by J. Kwiatek and J. K. Seyler. [1965] [5]p. incl. refs. (AFOSR 65-2362) (AF 49(638)1214) AD 629112 Unclassified

Also published in Jour. Organometal. Chem., v. 3: 433-437, 1965.

The protonation reactions of certain organocyanocobaltate (III) complexes were studied. Complexes containing organic groups (R), where R = -C-C=C or -C-C=O, are cleaved to yield RH. Those containing organic groups (R'), where R' = alkyl, benzyl or phenyl groups, undergo rearrangement to yield new complexes which release R'CN on further treatment with base. Mechanisms for these reactions are proposed and discussed.

3014

United States Industrial Chemicals Co., Cincinnati, Ohio.

PREPARATION OF ORGANOCYANOCOBALTATE(III) COMPLEXES, by J. Kwiatek and J. K. Seyler. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR 65-2363) (AF 49(638)1214) AD 629122 Unclassified

Also published in Jour. Organometal. Chem., v. 3: 421-432, 1965.

Two methods were found for the preparation of organocyanocobaltate (III) complexes. The first involves addition of $[Co(CN)_5H]^{3-}$ to activated olefins. The second involves reaction of $[Co(CN)_5]^{3-}$ with organic halides. Studies show the mode of attachment of the organic groupings and indicate the role of certain of these complexes in hydrogenations and hydrogenolyses catalyzed by pentacyanocobaltate (II) anion. Allylic conversions of the type σ-π and π-σ were demonstrated. A mechanism for the cleavage of organic halides is discussed.

3015

Uppsala U. Inst. of Physics (Sweden)

HIGH PRECISION NUCLEAR PROPERTIES STUDIES, by K. Siegbahn. Jan. 1, 1965 [6]p. (AF EOAR 62-123) Unclassified

Precision β-ray spectrometers have been employed in studies of nuclear transition energies and intensities. Angular correlations between (γ, γ), (γ, e) and (e, e) have been measured, as well as differential angular correlations in some cases.

3016

Uppsala U. [Inst. of Physics] (Sweden).

LOW FIELD GALVANOMAGNETIC EFFECTS ON Bi-Sb ALLOYS AT 4.2° K, by B. Rönnlund, L. Ericsson and O. Beckman. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-1175) (AF EOAR-63-53) AD 621615 Unclassified

Also published in Arkiv Fysik, v. 29: 237-244, Jan. 13, 1965.

Galvanomagnetic measurements at 4° K are reported on bismuth-antimony alloys containing 5 and 12 at-% antimony. The mobility tensor indicates electron ellipsoids of the same shape as in bismuth. A pronounced change in the parameters of the hole ellipsoids of revolution might be caused by the influence of an extra, high mobility valence band.

3017

Uppsala U. [Inst. of Physics] (Sweden).

STUDY ON THE RELAXATION OF DISLOCATIONS IN F F. C. C. METALS, by M. Mongy. [1965] [4]p. (AFOSR-65-1176) (AF EOAR-63-53) AD 622393 Unclassified

Also published in Acta Univ. Upsalien., v. 54: 3-6, 1965.

The effect of orientation of single crystals on the shape and position of the internal friction peak was investigated. Single crystals of 4 face centered cubic metals, aluminum, copper, silver, and gold were measured in the [100], [110], and [111] directions. Minimum values were obtained in the [111] direction for aluminum, copper, and gold. and in the [100] direction for silver. A high degree of anisotropy in the values of the activation energy and the relaxation frequency was observed in all the metals. The values of the activation energy and relaxation frequency in polycrystalline samples represent a mean value of those measured in the 3 principal directions of the single crystals.

3018

Uppsala U. [Inst. of Physics] (Sweden).

INVESTIGATION OF THE BORDONI PEAK IN GOLD AND OTHER F. C. C. METALS, by M. Mongy. [1965] [10]p. incl. diagrs. tables. (AFOSR-65-1385) (AF EOAR-65-53) AD 621313 Unclassified

Also published in Arkiv Fysik, v. 29: 343-352, Mar. 1965.

The Bordoni peak has been investigated in the 3 principal directions [111], [100] and [110] of a single crystal of gold at the frequencies 5, 10, 20 and 45 mc/s. The results confirm the previous measurements on single crystals of aluminum, copper and silver. The activation energy and the relaxation frequency differ much from one orientation to the other and the minimum values are obtained when the ultrasonic waves are applied in the [111] direction The comparison of the Bordoni peak with Zener's single relaxation theory shows that the peak in the [111] direction is due to a single relaxation process while a spectrum of relaxations is responsible for the peak in the other 2 directions. The activation energy and the relaxation frequency obtained in the [111] direction are found to be very near to those characterizing the single relaxation peak in copper and silver. The values of $(c_t H/f_0 b^4 \mu)$ calculated using these activation energies and relaxation frequencies, show that the ratio is invariant in the 3 metals. This is in agreement with Seeger's model and shows that the theory can only be applied when the peak is due to a single relaxation process. (Contractor's abstract)

3019

Uppsala U. Dept. of Physics, (Sweden).

STUDY OF THE BORDONI PEAK IN A SILVER SINGLE CRYSTAL, by M. Mongy, K. Salama and O Beckman. [1965] [8]p. incl. diagrs. tables. (AFOSR-65-1894) (AF EOAR-63-53) AD 626094 Unclassified

Also published in Nuovo Cimento, Series, X, v. 36: 10-17, Mar. 1965.

The Bordoni peak was investigated in the [100], [111] and [110] orientations of a silver single crystal. The measurements were made at frequencies 10, 20 and 50 mHz in the temperature range 80° to 300°K. The activation energies and the relaxation frequencies are found to be different from one orientation to the other; the minimum values are obtained when the ultrasonic waves are applied parallel to the [100] direction. The comparison of the peak with Zener's single relaxation theory shows that the peak in the [100] direction is due to a single relaxation process. In the other 2 directions, the results favor a spectrum of different relaxation frequencies with a constant activation energy. The values of the activation energy and the relaxation frequency characterizing the single relaxation process are compared with those previously obtained in copper. The results of both metals are discussed in view of Seeger's theory. (Contractor's abstract)

3020

Uppsala U. [Inst. of Physics] (Sweden).

DOPING PROPERTIES OF Sb_2Te_3 INDICATING A TWO VALENCE BAND MODEL, by B. Rönnlund, O. Beckman, and H. Levy. [1965] [6]p. incl. diagrs. (AF EOAR-63-53) Unclassified

Published in Jour. Phys. and Chem. Solids, v. 26: 1281-1286, Aug. 1965.

Seebeck coefficient and electrical conductivity has been measured on Sb_2Te_3 doped with Pb, I, $CuBr_2$, Sn, etc. The material is always strongly p-type with $S \simeq 80\ \mu V/°K$ and σ varying between $2 \cdot 10^5$ and $5 \cdot 10^5 (\Omega m)^{-1}$. The S vs σ curve indicates 2 valence bands with parameters $\mu_0(m^*/m)^{3/2} = 0{\cdot}0057\ m^2/Vs$ and $0{\cdot}034\ m^2/Vs$ separated by 0·23 eV. The doping behavior is discussed in terms of the crystal bonding. (Contractor's abstract)

3021

Uppsala U. Inst. of Physiology (Sweden).

RESEARCH ON THE GENESIS OF ACTION POTENTIAL IN EXCITABLE TISSUES, by T. Teorell. Final rept. May 20, 1965, [31]p. incl. diagrs. tables, refs. (AFOSR-65-1487) (AF EOAR-64-33) AD 623212 Unclassified

Research is reported on the genesis of action potentials in excitable tissues. The work is divided into 6 sections which discuss the following topics: (1) Some new results concerning stable and unstable concentration profiles in fixed charge membranes; (2) Pressure - volume relations in living cells in the electrohydraulic presso-receptor analog; (3) Ion fluxes in electro-convection systems; (4) Analysis of the components of action potentials in terms of nonlinear mechanics, (5) The fixed membrane theory in flocculation phenomena, and (6) The mechanism of selectivity of the dextran gels.

3022

Utah State U. Dept. of Chemistry, Logan.

PYROLYSIS STUDIES. XIII. KINETICS OF THE VAPOR PHASE PYROLYSIS OF ARYLETHYL METHYL CARBONATES. A LINEAR FREE-ENERGY RELATIONSHIP FOR ORTHO SUBSTITUENTS, by G. G. Smith and B. L. Yates. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-65-0678) (AF AFOSR-62-268) AD 616470 Unclassified

Also published in Jour. Org. Chem., v. 30: 434-438, Feb. 1965.

The absolute reaction rate constants in the pyrolysis of a series of ortho-, meta-, and para-substituted 1-arylethyl methyl carbonates and some ortho-substituted 1-arylethyl acetates have been determined. The mechanism of the pyrolysis of the carbonates is discussed. Even in the pyrolysis of the ortho-substituted esters, proximity effects are at a minimum for it is found that a linear free-energy relationship is obeyed between the pyrolysis of the ortho-substituted acetates and carbonates. Important differences are found between this relationship and the linear free-energy relationship obeyed by the meta- and para-substituted isomers. (Contractor's abstract)

3023

Utah State U. Dept. of Chemistry, Logan.

PYROLYSIS STUDIES. XIV. THE PYROLYSIS OF t-BUTYL BENZOATES, by G. G. Smith and B. L. Yates. [1965] [3]p. incl. tables. (AFOSR-65-0879) (AF AFOSR-62-268) AD 617231 Unclassified

Also published in Canad. Jour. Chem., v. 43: 702-704, 1965.

It was thought that a study of the thermal elimination of benzoic acids from t-butyl benzoate esters would be suitable for the determination of σ^0 values. Four consecutive runs were made for 4 different esters, the reactor having a completely deactivated surface before the measuring of each ester. From the results obtained, it is clear that the thermal decomposition of t-butyl benzoates is not a simple intramolecular homogeneous reaction but rather the reaction is subject to occurring also on the walls which activate the reactor and cause an increasing amount of heterogeneous reaction, it is apparent that pyrolysis of t-butyl benzoate is not suitable for studying linear free energy relationships.

3024

Utah State U. Dept. of Chemistry, Logan.

PYROLYSIS STUDIES. XV. THERMAL RETROGRADE ALDOL CONDENSATION OF β-HYDROXY KETONES, by G. G. Smith and B. L. Yates. [1965] [1]p. incl. diagrs. table. (AFOSR-65-1647) (AF AFOSR-62-268) AD 624374 Unclassified

Also published in Jour. Org. Chem., v. 30: 2067, 1965.

The vapor phase kinetics are investigated of a retrograde aldol condensation of 4-hydroxyl-4-methyl-2-pentanone which thermally decomposes to acetone. Based on the kinetics obtained and the products formed, it is proposed that β-hydroxy ketones thermally decompose in the vapor state through a 6-membered cyclic transition state mechanism similar to those formerly proposed for the pyrolysis of esters, β-hydroxyl olefins, and β, γ-unsaturated acids. The investigation indicates that although the acidity of the hydrogen, which is thought to be involved in the transition state, is not particularly important, the greater basicity of the C = O bond in the β-hydroxy ketones over that of C = C bond is significant.

3025

Utah State U. Dept. of Chemistry, Logan.

PYROLYSIS STUDIES, PART XVI. A MECHANISTIC STUDY OF THE PYROLYSIS OF β-HYDROXY-OLEFINS, by G. G. Smith and B. L. Yates. [1965] [4]p. incl. tables, refs. (AFOSR-66-0567) (AF AFOSR-62-268) AD 632591 Unclassified

Also published in Jour. Chem. Soc., v. 1331: 7242-7246, Dec. 1965.

The pyrolysis of β-hydroxy-olefins to olefins and carbonyl compounds has been shown to be a first-order homogeneous unimolecular reaction. Alkyl groups at the 1-position of but-3-en-1-ol have much less effect on the rate of pyrolysis than when they are in a structurally similar position of ethyl formate. This implies that there is less heterolytic splitting of the C-CHOH bond in β-hydroxy-olefins in the transition state than C-O splitting in ester pyrolysis. A 3-phenyl substituent in but-3-en-1-ol increases the rate of pyrolysis more than similar substitution in ethyl formate. Apparently there is greater use of the π-electrons in the transition-state pyrolysis of β-hydroxyolefins than in ester pyrolysis. Tertiary alcohols decompose more radily than secondary and primary alcohols. A comparison of the entropies of activation indicates that tertiary alcohols are in a more favorable conformation for thermal decomposition than the primary alcohols. (Contractor's abstract)

3026

Utah U. Dept. of Chemical Engineering, Salt Lake City.

IGNITION AND COMBUSTION OF SOLID PROPELLANTS, by J. Cheng, L. S. Bouck and others. Oct. 1,

1964-Sept. 30, 1965. 83p. incl. illus. diagrs. tables, refs. (AFOSR-66-1672) (AF AFOSR 65-40) AD 637496 Unclassified

This report discusses the progress and accomplishments of several projects during the grant period. Theoretical analyses have been made of the ignition process employing a model which considers surface regression and a simplified 2-dimensional model, which treats the nonhomogeneous nature of the composite propellant. Experimental studies of ignition were made by use of a shock tube and of electrically heated wires. A technique was perfected for the study of the thermal effects of propellant constituent reactions in the time scale of interest in ignition. A rarefaction tube was employed to extinguish samples of burning propellants, and extinguishment requirements of several propellants were determined.

3027

Utah U. Dept. of Chemistry, Salt Lake City.

INTRAMOLECULAR HYDROGEN BONDING IN cis-CYCLOPROPANEPOLYCARBOXYLIC ACIDS, by J. L. Haslam, E. M. Eyring and others. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-65-0720) (AF AFOSR-64-476) AD 615670 Unclassified

Presented at 146th National Meeting of the American Chemical Society, Denver, Colo., Jan. 22, 1964.

Also published in Jour. Amer. Chem. Soc., v. 87: 1-6, Jan. 5, 1965.

Acid dissociation constants and specific rates of reaction between a base and an intramolecularly hydrogen-bonded proton in monoanions of dicarboxylic acids have be have been determined at 10 and 25° in 0.1 M ionic strength aqueous solution for the following acids: cis-3,3-dimethylcyclopropane-1,2-dicarboxylic acid, cis-3,3-diphenylcyclopropane-1,2-dicarboxylic acid, and spiro[cyclopropane-1,9'-fluorene]-cis-2,3-dicarboxylic acid. The kinetic data obtained with the temperature-jump relaxation method permit an assignment of relative strengths of intramolecular hydrogen bonds in agreement with K_{a1}/K_{a2} data. Rough values of E_a, ΔH^*, and ΔS^* are calculated, and their significance is considered. Kinetic data are also reported for N,N-dimethyl-o-aminobenzoic acid at 25° and cis-cyclopropane-1,2,3-tricarboxylic acid at 10 and 25°.

3028

Utah U. Dept. of Chemistry, Salt Lake City.

EQUILIBRIUM AND KINETIC STUDIES OF THE DEPROTONATION OF THE MONOANION OF SEVERAL DICARBOXYLIC ACIDS IN WATER AND IN DEUTERIUM OXIDE, by J. L. Haslam, E. M. Eyring, and others. [1965] [5]p. incl. diagr. tables, refs. (AFOSR 65-2370) (Sponsored jointly by Air Force Office of Scientific Research under AF-AFOSR-64-476, National Institute of Arthritis and Metabolic Diseases, and Utah U. Research Fund) AD 629798 Unclassified

Presented at 149th National Meeting of the Amer. Chem. Soc. Detroit, Michigan, April 1965.

Also published in Jour. Amer. Chem. Soc., v. 87: 4247-4251, Oct. 5, 1965.

The rate constant for the rapid abstraction by hydroxide ion of a proton from the monoanion of 3 alkyl-substituted succinic acids varies inversely as the ratio of the acid dissociation constants Ka_1/Ka_2. These data confirm the generality of this result found previously for a series of 2,2-disubstituted malonic acids and for three cis-3,3-disubstituted cyclopropane-1,2-dicarboxylic acids. Acid dissociation constants and rate constants for the proton abstraction were also determined in D_2O for the 3 cyclopropane acids as well as for the 3 succinic acids. These isotopic data as well as acid dissociation constants for the monomethyl esters of these acids are consistent with the interpretation that the breaking of an intramolecular hydrogen bond in the monoanion is rate determining although these data cannot conclusively establish the presence of such an intramolecular hydrogen bond. (Contractor's abstract)

3029

Utah U. [Dept. of Chemistry] Salt Lake City.

LASER TEMPERATURE-JUMP STUDIES OF FAST REACTIONS, by E. M. Eyring. Final technical rept. Oct. 1, 1963-Sept. 30, 1965. 5p. incl. refs. (AFOSR-65-2941) (AF AFOSR-64-476) AD 628027 Unclassified

A ruby laser was assembled from commercial components for use as a single-pulse, source of heat in temperature-jump relaxation kinetic studies of very rapid reactions in aqueous and nonaqueous solutions. Preliminary results were obtained with an aqueous uranyl ion monomerdimer equilibrium to which copper nitrate was added. A neodymium doped glass laser rod radiating at 1.06μ was not found satisfactory for the same purpose. A concurrent investigation of a fast protolytic reaction in water and D_2O by the conventional Joule heating temperature-jump method yielded solvent D_2O kinetic isotope effect data with ramifications for enzyme kinetics.

3030

Utah U. Dept. of Metallurgy, Salt Lake City.

ORIGIN OF DETONATION-GENERATED IONIZATION WAVES, by M. A. Cook and D. A. Newell. Sept. 15, 1965. 34p. incl. diagrs. tables, refs. (AFOSR-65-1918) (AF AFOSR 65-56) AD 629231 Unclassified

The high electron density which exists in the external ionization wave that propagates away from the free surface of a detonating explosive was investigated by electrostatic probes and an impurity-doping method. Two impurities, potassium nitrate and cesium nitrate, were added to RDX in different molar concentrations. The conduction in the ionization wave was measured by the electrostatic probe technique. The increased maximum

conduction at the front of the ionization wave and the increased thickness of the wave for doped RDX as compared with conduction measurements obtained with pure RDX were discussed in terms of 2 current models for the origin of the ionization wave - the shock wave model and the detonation generated plasma model.

3031

Utah U. Dept. of Metallurgy, Salt Lake City.

DETONATION-GENERATED IONIZATION WAVES AT REDUCED PRESSURES, by M. A. Cook and D. A. Newell. Sept. 26, 1965, 40p. incl. illus. diagrs. refs. (AFOSR-65-2209) (AF AFOSR 65-56) AD 629238 Unclassified

Investigations were conducted into the phenomena accompanying detonation of RDX charges in constraining tubes at reduced air pressure. Electrostatic probe, and photomultiplier techniques were used to measure the conduction, luminosity, and velocity of the ionization wave which was expelled from the free surface of the explosive. Velocity data were also obtained for the detonation products. Color and infrared framing camera photographs of the ionization wave phenomena were obtained at different initial air pressures. The experimental results were compared with results reported of shock wave phenomena in shock tubes. (Contractor's abstract)

3032

Utah U. Dept. of Metallurgy, Salt Lake City.

INFLUENCE OF ELECTRICAL FIELDS ON SHOCK OF DETONATION TRANSITION, by M. A. Cook and T. Z. Gwyther. Sept. 28, 1968, [12]p. incl. illus. diagrs. tables. (AFOSR-65-2653) (AF AFOSR-65-56). AD 629239 Unclassified

The prediction that one should be able to influence detonations in condensed explosives as well as gaseous ones by means of axial electric fields is studied by means of the deflagration to detonation transition (DDT) in a modified card gap (or SPHF plate) test by observing the influence of an applied field on the distance S_2 into the receptor where the DDT occurs. This distance S_2 for Composition B was shown to be appreciably influenced by an applied electric field. The magnitude of the effect in 2 in. diameter cast Composition B (donor and receptor) and nearly a 5 cm lucite SPHF plate was about 0.15mm/KV/cm, a positive to negative potential increasing the distance S_2 and a negative to positive one decreasing S_2 (unless the DDT occurs too close to an electrode). (Contractor's abstract)

3033

Utah U [Dept. of Physics] Salt Lake City.

INTERNAL FRICTION UNDER HYDROSTATIC PRESSURE, by M. H. Miles, K. L. DeVries, and P. Gibbs. [1965] [3]p. incl. diagrs. refs. [AF 49(638)853] Unclassified

Published in Jour. Appl. Phys., v. 36: 852-854, Mar. 1965.

Internal friction measurements of zone-refined Al were obtained up to pressures of 5 kbar. The log of the background damping was found to increase linearly with pressure, with slopes of about 1.5×10^{-4} kbar^{-1} and 47.7×10^{-4} kbar^{-1} for CS_2 and kerosene pressure media, respectively. A reversible, intrinsic, pressure dependence of the amplitude-dependent part of the decrement Δ was found for Al of the approximate form $\partial(\ln\Delta)/\partial p = M + N\,\epsilon_0$, where $M = -4.5 \times 10^{-3}$ kbar^{-1}, $N = -4.2 \times 10^{-8}$ kbar^{-1}, and ϵ_0 is the strain amplitude. Theoretical expressions for the value of the "misfit parameter" ϵ' and its pressure derivative are derived from the Granato-Lücke theory in terms of M, N, and elastic constant data. It is suggested that the Granato-Lücke theory does not apply to zone-refined Al at these strain amplitudes. (Contractor's abstract)

3034

Utah U. Dept. of Physiology, Salt Lake City.

SYMPATHETIC ACTIVITY AND THE SYSTEMIC CIRCULATION IN THE SPINAL CAT, by A. F. de Molina and E. R. Perl. [1965] [21]p. incl. diagrs. refs. (AFOSR-66-1459) (AF AFOSR 65-748) AD 641173 Unclassified

Also published in Jour. Physiol., v. 181: 82-102, 1965.

A description is given of a series of experiments in the spinal cat whose purpose was to relate reflex and background discharge of sympathetic preganglionic neurones to the systemic circulation. Reflex discharges evoked by single afferent volleys in spinal nerves usually appeared in only certain post-ganglionic branches of the stellate and upper lumbar ganglia. A number of types of stimuli which reflexly excite preganglionic neurones evoked transient increases in the systemic arterial pressure, and/or altered flow in the femoral, inferior mesenteric and brachial arteries. Afferent fibers associated with reflex variations in arterial flow conducted between 10 and 25 m/sec, the same range of velocities as those evoking preganglionic reflexes. It was concluded that in the spinal cat: the distribution of preganglionic impulses is specific in terms of effector organs and demonstrates independent control of some portions of the sympathetic outflow; cycling of the systemic arterial pressure with its relation to sympathetic activity indicates some form of vasomotor control at the spinal level.

3035

Utah U. Dept. of Psychology, Salt Lake City.

PRODUCTIVE THINKING IN SCIENCE EDUCATION, by C. W. Taylor. Oct. 1965, 33p. incl. refs. (AFOSR-66-0010) (AF AFOSR 63-144) AD 631629 Unclassified

The paper discusses approaches to the communication of scientific information, at preuniversity level, which will stimulate creative thought processes. Distinctions are emphasized between teaching for the purpose of reproducing old knowledge vs. producing new ideas. Creativity is only beginning to become measureable. It is associated with such characteristics as the sensing of problems, originality, flexibility that is spontaneous, flexibility that is adaptive, fluency of ideas, fluency of associations, fluency of expressions, redefining in unusual ways, juggling many ideas simultaneously, penetration, visualization, elaboration, foresight, and certain kinds of evaluation abilities.

3036

Vanderbilt U. Dept. of Physics, Nashville, Tenn.

MEASUREMENTS OF A PRECURSOR ELECTRON FRONT, by J. P. Barach and J. A. Sivinski. [1965] [4]p. incl. illus. diagrs. refs. (AFOSR-66-1257) (AF AFOSR-64-287) AD 641714 Unclassified

Also published in Phys. Fluids, v. 8: 2158-2161, Dec. 1965.

A precursor electron front of a few kiloamperes is induced ahead of the shock flow in an electric shock tube. Velocity measurements show the electron front has a constant number density of 2×10^{13} cm^{-3} and a velocity proportional to gas conductivity. This front is a field-driven wave and heats the gas so the subsequent shock velocity is about doubled. (Contractor's abstract, modified)

3037

Vanderbilt U. Dept. of Physics, Nashville, Tenn.

FLOW MODES IN ELECTRIC SHOCK TUBES, by J. P. Barach and R. E. Vermillion. [1965] [9]p. incl. diagrs. refs. (AFOSR-66-1259) (AF AFOSR-64-287) AD 641715 Unclassified

Also published in Phys. Fluids, v. 8: 1976-1984, Nov. 1965.

Three modes of plasma flow in a low pressure electric shock tube have been studied. A diffusion type flow occurs below 10 μ initial pressure. Flow with a separated shock front ahead of the usual single luminous front is found to occur for high initial pressures, large distances downstream or lower Mach numbers. The separated shock front is found to occur when it is stable against Taylor interchange with the driver, brought on by flow deceleration. Calculations based on a simple blastwave model give agreement with the experimental data. (Contractor's abstract, modified)

3038

Vermont U. Dept. of Physics, Burlington.

PARAMETRICALLY EXCITED SURFACE WAVES, by R. P. Brand and W. L. Nyborg. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-65-1104) (AF AFOSR-63-62) AD 620532 Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 37: 509-515, Mar. 1965.

Experimental results are given on waves established at the upper surface of liquid in a rectangular plexiglas vessel executing uniform vertical oscillation, with frequencies primarily in the range 50-500 cps. Observed wave frequencies and wavelengths are in reasonable agreement with Benjamin-Ursell theory, but observed values of the critical onset amplitude ξ_c are much greater than expected. Considerable, though insufficient, improvement results from modifying the theory so that acoustic boundary layers at the container walls are taken into account. Using this modified theory, the ratio of observed to predicted ξ_c is as much a 14 at low frequency, but decreases to about 2 at the upper frequency limit. It is suggested that the discrepancy may arise, at least in part, from time-dependent solid-liquid surface energy, the time-dependence resulting from oscillation of the miniscus at vessel walls. (Contractor's abstract, modified)

3039

Vermont U. [Dept. of Physics] Burlington.

HIGH AMPLITUDE SOUND AS A PHYSICAL AGENT, by W. L. Nyborg. [1965] 7p. incl. diagr. table, refs. (AFOSR-65-2182) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-62 and National Institutes of Health) AD 627184 Unclassified

Presented at the meeting of the Fifth Internat'l. Cong. of Acoustics, Liege (Belgium), Sept. 7-14, 1965.

Also published in Proc. of the Fifth Internat'l. Cong. of Acoustics, Liege (Belgium), 1965, Belgium, v. Ia; KII Section, 1965.

In fluids, especially in liquids, an important second-order quantity in explaining sonically generated changes is a time-independent velocity field, the acoustic streaming. Using available theory, calculations are presented which, although not precise, are indicative of possibilities for more exact analysis of sonic effects. Only the moderately high amplitudes (10^3 - 10^5 cps) are considered due to the limited range of application of second-order analysis. Violent activity, i.e., transient cavitation, is excluded, but effects of stable cavitation, i.e., vibration of bubbles at sub-collapse levels, are included. It appears that bubble-associated acoustic streaming yields velocity gradients of sufficient magnitude to fragment droplets and macromolecules, provided their characteristics lie in certain ranges.

3040

Vermont U. Dept. of Physics, Burlington.

EFFECT OF LOCALIZED SOUND ON AN ELECTRODE REACTION (Abstract), by W. E. Rowe. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-62] and National Institutes of Health) Unclassified

Presented at Sixty-ninth meeting of Acoust. Soc. of Amer., June 2-5, 1965, Washington, D. C.

Published in Jour. Acoust. Soc. Amer., v. 37: 1214, June 1965.

Ultrasound in the absence of cavitation was applied in a special manner to a process in which the sonic effect on a surface monolayer could be studied. The process selected involved cyclic anodic and cathodic polarization of a platinum electrode in acid electrolyte. It was shown that in such a cycle adsorbed monolayers of

oxygen and hydrogen are deposited and removed, as revealed by characteristic changes in recordings of the electrode potential E as a function of time t. In the present study, the test electrode used was a platinum sphere approx 0.5 mm in diam mounted on the tip of an 85-kc/sec Mason horn. Sound applied during selected parts of the cycle caused pronounced changes in recorded E vs t plots. The observed changes probably result from mass transport of dissolved gas and from stress on adsorbed layers, both transport and stress being associated with acoustic streaming.

3041

Victoria U. Dept. of Chemistry, Wellington (New Zealand).

MOSSBAUER STUDIES OF CHEMICAL BONDING, by J. F. Duncan and R. M. Golding. [1965] [21]p. incl. diagrs. tables, refs. (AFOSR-65-1651) (AF AFOSR-63-27) AD 624363 Unclassified

Also published in Quart. Rev., v. 19: 36-56, 1965.

Mossbauer spectroscopy, the study of gamma-ray absorption or emission between the nuclear ground and excited states, is discussed relative to its pertinence to chemical analysis. The fundamental and theoretical aspects are first discussed, especially as they pertain to internal magnetic fields, electric-field gradients, isomeric or chemical shift, and temperature-dependence. Such practical aspects as experimental apparatus, the number of suitable isotopes, the prevention of loss in resonant gamma-ray energy, and the experimental features of the Mossbauer spectra are also considered. Chemical applications of Mossbauer spectroscopy are reviewed and several examples of its use in chemical works are presented.

3042

Victoria U. Dept. of Chemistry, Wellington (New Zealand).

APPLICATIONS OF THE MOSSBAUER EFFECT IN CHEMISTRY, by J. F. Duncan. Final rept. [1965] [5]p. (AFOSR-65-2530) (AF AFOSR-63-27) AD 627923 Unclassified

The quadrupole splitting for all iron compounds has been predicted and the magnetic susceptibility of Fe^{2+} and Fe^{III} complexes calculated, when the iron atom is in a crystal field of octahedral symmetry and tetragonal symmetry. The results have enabled the investigator to relate the electric field gradient at the iron nucleus and the magnetic moment of high spin ferrous and low spin ferric compounds. This work is related to the Mossbauer programme. Using quantum mechanics, predictions were made of the intensities and splitting of Mossbauer absorption lines. In particular, the asymmetry of the quadrupole split Mossbauer spectrum of polycrystalline triphenylchlorostannane observed by Goldanskii, the so-called 'Goldanskii effect', has been explained.

3043

Vienna U. Inst. for Theoretical Physics (Austria).

INVESTIGATION OF LOW MULTIPLICITY JETS FROM INACTIONS OF 24.5 GeV/c PROTONS WITH HYDROGEN, by K. J. G. Tölg-Hanke. Scientific note no. 8, March 1965, [18]p. incl. diagrs. (AFOSR-65-0998) (AF 61(052)433) Unclassified

The aim of this investigation is to collect data for comparison of pp and π^-p interactions, to search for resonances and, if any to see if they decay in a cascade. Low multiplicity jets namely 4-prongs were used because previous work dealing with comparison to π^-p-4-prong jets at 16 GeV/c has been done. The behavior of P-P^4 prong jets indicated that the initial particles tend to maintain their CM momentum and the pions created from a cylindrical cloud along the axis.

3044

Vienna U. Inst. for Theoretical Physics (Austria).

INVESTIGATION OF THE COULOMB-NUCLEAR INTERFERENCE IN ELASTIC K^-p SCATTERING AT LOW ENERGIES, by K. Schlosser, B. Buschbeck-Czapp, and others. Scientific note no. 29, Apr. 1965, [17]p. incl. diagrs. tables. (AFOSR-65-0990) (AF 61(052)644) Unclassified

Twenty-thousand photos have been scanned for elastic K^-p scattering in the momentum region 100-360 mev/c; 536 1-prong and 1923 2-prong events were analyzed. The phase angle and the absolute value of the nuclear part of the elastic scattering amplitude was determined. This result was found without the application of zero-range theory. (Contractor's abstract, modified)

3045

Vienna U. Inst. for Theoretical Physics (Austria).

THE $\omega \rightarrow \pi_0+\gamma$ DECAY IN THE QUARK MODEL, by W. E. Thirring. [1965] 2p. (AFOSR-65-0991) (AF-61(052)644) Unclassified

Also published in Phys. Ltrs., v. 16: 335, June 1, 1965. (AFOSR-65-0969; AD 635356)

An equation representing the partial width of the decay $\omega \rightarrow \pi_0+\gamma$ is derived from relativistic consideration. The equation is then compared with the standard expression representing the partial width.

3046

Vienna U. Inst. for Theoretical Physics (Austria).

ON CLASSICAL SYSTEMS WITH INTERNAL SYMMETRY GROUPS, by R. Sexl. Scientific note no. 28,

Mar. 22, 1965 [16]p. incl. refs. (AFOSR-65-0992) (AF 61(052)644 Unclassified

The invariance groups of the hydrogen atom and the harmonic oscillator are compared. They are known to be O_4 and U(3) respectively. The coordinates and momenta transform nonlinearly in the case of the hydrogen atoms. Therefore the finite symmetry transformations generated by Lenz's Vector cannot be given in closed analytic form. A geometrical interpretation of these transformations is however easily possible. It is shown, furthermore, that closed orbits in classical physics always correspond to a degeneracy with respect to angular momentum in quantum mechanics.

3047

Vienna U. Inst. for Theoretical Physics (Austria).

SYMMETRY GROUP CONTAINING LORENTZ INVARIANCE AND UNITARY SPIN, by T. Fulton and J. Wess. [1965] [4]p. (AFOSR-66-0875) (AF 61(052)-644) AD 638953 Unclassified

Also published in Phys. Ltrs., v. 14: 57-60, Jan. 1, 1965.

A previously proposed group, $\mathcal{G}_6$, embodying both ordinary spin and SU(3) to account for the symmetries of the strongly interacting particles is discussed. The group $\mathcal{G}_6$ is some extension of the inhomogeneous Lorentz group, L, by means of the unitary spin group, and its little group is [SU(6)]q, where q is the momentum. In view of the remarkable success in applying [SU(6)]q to the elementary particle spectrum, the difficult question of the Lorentz invariance of $\mathcal{G}_6$ becomes a crucial one. An approach to the problem of Lorentz invariance is proposed. Rather than studying $\mathcal{G}_6$, a simple formal generalization of L to a group $\mathcal{G}$, different from $\mathcal{G}_6$, which has L as a subgroup and [SU(6)]q as a little group, is considered. The generators of L commute with those of SU(3). It is also shown that the pseudoscalar octet and vector nonet mesons can be put into a manifestly L covariant representation which reduces to the 35 dimensional representation previously proposed for these particles.

3048

Vienna U. Inst. for Theoretical Physics (Austria)

ELECTROMAGNETIC FORM FACTORS AND THE GENERALIZED POINCARE GROUP, L, by T. Fulton and J. Wess. [1965] [5]p. incl. refs. (AFOSR-66-0876) (AF 61(052)644) AD 639453 Unclassified

Also published in Phys. Ltrs., v. 15: 177-179, Mar. 15, 1965.

The contribution of iso-orbit effects to the electromagnetic form factors is discussed. The generalized Poincaré group covarient arguments are used to construct current operators for mesons and baryons.

3049

Vienna U. Inst. for Theoretical Physics, (Austria).

MASS RELATIONS AND THE "SUPER-LORENTZ GROUP" L, by T. Fulton and J. Wess. [1965] [3]p. (AFOSR-66-0877) (AF 61(052)644) AD 639452 Unclassified

Also published in Phys. Ltrs., v. 14: 334-336, Feb. 15, 1965.

The significance of the 36 Hermitian momentum operators introduced in the generalization of Lorentz groups L_H to the inhomogeneous group L was discussed. It is shown that the mass-squared operator is a specific set of components of a L-covariant tensor, which yield the Gell-Mann-Okubo mass formula.

3050

Vienna U. Inst. for Theoretical Physics, (Austria).

HIGH ENERGY PARTICLE RESONANCES, CROSS SECTION AND SYMMETRIES, by W. E. Thirring. Mar. 11, 1965, 4p. Sept. 1, 1964-Feb. 28, 1965. (Technical status rept. no. 5) (AF 61(052)644) Unclassified

The line of approach was a relativistic extension of SU(6), a combination of internal and space-time symmetries. A group L which is the semidirect product of SL(6, c) and 36 translations was investigated. Relations between the Boson masses and the form factors of Baryons were derived and found to be in agreement with experimental numbers. Some results are given of elastic scattering of low energy K^- and charge exchange scattering at low K^- momenta.

3051

Vienna U. [Inst. for Theoretical Physics] (Austria).

[INVESTIGATION ON THE DYNAMICS OF LIQUIDS BY MEANS OF NEUTRON AND GAMMA SCATTERING] Zur Untersuchung der Dynamik von Flüssigkeiten mittels Neutronen-und Gamma-Streuung, by P. Wein Weinzierl and E. Ujlaki. [1965] 7p. incl. diagr. refs. (AFOSR-66-1682) (AF 61(052)645) AD 638529 Unclassified

Also published in Acta Phys. Austriaca, v. 21: 218-224, 1965.

The present situation of our knowledge on the dynamics of liquids, especially polar liquids like H_2O, is shortly summarized. A method is described by which information on liquid dynamics is obtained from Rayleigh scattering of recoilless emitted γ-radiation by the liquid sample. The condition of large source width, ΔE 10^{-5}ev, and high Mossbauer-factor seems best fulfilled by the 46 kev transition in W^{183}. A bent crystal diffraction spectrometer with 60 cm radius is required

to select the 46 kev line from the complex spectrum. The design of the entire equipment comprising this diffraction spectrometer and a velocity drive for speeds up to 10m/sec for the source is described.

3052

Vienna U. [Inst. for Theoretical Physics] (Austria)

[INVESTIGATION OF THE MOSSBAUER SPECTRUM OF THE K X-RAY OF Fe^{57} BY MEANS OF HYDRAULIC MOSSBAUER ANALYZER] Untersuchung des Mossbauerspektrums der K-Konversionslinie von Fe^{57} mit Hilfe eines hydraulischen Mossbauerspektrometers, by P. Schabel and E. Ujlaki. [1965] [9]p. incl. diagr. refs. (AFOSR-66-1683) (AF 61(052)845) AD 638955 Unclassified

Also published in Acta Phys. Austriaca, v. 21: 154-162, 1965.

A Mossbauer analyzer has been developed by using the constant flow of a viscous liquid. The principal parts of its construction are described. The results of some Mossbauer resonance experiments are given, including the the investigation of the velocity spectrum of the K conversion X ray occurring at resonance scattering by a stainless steel foil containing natural Fe^{57} abundance.

3053

Vienna U. Inst. for Theoretical Physics, (Austria).

[MOSSBAUER EFFECT OF THE 46.5 keV-LINE OF TUNGSTEN 183] Mossbauereffekt der 46,5 keV-Linie von W-183, by M. Drog and E. Ujlaki. [1965] [4]p. incl. diagrs. (AFOSR-66-1693) (AF 61(052)845) AD 638528 Unclassified

Also published in Acta Phys. Austriaca, v. 20: 171-174, 1965.

Comparative data on Mossbauer effects in tungsten of atomic weights 182 and 183 are given. For the latter, a separation of the excited states at 99 kev and 46.5 kev was obtained and the lifetimes measured.

3054

Virginia Polytechnic Inst. Dept. of Chemistry, Blacksburg.

THE OXIDATION OF ARSENIC (III) AND ANTIMONY (III), by J. G. Mason. Final rept. Feb. 1, 1963-Feb. 1, 1965. [17]p. incl. diagrs. (AFOSR-65-0662) (AF AFOSR-63-210) AD 614476 Unclassified

The kinetics of the Cr(VI)-As(III) reaction have been measured in perchloric acid solutions, acetic acid solutions, acetic acid-acetate buffers, NH_4NO_3, and $H_2PO_4^-$ - $HPO_4^{=}$ buffers. The reaction shows catalysis by H^+, and HOAc. The general form of the rate laws is Perchloric acid:

$$\frac{-d[Cr(VI)]}{dt} = (k_o + k_1[H^+] + k_2[H^+]^2)\frac{A[As(III)][Cr(VI)]}{1 + B[As(III)]}.$$

Acetic Acid and Acetate Buffers: $\frac{-d[Cr(VI)]}{dt} =$

$$(k_o + k_{HOAc}[HOAc])\ \frac{A[As(III)][Cr(VI)]}{1 + B[As(III)]};\ H_2PO_4^- - HPO_4^{=}$$

Buffers; $\frac{-d[Cr(VI)]}{dt} = \frac{k[As(III)][H_2PO_4^-][Cr(VI)]}{1 + B'[H_2PO_4^-]}$. In phosphate buffers, a Cr(VI) · $H_2PO_4^-$ complex is indicated as an oxidizing agent. In the other systems, the following mechanism is consistent with the experimental facts: As(III) + $HCrO_4^- \rightleftarrows$ As(III) · $HCrO_4^-$ pre-equilibrium; As(III) · $HCrO_4^- \xrightarrow{k}$ products.

3055

[Vitro Corp. of America] Vitro Labs., Silver Spring, Md.

NON-SEPARABLE SOLUTIONS OF THE HELMHOLTZ WAVE EQUATION, by D. S. Moseley. [1965] [4]p. (AFOSR-65-1076) (AF 49(638)1148) AD 619631 Unclassified

Also published in Quart. Appl. Math., v. 22: 354-357, Jan. 1965.

A set of solutions not obtainable by the method of separation of variables is presented for the vector Helmholtz wave equation in circular cylindrical coordinates limited to nonangular dependence. These are constructed of Bessel and trigonometric functions. For example, if A is the vector, the r-component of the simplest member of the set is $A_r = C_1 [mrJ_0(pr) \cos (mz) + pzJ_1(pr) \sin (mz)]e^{-i\omega t}$, where C_1 is an arbitrary constant, m and p are propagation constants, and ω is angular frequency. Brief reference is made to 3-dimensional solutions in rectangular coordinates. (Contractor's abstract)

3056

Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

RECOVERY OF INTERPLANETARY VEHICLES BY LOW-THRUST BRAKING OUTSIDE THE ATMOSPHERE, by L. Moulin. [1965] [7]p. incl. diagrs. (AFOSR-65-2346) (AF EOAR-63-39) AD 629209 Unclassified

Also published in Astronaut. Acta, v. 11: 110-117, 1965.

An attempt has been made to optimize the problem of recovering an interplanetary vehicle through the earth's atmosphere. Optimum conditions are defined as those which would minimize the deadweight, which includes the fuel required for rocket braking, and amount of material which is ablated for heat protection during the flight into the atmosphere. It is shown that when

electrical propulsion can be used, an optimum compromise between partial rocket and atmospheric braking may exist, depending upon the respective qualities of the propulsion system and ablative material. (Contractor's abstract)

3057

Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

DEVELOPMENT OF A METHOD FOR METEOR TRAJECTORY ANALYSIS, by L. Moulin and J. Devekay. Nov. 1965, [35]p. incl. diagrs. tables. (AFOSR-65-2940) (AF EOAR-65-12) AD 627695 Unclassified

Analysis of meteor trajectories has been viewed as a means to improve the knowledge about aerodynamic heating during atmospheric re-entry, for velocity ranges beyond escape velocity. A method of analysis is presented. Application to one natural meteor known as Meanook 132 has been made and the results compared with those obtained by other methods.

3058

Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).

LAMINAR SEPARATION IN SUPERSONIC AND HYPERSONIC FLOWS, by J. J. Ginoux. Final rept. Oct. 1965. [27]p. incl. illus. diagrs. tables, refs. (AFOSR 65-2715) (AF EOAR 65-11) AD 628182 Unclassified

High speed 2-dimensional reattaching flows are characterized by the development of regularly spaced vortices in the boundary layer, whose effect is to produce heat transfer rates at reattachment which are, locally over the span, considerably higher in laminar and transitional flows than in the turbulent case. These results are expected to occur both at supersonic and hypersonic speeds, as these vortices were observed over a range of Mach nos of 1.5 to 7.0. A basic difference in the recovery of total energy at reattachment was observed between laminar and transitional flows over ramps. In the latter case, the recovery temperature was maximum at reattachment and decreased to the laminar theoretical value in a region downstream of reattachment, where the flow was turbulent. The aerodynamic heating of sweptback wings can be predicted by a simple method derived from flat plate theory and by superimposing flow components parallel and perpendicular to the leading edge. Streamwise vortices do not seem to affect the average heat transfer coefficient.

3059

[Wales U. Coll.] Edward Davies Chemical Lab., Aberystwyth (Gt. Brit.).

THE REACTIONS OF METHYL RADICALS WITH FORMAMIDE, N-METHYL- AND NN-DIMETHYL-FORMAMIDE, by L. F. R. Cafferata, J. A. Kerr, and A. F. Trotman-Dickenson. [1965] [4]p. incl. tables, (AFOSR-65-1473) (AF EOAR-63-23) AD 622752 Unclassified

Also published in Jour. Chem. Soc. (London), No. 242: 1386-1389, Feb. 1965.

The following rate constants have been obtained for the abstraction of hydrogen atoms from formamide by methyl radicals: formamide (170 - 247°) log k (mol^{-1} cc $sec.^{-1}$) = 10.5 - (6,600/2.3 RT); N-methylformamide (161-287°) log k (mol^{-1} cc sec^{-1}) = 10.9 - (7,600/2.3 RT); NN-dimethylformamide (120-298°K) log k(mol^{-1} cc, sec^{-1}) = 11.4 - (8,300/2.3 RT). These results are compared with methyl-radical reactions with aldehydes and formates.

3060

[Wales U. Coll.] Edward Davies Chemical Lab., Aberystwyth (Gt. Brit.).

PYROLYSES OF ETHYL CYANIDE, T-BUTYL CYANIDE, CUMYL CYANIDE, AND ACETAMIDE, AND BOND STRENGTHS IN CYANIDES, by M. Hunt, J. A. Kerr, and A. F. Trotman-Dickenson. [1965] [6]p. incl. tables, refs. (AFOSR-65-2497) (AF EOAR-63-23) AD 627833 Unclassified

Also published in Jour. Chem. Soc., (London), No. 933: p. 5074-5080, Sept. 1965.

Pyrolyses of several cyanides and acetamide have been carried out by the aniline-carrier technique. Ethyl cyanide decomposes by 3 reactions yielding ultimately hydrogen, methane, and ethylene as gaseous products; the decomposition to give a methyl radical is a first-order homogeneous reaction with (686-765°K): log k (sec^{-1}) = 14.1 - (72,700/2.3RT). The analogous reaction for t-butyl cyanide has (602-652°K): log k (sec^{-1}) = 15.2 - (70,200/2.3RT). The rate-determining step for the production of methane in the pyrolysis of cumyl cyanide is of the first-order and homogeneous with (520-624°K): log k sec^{-1}) = 12.5 - (50,100/2.3RT). The methane probably arises from bond rupture in the nitrile yielding a methyl radical, but it is possibly produced by direct molecular elimination. Acetamide decomposes mainly by the molecular elimination of ammonia for which the rate constant is (563-747°) log k (sec^{-1}) = 14.7 - (73,400 2.3RT).

3061

[Wales U. Coll.] Edward Davies Chemical Lab., Aberystwyth (Gt. Brit.).

REACTIONS OF FREE RADICALS CONTAINING NITROGEN, by A. F. Trotman-Dickenson. Final rept. Oct. 25, 1965. [10]p. incl. tables (AFOSR-65-2886) (AF EOAR-63-23) AD 627816 Unclassified

Hydrazines, Anilines and Cyanides were pyrolysed and the heats of formation of the resultant radicals and the strengths of the bonds formed by them deduced. The reactions of methyl and ethyl radicals with a variety of amino compounds were studied. The reaction of difluoroamino radicals in the addition to olefins and aromatic compounds and in the transfer of hydrogen and halogen atoms were investigated. (Contractor's abstract)

3062

Warner and Swasey Co., Flushing, N. Y.

MATRIX ELEMENTS FOR VIBRATION-ROTATION TRANSITIONS IN THE HBr OVERTONE AND HOT BANDS, by H. J. Barkov, A. L. Shabott, and B. Sesh Rao. [1965] [8]p. incl. diagrs. tables, refs. (AFOSR-65-2262) (AF 49(638)1127) AD 625988 Unclassified

Also published in Jour. Chem. Phys., v. 42: 4124-4131, June 15, 1965.

The strengths of the vibration-rotation lines of the first overtone, hot-band, and fundamental band of HBr have been measured by a curve of growth method, applying a correction for 2 overlapping lines devised by Sakai. The squares of the electric-dipole matrix elements $|\mathfrak{m}_0^2(m)|^2$ and $|\mathfrak{m}_1^2(m)|^2$ for the lines have been calculated, and have been fitted, respectively, to a cubic and quadratic polynomial in m, using the method of least squares. The experimental results for all 3 bands are compared with the theory of Herman and Wallis. The fact that the experimental $|\mathfrak{m}_0^2(0)|^2$ is less than that calculated from a linear dipole-moment function clearly requires a positive value of M_2, the second derivative of the dipole-moment function. The squares of the matrix elements $|\mathfrak{m}_0^2(0)|^2$ are used to calculate M_1 and M_2, the dipole-moment coefficients, for Morse and anharmonic oscillators. Of all the possible sets of M_1 and M_2 obtained in each case, the one giving results in better agreement with $|\mathfrak{m}_1^2(0)|^2$ is chosen. The chosen values of the dipole-moment coefficients are $M_1 = +4.56 \times 10^{-11}$ esu and $M_2 = +0.69 \times 10^{-3}$ esu cm^{-1} for the Morse oscillator and $M_1 = +4.63 \times 10^{-11}$ esu and $M_2 = 0.70 \times 10^{-3}$ esu cm^{-1} for the anharmonic oscillator. Since the sign of M_2 is positive, the Morse oscillator results are preferred. (Contractor's abstract)

3063

Warner and Swasey Co., Flushing, N. Y.

APPLICABILITY OF INFRARED EMISSION AND ABSORPTION SPECTRA TO DETERMINATION OF HOT GAS TEMPERATURE PROFILES, by R. H. Tourin and B. Krakow. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-1436) [AF 49(638)1132] AD 622691 Unclassified

Also published in Appl. Opt., v. 4: 237-242, Feb. 1965.

Changes in IR emission and absorption spectra of hot gases brought about by controlled variations of gas temperature profile were measured. Spectral emission-absorption temperatures were determined from the spectral data as a function of wavelength. These temperatures proved independent of wavelength for an isothermal profile, despite a large variation of absorption with wavelength. For nonisothermal profiles, the emission-absorption temperature varied with wavelength in a characteristic manner for each profile. These results established more firmly the validity of the IR emission-absorption technique of gas temperature measurement, and confirmed a previous hypothesis that the wavelength dependence of spectrally determined temperature, observed for most flames, is a temperature profile effect. The spectral emittance equation for a gas was formulated in terms of observable quantities for isothermal and nonisothermal cases, taking the spectrometer slit function into account. (Contractor's abstract)

3064

Warner and Swasey Co., Flushing, N. Y.

DETERMINATION OF HOT-GAS TEMPERATURE PROFILES FROM INFRARED EMISSION AND ABSORPTION SPECTRA, by B. Krakow. [1965] [2]p. incl. diagr. tables. (AFOSR-66-0352) (AF 49(638) 1132) AD 631616 Unclassified

Presented at AIAA 2nd Aerospace Sciences Meeting, New York, N. Y., Jan. 25-27, 1965.

Also published in AIAA Jour., v. 3: 1359-1360, July 1965.

Emittance equations and methods of solution are derived for the temperature gradients existing in a gas. The method was tested by measurements of known temperature profiles of hot CO_2 produced by flames on flat flame burners. The temperature profile as calculated by means of an iteration scheme agreed well with the zonal temperatures determined by an infrared brightness method.

3065

Washington State U. [Dept. of Physics] Pullman.

PHOTODESORPTION, by R. O. Adams and E. E. Donaldson. [1965] [5]p. incl diagrs. refs. (AFOSR-65-1216) (AF AFOSR-62-86) AD 621315 Unclassified

Also published in Jour. Chem. Phys., v. 42: 770-774, Jan. 15, 1962.

Monochromatic radiation with a wavelength between 2000 and 6000 A is shown to desorb CO from surfaces of Fe, Ni, and Zr. The desorption efficiency has a maximum at 2700 A for Ni, at less than 2500 A for Zr, and in the visible region for Fe. Photodesorption from W and Mo was not detected. A suggested mechanism for photodesorption indicates that valuable information concerning surface binding can be obtained from refined measurements.

3066

Washington State U. Dept. of Physics, Pullman.

ELECTRICAL BREAKDOWN IN VACUUM: NEW EXPERIMENTAL OBSERVATIONS, by M. Rabinowitz and E. E. Donaldson. [1965] [6]p. incl. illus. diagrs. refs. (AF AFOSR-62-86) Unclassified

Published in Jour. Appl. Phys., v. 36: 1314-1319, Apr. 1965.

Electrode geometry effects neglected by previous investigators are shown to be significant for electrical breakdown in vacuum for gap lengths 0 to 1 mm exhibiting breakdown at 0 to 60 kv for Al, Cu, and stainless steel electrodes. In particular, data demonstrating curvature, area, and polarity effects are reported. The effects of material transfer, particle inertia, protrusion formation, erosion, and patterned deposits are also reported.

3067

Washington State U. [Dept. of Psychology, Pullman]

NOTE ON INDIVIDUAL STORAGE LOADS AND INDIVIDUAL LOAD REDUCTIONS, by K. E. Lloyd. [1965] [2]p. incl. table. (AFOSR-65-2669) (AF AFOSR-63-256) AD 629697 Unclassified

Also published in Psychol. Repts., v. 16: 995-996, 1965.

Sequential memory tasks requires E to construct a sequence of items to be remembered and cues to recall these items. In a series of studies, sequences were constructed in terms of the average number of items S was remembering at a recall point and of the average number of items S was asked to recall at a recall point. These averages were based on values assigned to individual items and recall points. The present study systematically varied the distribution of these individual values that formed the averages. Bimodal distributions affected recall differently from symmetrical distributions. (Contractor's abstract)

3068

Washington U. [Dept. of Electrical Engineering] St. Louis, Mo.

FUNCTIONAL REPRESENTATION OF NONLINEAR SYSTEMS. INTERPOLATION AND LAGRANGE EXPANSION FOR FUNCTIONALS, by D. Gorman and J. Zaborsky. [1965] [9]p. incl. diagrs. refs. (AFOSR-65-2061) (AF AFOSR-65-482) AD 627737 Unclassified

An original analytic representation is introduced for systems where differential equations are available. The structure of the functional is analyzed with nonzero initial conditions. Functional representations are introduced for systems described by past measured input-output records. (Contractor's abstract)

3069

Washington U. Dept. of Electrical Engineering, Seattle.

MACHINE LEARNING FOR GENERAL PROBLEM SOLVING, by D. L. Johnson. 1964-1965. 83p. incl. diagrs. tables, refs. (AFOSR-66-0835) (AF AFOSR-65-939) AD 632576 Unclassified

Three efforts are reported that explore different approaches to machine learning and problem solving. The first extends methods previously applied to trigonometric identities to problems of finding proofs of Boolean algebra identities. The problem of storing, choosing, and applying transformations was a major difficulty. A special coding system was developed that allows a single transformation to be stored that accounted for all possible combinations of variables. The program enables problems to be solved after "learning" that could not have been solved initially. Preliminary phases of an effort are described that investigates concept formation modeled in one sense after the work of Piaget. The second extends an adaptive tree pruning system exemplified in playing chess. The present system has a higher playing-to-learning time ratio resulting from the removal of "statistical learning". A record of decisions during search is stored without perturbing learning parameters and is subsequently processed to form two new lists, each containing learning parameters and thresholds that caused parts of the tree that could and could not be pruned. Constraints imposed on the system for pruning adjustment are discussed. The third effort, an attempt to apply some of the learning methods to Slagle's symbolic integration (SAINT) program, was discontinued, both because of hardware and software limitations and because complexity of the integration process might obscure the basic learning problem that is being studied.

3070

Washington U. [Dept. of Mathematics] St. Louis, Mo.

SETS OF UNIQUENESS AND MULTIPLICITY FOR $1^{p,a}$, by I. I. Hirschman, Jr. and Y. Katznelson. [1965] [11]p. (AFOSR-66-2440) (AF AFOSR-65-721) AD 644357 Unclassified

Also published in Israel Jour. Math., v. 3: 221-231, Dec. 1965.

The spaces $\chi^{p,\alpha}$ induce a classification of the closed subsets Θ of T, the reals modulo 1, as sets of (p, α) multiplicity (or (p, α) uniqueness) as Θ is (or is not) the support of a non-zero distribution ψ such that $\psi(n) \in \chi^{p,\alpha}$. (Contractor's abstract)

3071

Washington U. [Dept. of Physics] St. Louis, Mo.

TRIPLET STATE ESR OF METAL CHELATE COMPOUNDS, by I. M. Brown, S. I. Weissman, and I. C. Snyder. [1965] [7]p. incl. diagrs. table, refs. (AFOSR-65-1341) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-62-365] Atomic Energy Commission and National Science Foundation) AD 622911 Unclassified

Also published in Jour. Chem. Phys., v. 42: 1105-1111, Feb. 1, 1965.

The electron spin resonance spectra of a series of metal chelate compounds are reported. The metals are alkaline earths; the ligands are bidentate and tridentate derivatives of 2, 2'-bipyridine and 1, 10-phenanthroline and related compounds. The ESR spectra are interpreted as due to randomly oriented molecular triplets. Most spectra can be computer-simulated with a spin-Hamiltonian corresponding to a magnetic dipole-dipole interaction of the unpaired electrons of $D \approx 0.01\ cm^{-1}$ and $E = 0$. The vanishing value of E is interpreted to mean that the complexes have S_4 symmetry with the ligands on opposite sides of the cation and having mutually perpendicular planes. The spectra of some potassium chelate dimers are also reported. These characteristically appear to have nonvanishing E values.

3072

Washington U. [Dept.] of Physics, St. Louis, Mo.

MATRIX ELEMENTS OF A FERMION SYSTEM IN A REPRESENTATION OF CORRELATED BASIS FUNCTIONS, by E. Feenberg and C.-W. Woo. [1965] [15]p. incl. diagr. tables, refs. (AFOSR-65-0811) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-412 and National Science Foundation) AD 616219 Unclassified

Also published in Phys. Rev., v. 137: A391-A405, Jan. 18, 1965

The ground state and low excited states of liquid He^3 (and other fermion systems) can be constructed from a set of basis functions $\Psi(|n) = \psi_0^B \Phi(|n)$ in which ψ_0^B is the ground-state boson-type solution of the Schrödinger equation and the model functions $\Phi(|n)$ are Slater determinants suitable for describing states of the noninteracting Fermion system. Diagonal and

nondiagonal matrix elements of the identity and the Hamiltonian operator are evaluated by a cluster-expansion technique. An orthonormal basis system is constructed from $\Psi(|n)$ and used to express the Hamiltonian operator in quasiparticle form: a large diagonal component containing constant, linear, quadratic, and cubic terms in free-quasiparticle occupation-number operators and a nondiagonal component representing the residual interactions involved in collisions of 2 and 3 free quasiparticles. (Contractor's abstract)

3073

Washington U. [Dept.]of Physics, St. Louis, Mo.

GROUND STATE AND LOW EXCITED STATES OF A BOSON LIQUID WITH APPLICATIONS TO THE CHARGED BOSON SYSTEM, by D. K. Lee and E. Feenberg. [1965] [12]p. incl. diagrs. tables, refs. (AFOSR-65-0812) (AF AFOSR-62-412) AD 617236
Unclassified

Also published in Phys. Rev., v. 137: A731-A742, Feb. 1, 1965.

The maximum deviation of the radial distribution function from its asymptotic value is used as an expansion parameter in calculating the properties of a degenerate boson system. The uniform limit holds at low densities under appropriate constraints on the Fourier transforms of the interaction potential and also at high densities for the charged-boson system. In the uniform limit a procedure based on (1) a Jastrow-type trial function, (2) the Wu-Feenberg functional for the kinetic energy, (3) the Kirkwood superposition approximation, or the more accurate Abe form for the 3-particle distribution function, yields the Bogoliubov formulas for the ground-state energy and the excitation energies of a degenerate or nearly degenerate boson system. Numerical results are also computed at intermediate and moderately low densities ($0.01 \lesssim r_s \lesssim 100$). (Contractor's abstract, modified)

3074

Washington U. Dept. of Physics, St. Louis, Mo.

DYNAMIC NUCLEAR ENHANCEMENT IN METALLIC SODIUM, by J. F. Reichert and J. Townsend. [1965] [7]p. incl. diagrs. refs. (AFOSR-65-0813) [AF AFOSR-62-412] AD 616268 Unclassified

Also published in Phys. Rev., v. 137: A476-A482, Jan. 18, 1965.

A double-resonance spectrometer was constructed capable of making accurate measurements of all the dynamical variables expressed in the master equation governing the time evolution of the dynamic nuclear enhancement of a single sodium sample. This system could measure the rate of rise of the nuclear polarization after the onset of saturation, the rate of decay of the polarization after the saturation was removed, and the nuclear T_1 by the standard 180°-90° pulse method. It was found that each of these processes had the same time constant $T_1 = 13.2 \pm 0.2$ msec within experimental error, in agreement with theory. The steady-state enhancement as a function of electron saturation gave a value of the leakage coefficient f to be 0.88 ± 0.05 at 29°C. The values of T_1 and f enable one to calculate T_{1e}, i.e., the spin-lattice relaxation time due to the conduction-electron-nuclear contact interaction, to be 14.9 ± 0.8 msec. These data demonstrate that the electron-nuclear contact interaction is the dominant mode of nuclear relaxation for sodium at room temperature. (Contractor's abstract)

3075

Washington U. [Dept. of Physics] St. Louis, Mo

NECESSARY CONDITION ON THE RADIAL DISTRIBUTION FUNCTION, by E. Feenberg. [1965] [2]p. (AFOSR-65-1810) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-412 and National Science Foundation) AD 625682
Unclassified

Also published in Jour. Math. Phys., v. 6: 658-659, Apr. 1965.

Trial functions g(r) may be used as radial distribution functions to study the ground-state properties of a uniform extended quantum fluid. A result obtained by Wigner and Seitz in the study of the charged electrons gas imposes an integral inequality on any assumed g(r). The relation is $\int_0^\infty [1 - g(r)]r\,dr / [\int_0^\infty [1 - g(r)]r^2\,dr]^{2/3} \geq 1.792/3^{1/3} = 1.243$. This inequality places an effective constraint on the location, magnitudes, and width of the nearest-neighbor peak. (Contractor's abstract)

3076

Washington U. [Dept.] of Physics, St. Louis, Mo.

DYNAMICAL CORRELATIONS AND THE NUCLEAR PHOTOEFFECT, by T.-P. Wang and J. W. Clark. [1965] [38]p. incl. tables, refs. (AFOSR-66-0447) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-412) AD 630313
Unclassified

Also published in Prog. Theoret. Phys. (Japan), v. 34: 776-813, Nov. 1965.

Strong dynamical correlations implied by realistic 2-nucleon potentials have substantial effect on energy moments of the photonuclear cross section calculated by means of the dipole sum rules. A model is devised in which it is found that the bremsstrahlung weighted cross section, which is sensitive to the long-range behavior of the 2-body correlation factor f, may be significantly decreased, and the integrated cross section and the first moment of the cross section, which are sensitive to the 2-nucleon potential and to the

short-range behavior of f, are strongly enhanced relative to values of these moments based on a Fermi gas model and monotonic central potentials. The numerical results are not inconsistent with the most relevant experimental data.

3077

Washington U. [Dept. of Physics] St. Louis, Mo.

PRIMARY COSMIC-RAY ALPHA-PARTICLES. IV - ENERGY SPECTRUM AT41°N GEOMAGNETIC LATTITUDE, by D. E. Guss. [1965] [15]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-382], Army Research Office (Durham) and National Science Foundation) Unclassified

Published in Nuovo Cimento, Series X, v. 39: 27-41, Sept. 1, 1965.

From the analysis of an emulsion stack exposed to the primary cosmic radiation over Texas on Feb. 8, 1959, the α-particle integral energy spectrum was found to be well represented by a simple power law of the total energy $N(W) = CW^{-\gamma}$ in the kinetic energy range (2.5 - 7.5) gev/nucleon. The value of exponent was found to be $\gamma = 1.56 \pm 0.18$, which is not appreciably different, but perhaps somewhat lower than a value $\gamma \simeq 1.65$ found at solar minimum in the kinetic energy range (1.8 ÷ 3) gev/nucleon. A slightly smaller exponent at solar maximum is consistent with a solar modulating mechanism which preferentially removes low-energy particles from the primary cosmic-ray spectrum. These emulsions were exposed at a time near solar maximum, and the result is not consistent with a value $\gamma = 1.0$ in this energy range at solar maximum, as has been suggested. By using glass-backed plates and a low-temperature isothermal processing technique, the emulsion noise was reduced to a level where measurements could be extended to α-particle kinetic energies of 7.5 gev/nucleon. Agreement of the point on the integral spectrum at a kinetic energy of 7 gev/nucleon with flux values found at Guam during a period of similar cosmic-ray intensity shows that there is no significant noise contribution in these emulsions which varies with cell size in the same way as the Coulomb scattering signal.

3078

Washington U. Dept. of Physics, St. Louis, Mo.

MEASUREMENT OF THE MÖSSBAUER RECOILLESS FRACTION IN β-Sn FOR 1.3 TO 370°K, by C. Hohenemser. [1965] [12]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-383] and National Science Foundation) Unclassified

Published in Phys. Rev., v. 139: A185-A196, Jul. 5, 1965.

Doppler-shift measurements of Mössbauer recoiless fractions f in β-Sn show discrepancies of the order of 20 to 30% and sometimes bear quoted errors of ± 10%. Such discrepancies can be caused by using incorrect values of α, the internal conversion coefficient; τ_m, the mean life of the excited state; Γ_A and Γ_S, the absorber and source linewidths; and B, the nonresonant background present in the detector at the energy of the Mössbauer γ rays. In the present work, the use of a black resonant absorber and the technique χ-γ delayed coincidences combine to eliminate dependence on these parameters in first approximation. In particular, the results $f = 0.455 \pm 0.010$ at 77.3°K and $f = 0.72 \pm 0.01$ at 4.2°K are obtained. The errors are systematic, and are due largely to uncertainties in evaluating the residual resonant transmission of the black absorber, the total magnitude of which is about 5% for $T _ 100$°K. For the experimental temperature range of $1.3 _ T _ 370$°K, f values are obtained at over 300 points for two different source samples. The results are as much as 20% higher than some previously reported values, and also do not agree well with the theoretical calculations of DeWames, Wolfram, and Lehaman for $T _ 150$°K. On the other hand, when the data are expressed in terms of a Debye temperature Θ derived at each temperature from the Debye formula for f, the Θ values show remarkably little variation with temperature, and fall on a smooth curve. The results at low temperature help to clarify the data of Wiedemann, Kienle, and Pobell in the superconducting region and immediately above. (Contractor's abstract)

3079

Washington U. [Dept. of Physics] St. Louis, Mo.

NEW MÖSSBAUER f VALUES IN β-Sn (Abstract), by C. Hohenemser and W. F. Walters. [1965] [2]p. Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-383] and National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 64-65, Jan. 28, 1965.

Doppler-shift measurements of Mössbauer f values show discrepancies of the order of 20%-30%, and sometimes bear quoted errors of ±10%. Such discrepancies can be caused by using incorrect values of α, the internal conversion coefficient; Γ^1/Γ, the emission-absorption width over the natural width; and B, the nonresonant background. In a previous "relative" experiment for 1.3 to 373°K, a black resonant absorber was clamped in front of the source. The counting rate depended only weakly (through the resonant transmission correction) on α and Γ^1/Γ. However, f values were obtainable only if f was known for a single temperature (for normalization) or, equivalently, if B was known. In a new experiment, the black absorber is retained, but B dependence is avoided by identifying the 23.8-kev γ-rays by their electronically measured life-time. Prompt coincidences from Te x-rays are removed by critical absorption. The result: $f = 0.46 \pm 0.01$ at 77°K. This converts the relative data to f values. It yields $f = 0.74 \pm 0.02$ at 4°K.

3080

Washington U. [Dept. of Physics] St. Louis, Mo.

ON ARYLBORON FREE RADICALS, by S. I. Weissman and H. van Willigen. [1965] [2]p. incl. diagr. (AFOSR-65-2079) (Sponsored jointly by [Air Force Office of Scientific Research under AF AFOSR-65-771] and National Science Foundation) AD 627494 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 2285-2286, May 20, 1965.

Experiments are conducted on trimesitylboron, which are in disagreement with those of Leffler, Doland, and Tanigaki (Jour. Amer. Chem. Soc., v. 87: 928, 1965). Leffler, et al, concluded that dimesityboron fluoride over Na-K alloy gives the radical Mes_2B, that addition of pyridine to this radical gives a second radical Mes_2B-Pyr, and that the trimesitylboron negative ion, Mes_3B, decomposes to Mes_2B after prolonged reduction. It is concluded from the present investigation that it is the dimesitylboron fluoride or its radical which decomposes and forms the trimesitylboron negative ion. Formation of Mes_2-Pyr is highly improbable. (Contractor's abstract)

3081

Washington U., Dept. of Physics, St. Louis, Mo.

PARAMAGNETIC RESONANCE ABSORPTION OF FREE RADICALS AND OTHER SUBSTANCES, by R. E. Norberg, S. I. Weissman and others. Final technical rept. Oct. 1, 1964-Sept. 30, 1965. Oct. 21, 1965 [4]p. (AFOSR-66-0167) (AF AFOSR-65-771) AD 628138 Unclassified

Results of studies in the following areas are briefly summarized: spectra of triplets and biradicals; effect of optical configuration on rates of electron transfer; intramolecular migration of triplet excitation; triarylboron free radicals; ESR of MnF_6 ions in potassium and ammonium fluogermanates; pulsed NMR in Al and Cu single crystals; spin-spin relaxation of F^{19} in LaF_3 single crystals; and pulsed NMR Ne^{21} in liquid and solid neon.

3082

Washington U. Dept. of Chemistry, Seattle.

VAN DER WAALS FORCES IN CONDENSED SYSTEMS, by G. D. Halsey, Jr. Final rept. [1965] [5]p. (AFOSR-65-0014) (AF 49(638)723) Unclassified

A brief summary of scientific accomplishments under this contract is presented. Most of the work pertained to the study of the relatively high-temperature interaction of gases with solids. A second general topic treated was that of solid solutions of the simplest molecules available. After observing that rapid equilibrium with an adsorbed solid solution was obtained, an attempt was made to study these systems in the absence of the adsorbent, but many difficulties were encountered. Studies of the sulfur trioxide system were an accidental by-product of an attempt to study a simple molecular interaction of chains of SO_3 molecules in the monomer SO_3. The actual situation was much more complicated than anticipated, and the result of the work was the first lengthy contribution to the physical chemistry of this very important compound since the 1920's. Work on the botanical polymer from locust bean gum represents an attempt to apply the methods of adsorption study to a much more complex system, and it presents many problems of interest in biochemistry as well as in pure physical chemistry. Dilute solutions of hydrogen in simple liquids was studied in 2 contrasted situations: the physical interaction that leads to solution as H_2 in liquid argon, and the chemical solution in liquid sodium. A bibliography of publications is included.

3083

Washington U. Dept. of Chemistry, Seattle.

SOLID SOLUTION OF ARGON AND KRYPTON: REFINED MEASUREMENTS, by B. E. F. Fender and G. D. Halsey, Jr. [1965] [5]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)723] and Petroleum Research Fund) Unclassified

Published in Jour. Chem. Phys., v. 42: 127-131, Jan. 1, 1965.

Vapor pressures of argon-krypton mixtures at vanishingly small solid accumulation have been analyzed to give values of the interaction energy parameter w_{AB} for a number of Ar-Kr solid solutions at temperatures between 85° and 101°K and in the argon mol-fraction range 4% to 18%. Vapor pressures and triple points of pure argon and krypton are also reported. The mol-fraction dependence of w_{AB} is negligible, and compatible with that predicted by an exact form of the regular solution or Ising lattice problem. (Contractor's abstract)

3084

Washington U. Dept. of Chemistry, Seattle.

THE SOLUBILITY OF HYDROGEN IN LIQUID SODIUM, by D. W. McClure and G. D. Halsey, Jr. [1965] [6]p. incl. diagrs. refs. [AF 49(638)723] Unclassified

Published in Jour. Phys. Chem., v. 69: 3542-3547, Oct. 1965.

The solubility of gaseous hydrogen in molten sodium has been determined over the temperature range 260-350°, in the region where concentration varies as the square root of the pressure, up to the concentration where there is separation of a hydride phase. The heat of

solution is small, - 2 ± 2 kcal mol of H_2. Similar results for deuterium are reported. (Contractor's abstract)

3085

Washington U. Dept. of Chemistry, Seattle.

INFRARED SPECTRUM OF $^{12}C^{18}O_2$, by C. Chackerian, Jr. and D. F. Eggers, Jr. [1965] [1]p. incl. tables. (AFOSR-65-2163) (Sponsored jointly by Air Force Office of Scientific under [AF 49(638)797] and National Science Foundation) AD 629380
Unclassified

Also published in Jour. Chem. Phys., v. 43: 757-758, July 15, 1965.

The observed vibrational-band centers of $^{12}C^{18}O_2$ between 1800 and 5000 cm^{-1} are reported and compared with calculated values. A 1.5-m Ebert vacuum-grating spectrometer was used with spectral slitwidth between 0.1 and 0.3 cm^{-1} to obtain the spectrograms. The vibrational-band centers given are believed to be accurate to ± 0.05 cm^{-1}.

3086

Washington U. Dept. of Chemistry, Seattle.

PERTURBATION OF SINGLET-TRIPLET TRANSITIONS ENERGIES, by R. E. Kellogg and W. T. Simpson. [1965] [5]p. incl. diagr. table, refs. [AF AFOSR-63-64]
Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 4231-4234, Oct. 5, 1965.

The first singlet-triplet transition energies for various substituted butadienes have been measured. A red shift found consistently going with 1- or 1, 4-substitution but not consistently with 2- or 2, 3-substitution is taken as evidence of hyperconjugation. A major conflicting possibility for explaining spectral shifts is internal dispersion forces. The dispersion force effect here is minimized because the transition studied has almost zero transition moment. A valence bond theory of perturbation of π-electron systems is developed and used to explain the results. A formula for free valence of residual affinity can be adapted from another, complementary, expression which automatically appears in the theory. It is judged more approximate to emphasize the complementary expression, which is called fixed valence. The fixed valence for a site is the sum of the Dirac-Penney bond orders of all bonds in the unperturbed molecule involving that site. The perturbation energy for radical attack is found to be inversely proportional to the fixed valence. (Contractor's abstract)

3087

Washington U. Dept. of Chemistry, Seattle.

A STUDY OF BONDING IN IRON COMPOUNDS USING THE MÖSSBAUER EFFECT, by N. E. Erickson. Final rept. June 3, 1965, 186p. incl. diagrs. tables, refs. (AFOSR-65-1225) (AF AFOSR-63-253, AF AFOSR-64-594, and AF 49(638)1004)
Unclassified

A series of studies are described in which the relationship between certain features of Mössbauer spectra and the bonding characteristics of iron in various types of compounds were investigated. A study of Mössbauer spectra of a number of low-spin and high-spin ferrous and ferric mixed cyanide-di-imine complexes is reported. It was found that when the differences in chemical isomeric shifts between similar ferrous-ferric compounds are plotted versus the average shift of the pair, the resulting curve is linear and valid for both high-and low-spin compounds. A linear relationship was found to exist between average chemical isomeric shift and redox potentials of these pairs. This work reports the first Mössbauer study of iron in a negative oxidation state and the first Mössbauer studies of cis-trans isomerism in iron compounds, where the isomerism arises from the relative positions of 2 groups around a single metal atom.

3088

Washington U. Dept. of Chemistry, Seattle.

AN EXAMPLE OF Sni CLEAVAGE OF A SULFIDE, by W. M. Schubert and Y. Motoyama. [1965] [2]p. incl. diagr. table, refs. (AFOSR-66-0306) (AF AFOSR-64-590) AD 629806
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 5507-5508, Dec. 5, 1965.

It has been established that unimolecular carbon-sulfur heterolysis is the rate-controlling step in the conversion of alkyl α-dimethylaminobenzyl sulfides to N, N-dimethyl-benzalimmium ion in aqueous acidic media. This appears to be the first authentic instance of an alkyl-sulfur bond of a sulfide. In pure water, the alkyl α-dimethylaminobenzyl sulfides are hydrolyzed to benzaldehyde practically instantly. In dilute aqueous acidic media, in which the substrate is present largely as the nitrogen conjugate acid, SH^+, the reaction rate is slow enough to measure. The over-all reaction proceeds quantitatively in two stages: the sulfide to $PhCH = NME_2$ and then to PhCHO. The report concerns the kinetics of the first stage. First-order rate constants for the stage were obtained by an ultraviolet spectrophotometric method.

3089

Washington U. [Dept. of Physics] Seattle.

EFFECTS OF TURBULENCE IN He II THERMAL COUNTERFLOW, by J. T. Tough, W. D. McCormick, and J. G. Dash. [1965] [5]p. incl. diagrs. refs. (AFOSR-66-0401) (AF AFOSR-62-298) AD 629533
Unclassified

Also published in Phys. Rev., v. 140: A1524-A1528, Nov. 29, 1965.

Measurement of the damping of small-amplitude transverse vibrations of a fine wire was used to investigate thermal counterflow of He II in wide channels of rectangular cross section. Below a critical heat current, the damping is independent of the current, and is dictated by laminar viscous flow of normal fluid. At higher heat currents, the damping increases above the subcritical value, and the excess damping has been studied as a function of parameters of the apparatus and liquid. The dependence of the magnitude of the critical heat current on temperature and channel width is described by a critical Reynolds number $R_c = \rho V_{nc} d/\eta \cong 1200$, where V_{nc} is the normal fluid velocity corresponding to the critical heat current, d is the channel width, η is the normal fluid viscosity, and ρ is the total density. R_c is independent of wire diameter and vibration frequency. The excess damping was found to fit a single empirical expression over a wide range of experimental parameters. An outstanding characteristic of the supercritical damping force is its dependence on the Reynolds number $(R - R_c)^{1/2}$. (Contractor's abstract)

3090

Washington U. [Dept. of Physics] Seattle.

THE SPECIFIC HEAT OF ADSORBED MONOLAYERS OF ^{3}He, by D. L. Goodstein, W. D. McCormick, and J. G. Dash. [1965] [2]p. (AFOSR-66-2849) (AF AFOSR-62-298) AD 645173 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards, and others. New York, Plenum Press, v. LT9 (Pt. B): 368-369, 1965.

Apparatus and measurements on the specific heat capacity of adsorbed helium-three are described in in terms of a fractional coverage referred to argon atom monolayer films. A report of initial findings for helium-four on copper and on argon are also reported along with more extensive data of helium-three on argon between 0.2 and 2.0°K.

3091

Washington U. [Dept. of Physics] Seattle.

THE FLOW OF He II AT MODERATE REYNOLDS NUMBERS, by J. T. Tough, W. D. McCormick, and J. G. Dash. [1965] [4]p. incl. diagrs. (AF AFOSR-62-298) Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards, and others, New York, Plenum Press, v. LT9(Pt. A): 287-290, 1965.

The damping of small-amplitude vibrations of a fine wire is used as a probe of the onset and development of critical flow phenomena in He II. The wire is located in a thermal counterflow produced in a channel of rectangular cross-section. The vibrating wire results are another indication of classical turbulence type phenomena in He II counterflow, both in the occurrence of a critical Reynolds number and in the dependence of the excess damping force on $(R - R_c)^{1/2}$.

3092

Washington U. [Dept. of Physics] Seattle.

DISCUSSION OF FACTORS AFFECTING THE ABSOLUTE ACCURACY OF MÖSSBAUER f MEASUREMENTS, by R. M. Housley. [1965] [6]p. incl. diagrs. (AFOSR-65-1966) (AF AFOSR-64-594) AD 626525 Unclassified

Also published in Nuclear Instr. and Methods, v. 35: 77-82, July 1965.

The possible influence on Mössbauer f measurements of the following effects are considered: (1) resonant nuclear self absorption in the source; (2) inelastic electronic scattering in the source; (3) non-resonant nuclear absorption in the absorber; and (4) inelastic electronic scattering and resonant nuclear scattering in the absorber. Sources of the effects and methods of calculating or measuring the strength of the effects are discussed.

3093

Washington U. [Dept. of Physics] Seattle.

INTERNAL CONVERSION IN Fe^{57} FROM THE MÖSSBAUER EFFECT IN IRON, by R. H. Nussbaum and R. M. Housley. [1965] [8]p. incl. diagr. table, refs. (AFOSR-65-2571) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-594 and National Science Foundation) AD 628824 Unclassified

Also published in Nuclear Phys., v. 68: 145-152, June 1965.

The conversion coefficient of the 14.4 kev Mössbauer transition in Fe^{57} was determined from the effective nuclear resonance cross section of a thin natural iron foil placed in a saturating magnetic field. Near natural line widths, were obtained with a single line source with precisely known resonant fraction. The total conversion coefficient of 9.0 ± 0.4 is in agreement with recent values from nuclear spectroscopy. (Contractor's abstract)

3094

Washington U. [Dept. of Physics] Seattle.

MEAN-SQUARE NUCLEAR DISPLACEMENT OF Fe^{57} IN Zn FROM THE MOSSBAUER EFFECT, by R. M. Housley and R. H. Nussbaum. [1965] [2]p. incl. diagr. (AFOSR-65-2597) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-594 and National Science Foundation) AD 628825 Unclassified

Also published in Phys. Rev., v. 138: A753-A754, May 3, 1965.

Fe^{57} in Zn shows a quadrupole splitting of 0.53 ± 0.03 mm/sec and a chemical shift of 0.53 ± 0.02 mm/sec relative to an Fe metal absorber at room temperature. The measurements of the Mössbauer fraction f indicate a ratio of mean-square displacements $\langle x^2 \rangle_{\parallel} / \langle x^2 \rangle_{\perp} > 2$ at room temperature relative to the crystal c axis. This is in qualitative agreement with lattice-dynamical calculations. (Contractor's abstract)

3095

Washington U. [Dept. of Physics] Seattle.

f MEASUREMENTS WITH BLACK ABSORBERS, by J. G. Dash. [1965] [6]p. incl. diagrs. (AFOSR-66-1605) (AF AFOSR-64-594) AD 641765 Unclassified

Also published in Mössbauer Effect Methodology, Proc. of the First Symposium, New York (Jan. 28, 1965), ed. by I. J. Gruverman. New York, Plenum Press, v. 1: 107-114, 1965.

A discussion is given of a technique for the measurement of the Mössbauer fraction (f) of γ radiation intensity which employs an absorber which is opaque to the Mossbauer line but transparent to the recoil radiation.

3096

Washington U. [Dept. of Physics] Seattle.

FERROMAGNETISM OF DILUTE SOLUTIONS OF COBALT IN PALLADIUM, by R. D. Dunlap, J. G. Dash and others. [1965] [5]p. incl. diagrs. table. (AFOSR-66-1608) (AF AFOSR-64-594) AD 643424 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. B): 1007-1011, 1965.

Previously reported measurements of ferromagnetic transitions in solid solutions of the cobalt-palladium system cover the concentration range from 100 to 0.1% Co. The most dilute sample was reported to have a Curie temperature of 7°K and the extrapolation of the T_c vs concentration curve seemed to indicate that a transition would occur for arbitrarily small concentrations of cobalt. The present work is an extension of these results in an attempt to determine whether there is a critical concentration below which ferromagnetism does not exist at T = 0.

3097

Washington U. [Dept. of Physics] Seattle.

INTERNAL FIELD OF FE^{57} IN NI IN THE REGION OF THE CURIE POINT, by D. G. Howard, B. D. Dunlap, and J. G. Dash. [1965] 5p. incl. diagrs. refs. (AF AFOSR-64-594) Unclassified

Published in Phys. Rev. Ltrs., v. 15: 628-632, Oct. 11, 1965.

The variation of magnetization with temperature of a ferromagnetic material near the Curie point T may be calculated to be $M = \text{const} \times (1 - T/T_c)^{\beta}$, where β depends upon the model used. Beta is ≈ 0.31 for a 3-dimensional Ising model and 1/2 for the molecular field approximation. Mössbauer spectra were obtained with a multichannel spectrometer and these were resolved into 6-line patterns up to 0.98 T_c. Above this temperature the normal intensity ratios appear to be preserved, though they are no longer resolved. Beta was found to be 0.33 ± 0.03 in the region $0.84 < T/T_c < 0.99$ and followed the 1/2 power law closely at higher temperatures.

3098

Washington U. [Dept. of Physics] Seattle.

PHASE CHANGE IN ADSORBED HELIUM AT LOW TEMPERATURE, by D. L. Goodstein, J. G. Dash, and W. D. McCormick. [1965] [3]p. incl. diagrs. refs. (AFOSR-66-0378) (AF AFOSR-65-923) AD 629831 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 447-449, Sept. 6, 1965.

Specific-heat data are presented for adsorbed helium in the temperature range from 0.25 to 4°K, at several partial monolayer coverages. The results are interpreted as indicating the existence of 2 surface phases.

3099

Wayne State U. Dept. of Physics, Detroit, Mich.

LANDAU LEVEL OSCILLATIONS IN THE MAGNETO-ACOUSTIC ABSORPTION IN ZINC, by H. V. Bohm and L. Mackinnon. [1965] [4]p. incl. diagrs. (AF AFOSR-62-379) Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards, and others. New York, Plenum Press, v. LT9(Pt. B): 786-789, 1965.

Most of the work so far described has been confined to the orientations $H \perp q$ and $H \parallel q$, where H is the magnetic field and q the propagation direction of longitudinal megacycle ultrasonic waves. This paper describes some experimental results obtained for other relative orientations of H and q. The ultrasonic

apparatus used was that described by Kamm and Bohm (Rev. Scient. Instr., v. 33: 957, 1962) operating at frequencies between 230 and 350 mcps in the temperature range 4.2° to 1.4°K. Experimental results indicate that the magnetoacoustic technique is capable of providing information on certain fermi surface cross-sectional areas as well as on caliper dimensions.

3100

Wayne State U. Dept. of Physics, Detroit, Mich.

INVESTIGATIONS OF THE ELECTRONIC STRUCTURES OF METALS USING ULTRASONIC TECHNIQUES, by N. Tepley. [1965] [18]p. incl. diagrs. refs. (AFOSR-66-0079) (AF AFOSR-64-695) AD 629858 Unclassified

Also published in Proc. IEEE, v. 53: 1586-1603, Oct. 1965.

The paper reviews ultrasonic research on the electronic properties of metals performed since the first observations, about 10 yr ago, that at low temperatures electrons are responsible for the primary contribution to the ultrasonic attenuation. After a description of the Fermi surface and other aspects of the physics of electrons in metals, there is a sketch of the origins of geometric resonances, acoustic cyclotron resonances, and quantum oscillations, as well as other less familiar magnetoacoustic effects in the ultrasonic attenuation in pure metals. The types of information that each of these effects can give about the Fermi surface are cited. There is a discussion of ultrasonic attenuation experiments in superconductors, and of the kinds of information that these experiments can provide. In each area, the present status of research is indicated. The paper concludes with a brief description of the experimental techniques involved in this branch of research. Included are some relatively new techniques for performing simultaneous experiments at several ultrasonic frequencies and for performing ultrasonic attenuation experiments in metals at 9 Gc s. (Contractor's abstract)

3101

Wayne State U. Dept. of Physics, Detroit, Mich.

QUANTUM OSCILLATIONS IN THE ULTRASONIC ATTENUATION IN CHROMIUM, by W. B. Wallace, N. Tepley and others. [1965] [2]p. incl. diagr. (AFOSR-66-1318) (In cooperation with Massachusetts Inst. of Technology , Cambridge AF 49(638)1468) (AF AFOSR-64-695) AD 639007 Unclassified

Also published in Phys. Ltrs., v. 17: 184-185, July 15, 1965.

A report is given of preliminary observations of quantum oscillations in the ultrasonic absorption in single crystal samples of chromium which were measured at 1.2 K in magnetic fields up to 110 kgauss.

3102

Weizmann Inst. of Science, Rehovoth (Israel).

ULTRASOUND CHEMICAL EFFECTS ON PURE ORGANIC LIQUIDS, by A. Weissler, I. Pecht, and M. Anbar. [1965] [2]p. incl. refs. (AFOSR-66-0063) (AF EOAR-65-87) AD 629295 Unclassified

Also published in Science, v. 150: 1288-1289, Dec. 1965.

Molecular fragmentation of organic liquids was produced by cavitation due to ultrasound waves, even in the absence of water. The sonolysis of acetonitrile under argon yielded N_2, CH_4, and H_2; but under oxygen the products were H_2, CO, CO_2, and H_2O. Pure non-aqueous carbon tetrachloride also underwent sonolytic decomposition under either argon or oxygen, with the production of elemental chlorine. (Contractor's abstract)

3103

Weizmann Inst. of Science. Dept. of Applied Mathematics, Rehovoth, Israel.

FINE STRUCTURE OF THE 2^3P and 3^3P STATES OF HELIUM, by B. Schiff, C. L. Pekeris, and H. Lifson. [1965] [4]p. incl. tables, refs. (AF EOAR-65-69) Unclassified

Published in Phys. Rev., v. 137: A1672-A1675, Mar. 15, 1965.

Nonrelativisitic eigenvalues accurate to one part in 10^9 to 10^{10} have been obtained for the 2^3P and 3^3P states of helium by improving the method previously developed for calculating 2-electron atom P-state wave functions, and by including up to 560 terms in the expansion. The corresponding values for the fine-structure splitting of the 2 levels are accurate to between 10^{-5} and 10^{-6} cm^{-1}, and the small discrepancy with experiment is presumed to be due to the neglect of quantum-electrodynamic correction terms of relative order α^2 in the calculation. The results for the 2^3P state are in good agreement with those obtained recently by C. Schwartz. (Contractor's abstract)

3104

Weizmann Inst. of Science. Dept. of Applied Mathematics, Rehovoth (Israel).

THE NUMERICAL INTEGRATION OF THE EQUATIONS OF MOTION OF A VISCOUS FLUID, by J. Gillis and A. Brandt. Final rept., pt. 1, Aug. 25, 1965 [3]p. [AFOSR-65-2213, pt. 1] (AF EOAR-63-73) AD 628179 Unclassified

A brief review is given of work on the development of methods for solving the equations of motion of magneto-hydrodynamics, taking account of viscous effects. The case of an electrically conductive fluid in an external transverse magnetic field is investigated. When the external field is zero, the equations reduce to those of Navier-Stokes. Several checks to the accuracy of the solutions are considered.

3105

Weizmann Inst. of Science. Dept. of Applied Mathematics, Rehovoth (Israel).

MAGNETOHYDRODYNAMIC FLOW IN THE INLET REGION OF A STRAIGHT CHANNEL, by A. Brandt and J. Gillis. [Final rept., pt. 2] Aug. 25, 1965. 42p. incl. diagrs. tables. [AFOSR-65-2213, pt. 2] (AF EOAR-63-73) AD 628180 Unclassified

Also published in Phys. Fluids, v. 9: 690-699, Apr. 1966.

For the problem discussed in part 1, the complete equations are solved numerically without any approximating assumptions, and the velocity profiles, magnetic liners of force, and pressure distribution are calculated. Comparison of the results to other studies are made in the limiting case of large Reynolds number.

3106

Weizmann Inst. of Science. Dept. of Applied Mathematics, Rehovoth (Israel).

ASYMPTOTIC APPROACH TO HARTMANN-POISEUILLE FLOWS, by J. Gillis and A. Brandt. [Final rept., pt. 3] Aug. 25, 1965, 26p. incl. tables. [AFOSR-65-2213, pt. 3] (AF EOAR-63-73) AD 628181 Unclassified

The steady state flow is considered with or without the magnetic field. Special attention is given to the rate of approach of the flow to the Hartmann-Poiseuille patterns downstream. In general the approach to the limiting pattern is exponential. The exponents are found to fall into 2 classes, one depending chiefly on the Reynolds number and Hartmann number, and the other on the magnetic Reynolds number and Hartmann number. (Author's abstract)

3107

Weizmann Inst. of Science. Dept. of Biochemistry, Rehovoth (Israel).

THE EFFECTS OF STRUCTURAL DEGRADATION ON THE COUPLED PHOTOCHEMICAL ACTIVITIES OF ISOLATED CHLOROPLASTS, by J. Gressel and M. Avron. [1965] [11]p. incl. diagrs. tables, refs. (AFOSR-65-1298) (Sponsored jointly by Air Force Office of Scientific Research under [AF EOAR-64-19] and Charles F. Kettering Foundation) AD 620594 Unclassified

Also published in Biochim. et Biophys. Acta, v. 94: 31-41, Jan. 1965.

Isolated washed chloroplasts were degraded by sonication or lipolytic enzymes and the inhibition of photophosphorylation coupled to photoreduction was measured. Sonication, pancreatic lipase and phospholipase inhibited photophosphorylation with ferricyanide. This differential inhibition of phosphorylation could not be accounted for by any type of ATPase activity. Wheat germ lipases, which best hydrolyse lipids with short fatty acid chains, did not affect the photoreactions. Some poorer-grade preparations were contaminated with an ATPase which could account for some uncoupling. The data support the hypothesis that, as with mitochondria, a more complex phospholipoprotein structure is necessary for coupled reactions than for electron transport alone.

3108

Weizmann Inst. of Science. [Dept. of Biochemistry] Rehovoth (Israel).

ON THE OXIDATION-REDUCTION POTENTIAL OF THE PHOTOPRODUCED REDUCTANT OF ISOLATED CHLOROPLASTS, by G. Zweig and M. Avron. [1965] [4]p. incl. table. (AFOSR-65-2858) [AF EOAR-64-19] AD 629288 Unclassified

Also published in Biochem. and Biophys. Research Commun., v. 19: 397-400, May 3, 1965.

Observations that the experimentally obtained value for the redox potential of the photoproduced reductant in isolated chloroplasts is about -0.5 v and that ferredoxin is not required for the photoreduction of diquat (1, 1'-ethylene, 2, 2'-dipyridylium dibromide), led to the conclusion that ferredoxin may not be the endogenous reductant with the most negative oxidation-reduction potential.

3109

Weizmann Inst. of Science. Dept. of Biophysics, Rehovoth (Israel).

USE OF POLY-α-AMINO ACIDS IN BIOLOGICAL STUDIES, by E. Katchalski. [1965] [36]p. incl. illus. diagrs. tables, refs. (AFOSR-66-0288) [AF EOAR-63-59] AD 639505 Unclassified

Also published in Harvey Lectures, Series 59: 243-278, 1965.

Polyamino acids have been useful in the elucidation of the mode of action of known proteolytic enzymes, as well as in the search for new proteolytic enzymes. The work performed using synthetic polypeptide antigens has contributed much to knowledge of the factors determining antigenicity of proteins. The close resemblance between the antibacterial and antiviral properties of basic polyamino acids and some natural peptides indicates that both the synthetic model compounds and the natural materials may act biologically by a similar mechanism. Basic polyamino acids may prove to be useful in the clarification of the role of the basic

proamines and histones in regulating chromosome activity. In view of the achievements attained with simple high molecular weight model compounds, it might be anticipated that when the organic chemists have a large number of synthetic high molecular weight polypeptides of a predetermined amino acid sequence, these macromolecules will be of even greater use than the polyamino acids in unraveling the secrets of protein molecules and in establishing the correlation between their structure and function.

3110

Weizmann Inst. of Science. [Dept. of Biophysics] Rehovoth (Israel).

PREPARATION AND CHARACTERIZATION OF POLY-DL-ALANYL RABBIT γ-GLOBULIN, by S. Fuchs and M. Sela. [1965] [10]p. incl. illus. diagrs. tables, refs. (AFOSR-66-1140) (Sponsored jointly by Air Force Office of Scientific Research under [AF EOAR-64-22] and National Institutes of Health) AD 639528 Unclassified

Also published in Jour. Biol. Chem., v. 240. 3558-3567, Sept. 1965.

Poly-Dl-alanyl rabbit γ-globulin was prepared from γ-globulin and N-carboxy-DL-alanine anhydride, and purified by chromatograph on columns of Sephadex G-50. Over 75% of the ε-amino groups reacted with the monomer, yielding derivatives in which around 700 alanine residues are attached, on the average, per globulin molecule. Polyalanyl globulin preparations were cleaved with mercaptoethanol in the absence of urea, and could be fragmented with papain to yield alanylated chains and fragments. These were separated and analyzed for their alanine content. The extent of attachment of alanine residues per ε amino group of chain A or B was essentially the same. Alanylated globulins, chains, and fragments were characterized physico-chemically and compared with their unalanylated analogues. Solubility is increased upon poly-DL-alanylation; polyalanyl globulin is not precipitated by 37% saturated aqueous ammonium sulfate; and the alanylated A Chain is completely soluble at all pH values, unlike the A chain obtained upon partial reduction of unmodified γ-globulin. Alanylated antibody molecules kept their capacity to bind the antigen, but lost their ability to precipitate the antigen. Thus polyalanylation of rabbit immune γ-globulin increased its solubility significantly without drastically affecting its antigenic or antibody properties.

3111

Weizmann Inst. of Science. [Dept. of Biophysics] Rehovoth (Israel).

COMPETITION OF ANTIGENIC DETERMINANTS, by I. Schechter. [1965] [3]p. incl. tables. (AFOSR-66-1881) (AF EOAR-64-22) AD 63233[illegible] Unclassified

Also published in Biochim. et Biophys. Acta, v. 104: 303-305, 1965.

Interference in the immune response between peptide determinants is reported. Polypeptidyl proteins were used as immunogens, and antibody to the polypeptidyl moiety was measured by using for precipitation a polypeptidyl protein in which the protein moiety was incapable of reacting with any antibody formed. Thus, in the system employed the competing determinants are chemically defined and molecular parameters of the immunogens may be varied by changing either the peptides or the protein carrier.

3112

Weizmann Inst. of Science. [Dept. of Biophysics]Rehovoth (Israel).

IMMUNOGENICITY AND ROLE OF SIZE: RESPONSE OF GUINEA PIG TO OLIGOTYROSINE AND TYROSINE DERIVATIVES, by F. Borek, Y. Stupp, and M. Sela. [1965] [2]p. incl. diagr. table, ref. (AF EOAR-64-22) AD 632324 Unclassified

Also published in Science, v. 150: 1177-1178, Nov. 26, 1965.

Guinea pigs injected with 100 micrograms of p-azobenzenearsonate derivatives of hexal-L-tyrosine, tri-L-tyrosine, or N-acetyl-L-tyrosine amide, in complete Freund's adjuvant, developed, after 10 to 19 days, delayed-type hypersensitivity to these substances. This was shown by skin reactions, followed by the formation of circulating antibodies that were detectable by passive cutaneous anaphylaxis. Experiments with p-azobenzenearsonate-hexa-L-tyrosine labeled with iodine-131 showed that this substance was bound in vitro to proteins of normal guinea pig serum. Binding was similar with the nonantigenic hexa-L-tyrosine and its p-azobenzoate derivate. (Contractor's abstract)

3113

Weizmann Inst. of Science. [Dept. of Biophysics] Rehovoth (Israel).

RELATION BETWEEN OPTICAL CONFIGURATION AND IMMUNOGENICITY OF SYNTHETIC POLYPEPTIDES, by F. Borek, Y. Stupp and others. [1965] [6]p. incl. tables, refs. (AF EOAR-64-22) AD 632325 Unclassified

Also published in Biochem. Jour., v. 96: 577-582, Sept. 1965.

Three random linear copolymers composed of 2 or 3 of the amino acids D-tyrosine, D-glutamic acid, D-alanine and D-lysine, and a branched multichain copolymer with a poly-D-lysine backbone and polymeric side chains of D-tyrosine and D-glutamic acid, were found to be non-antigenic in rabbits, by precipitin and passive cutaneous anaphylaxis, and in guinea pigs, by delayed hypersensitivity tests. The corresponding 4 copolymers of L-amino acids were shown to be antigenic by all the 3 criteria. No immunological cross-reactions were observed between the polypeptides composed of

D-amino acids and the corresponding L-amino acid copolymers. Similarly, an azobenzenearsonic acid conjugate of poly-D-tyrosine was shown to be non-antigenic in guinea pigs, in contrast with an analogous conjugate of poly-L-tyrosine. Animals sensitized with the conjugate of poly-L-tyrosine did not exhibit delayed skin reactions when cross-tested with the D-conjugate. A linear polymer composed of D-tyrosine, L-glutamic acid and L-alanine was found to be immunogenic and to cross-react with the corresponding polymer composed exclusively of D-amino acids.

3114

Weizmann Inst. of Science. [Dept. of Biophysics] Rehovoth (Israel).

SPECIFICITY OF DELAYED REACTIONS TO HAPTEN-POLYPEPTIDE CONJUGATES, by F. Borek and Y. Stupp. [1965] [6]p. incl. tables, refs. (AF EOAR-64-22) AD 632326 Unclassified

Also published in Immunochemistry, v. 2: 323-328, Dec. 1965.

Guinea pigs sensitized with p-azobenzenearsonate conjugate of polytyrosine, poly Lys^{51}, Tyr^{47}, poly Glu^{52}, Tyr^{48} and poly Ala^{34} Glu^{36} Tyr^{30}, showed delayed cross-reaction with p-azobenzenearsonate conjugate of bovine serum albumin. When conjugates of polypeptides containing other haptens such as p-azobenzoate, p-azobenzenesulfonate and p-nitrophenylazo were used as sensitizing antigens, no delayed cross-reactions were observed with the corresponding hapten-bovine serum albumin conjugates, in conformity with the carrier-specificity known to exist in most delayed hypersensitivity reactions. (Contractor's abstract)

3115

Weizmann Inst. of Science [Polymer Dept.] Rehovoth (Israel).

EQUILIBRIUM MECHANOCHEMISTRY OF COLLAGEN FIBRES, by J. Yonath, A. Oplatka, and A. Katchalsky. [1965] [7]p. incl. diagrs. (AFOSR-66-2593) [AF 61(052) 919] AD 645042 Unclassified

Also published in Structure and Function of Connective Tissue; Proc. of an Advanced Study Institute, St. Andrews (Scotland) (June 15-25, 1964), London, Butterworths, 1965, p. 381-387.

Collagen fibers contract by interaction with numerous ionic reagents, such as KCNS or LiBr, and relax upon removal of the contracting agent. The contraction is due to a process of chemical melting in which chemical energy may be converted into mechanical work under isothermal conditions. In order to correlate the investment of chemical energy with the mechanical work obtainable in such mechanochemical conversions, the force-length relations for collagen fibers interacting with KCNS was studied.

3116

Weizmann Inst. of Science. Polymer Dept., Rehovoth (Israel).

MECHANOCHEMISTRY, by A. Katchalsky. [1965] [5]p. incl. illus. diagrs. (AFOSR-66-1475) [AF EOAR-62-58] AD 637917 Unclassified

Also published in Rehovoth, 1965, 8-12.

The variety of energy transformations used in modern industry does not include the conversion of chemical energy into mechanical energy - a type common in nature and the sole energy conversion utilized by living creatures. At the end of the 1940's, it was discovered that chemical energy can be converted into mechanical energy by the use of synthetic polymers, the first proof that man-made appliances were able to achieve mechano-chemical conversions thought to be characteristic of living organisms alone. The theory behind mechano-chemical transformations is explained. Experimenting with collagen as the mechanochemical material and providing a salt solutions as fuel, a model engine was successfully built which converts mechanochemical contraction into continuous rotary motion; the concentration of the solution supplying chemical energy becomes diluted, thus preserving the Law of Conservation of Energy. These models help in understanding natural systems but they don't provide an alternative to the study of the systems themselves.

3117

Weizmann Inst. of Science. [Polymer Dept.] Rehovoth (Israel).

MECHANOCHEMISTRY OF COUPLED CONTRACTILE AND CHEMICAL RATE PROCESSES, by A. Katchalsky. Final rept. Jan. 1, 1964-Dec. 31, 1965. [74]p. incl. illus. diagrs. tables, refs. (AFOSR-66-1181) (AF EOAR-64-25) AD 635032 Unclassified

After briefly presenting concepts involved in mechano-chemical conversions, some work done on the equilibrium and kinetic behavior of the contractile fibers is summarized. The strong influence of LiBr on collagen fibers is based on complex formation which is accompanied by a relatively sharp transition from a rigid, triple helical structure, to an amorphous randomly kinked structure; while the crystalline well organized region presents a Hooke'an behavior, well known from the study of rigid materials, the amorphous region exhibits some novel features not described before. An equation is derived which permits the prediction of the kinetics of contraction in the amorphous range. There is a clear indication of a phase transition in the equilibrium f-l-c curves, but it is never sharp and at higher forces becomes so smeared out that it is doubtful whether the thermodynamic criteria of first order transition may be applied to collagen fibers. To investigate the point more closely, 2 series of measurements are applied to the region under consideration. The operation of mechanochemical engines is analyzed, and it is pointed out that the cyclic operation of the engine is self-regulatory and may serve as a simple

model for biological cybernetic systems. Five articles and 3 abstracts of articles concerning work done under this contract are included.

3118

Weizmann Inst. of Science. [Polymer Dept.] Rehovoth (Israel).

MECHANOCHEMICAL ENGINES, by I. Z. Steinberg, A. Oplatka, and A. Katchalsky. [1965] [12]p. incl. illus. diagrs. (AFOSR-66-2617) (Bound with its AFOSR-66-1181; AD 635032) [AF EOAR-64-25] AD 644735 Unclassified

Also published in Nature, v. 210: 568-571, May 7, 1966.

A description is given of the isothermal conversion of chemical metabolic energy and mechanical work. Given are several diagrams of machines which can be run for varying periods of time by running collagen fibers into a solution of strong salts, i.e. lithium bromide and out over various pulleys into pure water. The amount of energy converted into work is given and formulas are given which describe the adequate length relation to the different parts of the collagen fibers and the constant effect of different concentrations of salts upon the mechanical power developed. Given also are diagrams of mechanical engines for converting chemical work directly into mechanical work.

3119

[Weizmann Inst. of Science. Polymer Dept., Rehovoth (Israel)].

CHANGES IN THE INFRARED ABSORPTION SPECTRUM OF COLLAGEN DUE TO THE INTERACTION WITH LITHIUM BROMIDE, by M. Sherebrin. [1965] 4p. incl. tables. (Bound with its AFOSR-66-1181; AD635032) [AF EOAR-64-25] Unclassified

Collagen contracts when placed in concentrated solutions of LiBr. The molecular mechanism of this contraction is of primary interest especially in terms of the interaction of LiBr with the collagen molecule. The investigation was conducted to determine whether there are changes in absorption frequencies of collagen in the infrared with varying concentrations of LiBr and with the mechanical changes in length. The absorption line at 1250 cm^{-1} was observed to increase to 1270 cm^{-1} when the film was treated with increasing concentrations to 8.95 M LiBr. No changes in absorption lines were observed when the length of the film was stretched from 2.5 to 4.0 cm.

3120

[Weizmann Inst. of Science. Polymer Dept., Rehovoth (Israel).]

MEASUREMENTS ON POWER AND EFFICIENCY OF A MECHANOCHEMICAL ENGINE, by G. Goldman [1965] [9]p. incl. diagrs. tables. (Bound with its AFOSR-66-1161; AD 635032) [AF EOAR-64-25] Unclassified

A study was undertaken to measure the physicochemical properties of a mechanochemical engine. The properties measured were the mechanical power output under various loads and the flows of both salt and water through the system. The chemical work investment determined from these flows enabled the evaluation of the efficiency of the machine. (Contractor's abstract)

3121

[Weizmann Inst. of Science. Polymer Dept., Rehovoth (Israel).]

THE RELATION BETWEEN FORCE AND RATE OF CONTRACTION IN COLLAGEN IN THE PRESENCE OF CONTRACTING SALT, by J. Yonath. [1965] [26]p. incl. diagrs. tables. (Bound with its AFOSR-66-1181; AD 635032) [AF EOAR-64-25] Unclassified

Previous reports have described the kinetics of contraction and relaxation of collagen fibers following transfer of the fibers from one chemical environment to another. This type of contraction-relaxation process may be denoted as "chemical contraction (or relaxation)" or as "chemical melting (or crystallization). Melting or crystallization of a fiber in a contracting medium may be brought about by changing the length or the stretching force. Such changes can be either abrupt, e.g. by suddenly diminishing a high stretching force which had been applied on the fiber in a concentrated salt solution so as to prevent melting; or continuous, e.g. by continuously contracting a highly stretched fiber in salt solution. Such contractions (and relaxations) may be denoted as "mechanical contraction (or relaxation)" or as "mechanical melting (or crystallization)". Experiments carried out in order to study the kinetics of mechanical melting are described.

3122

[Weizmann Inst. of Science. Polymer Dept., Rehovoth (Israel).]

THF VIBRATING REED TECHNIQUE, by S. Reich. [1965] [10]p. incl. diagrs. (Bound with its AFOSR-66-1181; AD 635032) [AF EOAR-64-25] Unclassified

A vibrating reed instrument was built in order to study the dynamical properties of collagen fibers in the low frequency range as functions of both LiBr content and of temperature. The driving element is a magnetic phonograph recording head. A small aluminum clamp which holds the end of a collagen reed is mounted in the recording head in place of the stylus. The flexural vibration of the reed is excited by imparting a sinusoidal motion to the reed clamp. The recording head with the sample is mounted in a transparent container in which temperature and humidity are controlled. The experimental procedure

consists of observing the tip of the reed with a low power microscope and recording the resonance frequency and the band width.

3123

Wesleyan U. Dept. of Physics, Middletown, Conn.

RANGE OF FERROMAGNETIC EXCHANGE INTERACTION IN NONMAGNETIC FILMS ON IRON SUBSTRATES, by W. L. Trousdale and R. A. Lindgren. [1965] [3]p. incl. diagrs. (AFOSR-65-1370) (AF AFOSR-64-636) AD 622905 Unclassified

Presented at Tenth Conf. on Magnetism and Magnetic Materials, Minneapolis, Minn., Nov. 16-19, 1965.

Also published in Jour. Appl. Phys., v. 36: 968-970, Mar. 1965.

A experiment was performed to measure the penetration of conduction electron spin polarization into nonmagnetic metallic films deposited on an iron substrate. The technique was to evaporate the metal in question on the iron and then to probe the effective exchange field, produced by the electron spin polarization, as a function of the distance from the substrate by evaporating an intermediate partial layer of Co^{57}. The hyperfine field of the Fe^{57} was measured by the Mossbauer method and the exchange was calculated from the hyperfine field under the assumption that the hyperfine field is related to the exchange field through the Brillouin function of the local spin. Measurements were carried out at 300, 78, 4.20, and 1.22°K. Samples using palladium on an iron substrate were investigated with the Fe^{57} placed from 20 to 120 lattice spacings away from the substrate with the following results: (1) The size of the exchange field varies from 0 to approx. 150°K in the thinnest sample and from 0 to 25°K in the thickest. (2) For samples of given thickness, an empirical probability distribution function for the exchange field was found which gave a good fit to the hyperfine spectra at all temperatures. (3) The probability function is maximum at zero exchange field, decays initially quite rapidly, and then tails off slowly. A few measurements were made with copper and silver as the intermediate metal. The indication is that the effective exchange field in copper is greater than in silver but considerably less than in palladium. (Contractor's abstract)

3124

Westat Research Analysts, Inc., Denver, Colo.

SOME THEORETICAL ASPECTS OF THE IMPROVEMENT OF DOCUMENT SCREENING BY ASSOCIATIVE TRANSFORMATIONS, by E. C. Bryant, D. T. Searls, and R. H. Shumway. Nov. 30, 1965, 50p. incl. diagr. tables, refs. (AFOSR-66-0171) (AF 49(638)1484) AD 628191 Unclassified

With respect to document storage and retrieval, associative techniques can be considered that improve the file or improve the search query. In this study, techniques that improve the files are considered. The file may be one in which terms are selected by indexers or by machines. The index is considered a matrix of zeros and ones; no weighting of index terms is implied. Two kinds of zero-one files were investigated. The first is a file constructed from an orderly subject matter (organic chemistry; electronics), with a well defined term list and a rigid set of rules for term selection. A "correct" indexing can be defined, and formulas were devised to show anticipated gain by associative techniques. The second is a file in which assignment of terms is made after subjective judgment concerning applicability of the term to the document. Terms are less well defined, and partial synonymity is an acute indexing problem. It was postulated, therefore, that selection by a high proportion of indexers is a measure of term applicability to the given document. No attempt was made to "solve" this problem. Instead, a particular associative scheme was selected that was shown to provide gain. A well structured file (a Patent Office file on analog, digital converters) was used. The associative technique provided gain even after noise was introduced by randomization.

3125

Western Australia U. Dept. of Chemistry, Nedlands.

PARTIAL DISLOCATIONS, PHASE TRANSFORMATIONS AND NON-STOICHIOMETRY IN METAL OXIDES, by B. G. Hyde. [1965] [2]p. incl. diagrs. refs. (AFOSR-65-2089) [AF AFOSR-65-853] Unclassified

Also published in Internat'l. Conf. on Electron Diffraction and Crystal Defects, Melbourne (Australia) (Aug. 16-21, 1965), New York, Pergamon Press, 1965.

The relationships between the structure-types α-UO_3, fluorite, and rare earth sesquioxide type-A are examined: a plausible dislocation mechanism for phase transformations (accompanied by composition changes) between these types is proposed. A cursory examination of the effect of "radius-ratio" in determining whether non-stoichiometry in metal oxides will be accommodated by (1) shear, or (2) anion vacancies is made.

3126

Western Australia U. Dept. of Chemistry, Nedlands.

A STRUCTURAL MODEL OF THE RARE-EARTH OXIDES RO_x (R = Ce, Pr, Tb; $1.5 < x < 2.0$), by B. G. Hyde, D. J. M. Bevan, and L. Eyring. [1965] [2]p. incl. diagrs. (AFOSR-65-2090) [AF AFOSR-65-853] AD 626516 Unclassified

Also published in Internat'l. Conf. on Electron Diffraction and Crystal Defects, Melbourne (Australia) (Aug. 16-21, 1965), New York, Pergamon Press, 1965, p. 11.

A plausible but unconfirmed model for the structures of the ordered, intermediate rare-earth oxide phases

R_nO_{2n-2} is presented, and extended so as to account for the structure and behavior of the (disordered) non-stoichiometric phases $RO_{1.5+x}$, RO_{2-y}. All the proposed defect structures may be regarded as deriving from ordered arrangements of anion "vanancies" in a parent fluorite lattice.

3127

Western Ontario U. Dept. of Chemistry, London (Canada).

THE PHOTOCHEMICAL PRODUCTION OF STRAINED RINGS, by P. de Mayo. Final rept. May 3, 1965, 6p. incl. diagrs. (AFOSR-65-0970) (AF AFOSR-63-99) AD 617927 Unclassified

In this study, the photochemical synthesis of strained rings was investigated. It was found that intermolecular cycloaddition could be induced photochemically. While simple unsaturated ketones appeared unreactive the hydrogen bonded "cyclic' ketone acetyl acetone could be induced to participate. Further, this diketone had the advantage that any hydrogen abstraction would give a diradical which would be immediately converted, by spin inversion, into the starting material. Two other unrelated photochemical studies are also reported. (1) the photosensitized oxidation of pyrrole, providing the structure of the product maleimide and the mechanism of oxidation; and (2) the dimerisation of α-pyridones and sultones as a means of building up cyclic systems.

3128

[Western Ontario U. Dept. of Physics, London (Canada)]

FRANCK-CONDON FACTORS FOR THE GAYDON-GREEN BAND SYSTEM OF N_2, by R. W. Nicholls. [1965] [2]p. incl. tables, refs. (AFOSR-65-1086) (Sponsored jointly by Air Force Cambridge Research Center, Air Force Office of Scientific Research under AF AFOSR-62-236, and National Aeronautics and Space Administration) AD 619136 Unclassified

Also published in Jour. Chem. Phys., v. 42: 804-805, Jan. 15, 1965.

A provisional array of Franck-Condon factors for the Gaydon-Green band system of N_2 is presented. The data are given in tabulated form together with the wavelengths of the α-heads of the known bands. The Condon loci are traced by printing locally maximum Franck-Condon factors in bold-faced type.

3129

[Western Ontario U. Dept. of Physics, London (Canada)]

ON THE RELATIONSHIP BETWEEN r CENTROID AND BAND FREQUENCY, by R. W. Nicholls. [1965] [4]p. (AFOSR-65-1092) (Sponsored jointly by Air Force Cambridge Research Center, Air Force Office of Scientific Research under AF AFOSR-62-236, and National Aeronautics and Space Administration) AD 618285 Unclassified

Also published in Proc. Phys. Soc. (London), v. 85: 159-162, Jan. 1965.

The monotonic relationship between r centroid and band frequency has been investigated in detail, and the circumstances which cause r centroids to increase or decrease with increasing frequency as $r'_e <$ or $> r'_e$ are discussed.

Except in cases where change in molecular properties with internuclear separation is of specific interest, band frequency (or wavelength) may thus often be more conveniently used as an alternative to the r centroid as an independent variable in the discussion of the change of such molecular properties as transition probabilities from band to band in a system. (Contractor's abstract)

3130

[Western Ontario U. Dept. of Physics, London (Canada)]

FRANCK-CONDON FACTORS FOR THE H_2 LYMAN BAND SYSTEM, by R. W. Nicholls. [1965] [1]p. incl.table. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-62-236 and National Aeronautics and Space Administration) Unclassified

Published in Astrophys. Jour., v. 141: 819, Feb. 15, 1965.

A provisional array of "Morse" Franck-Condon factors is provided for the interpretation of intensities for the Lyman-band system of H_2.

3131

Western Ontario U. Dept. of Physics, London (Canada).

ROTATIONAL EXCITATION IN ALKALI-ION COLLISIONS, by R. P. Lowe and H. I. S. Ferguson. [1965] [2]p. incl. table. (Sponsored jointly by Air Force Cambridge Research Center; Air Force Office of Scientific Research under AF AFOSR-62-236, National Aeronautics and Space Administration, and National Research Council of Canada) Unclassified

Published in Fourth Internat'l. Conf. on Physics of Electronics and Atomic Collisions: Abstracts of Papers, Laval U., Quebec (Canada) (Aug. 2-6, 1965), New York, Science Bookcrafters, Inc. [1965] p. 285-286.

This paper reports an extension of previous studies to include excitation by Li^+, Na^+, K^+, Rb^+, and Cs^+ ions at energies up to 10 kev. Spectra of the R-branch of the (0, 0) first negative band at 3914 A taken with a photoelectric Ebert monochromator at a spectral slit width of 0.65 A were used to deduce the population distribution. The beam current of alkali ions ranged from 50 to 200 μamp and the collision chamber pressure was 20 μ Hg. For Li^+ excitation, the rotational temperature increases rapidly with decreasing ion energy. The temperatures for Na^+ excitation are comparable with those for Li^+ ions at 4 kev. The heavier ions K^+, Rb^+, and Cs^+ produce temperatures which only slightly exceed that of the accelerator. No significant redistribution of rotational energy by gas-kinetic collisions after excitation is possible. An investigation of the

variation of intensity with pressure and beam current suggest that the excitation takes place in primary collisions for Li^+ and Na^+, but that a secondary process, probably involving secondary electrons, dominates for the heavier ions.

3132

Western Ontario U. Dept. of Physics, London (Canada).

ELECTRON ENERGY MEASUREMENTS OF THE RACETRACK MICROTRON BEAM, by V. Sells, H. Froelich, and E. Brannen. Jan. 1965, 57p. incl. illus. diagrs. table, refs. (Technical rept. no. RMG-T-2) (AFOSR-65-1627) (AF AFOSR-63-297) AD 624038 Unclassified

The momentum spread in the beam of a racetrack microtron is measured using a high resolution beta ray spectrometer. The design of the semicircular double focusing magnetic spectrometer is described. A method of continuous magnetic field measurement in the spectrometer is discussed. The object and image positions relative to the entrance and exit planes of the spectrometer are calculated. The momentum spread in the electron beam of the accelerator as taken directly from the spectrometer is 0.41% at the half width position; 0.62% at half current; 1.28% at 90% current and 1.86% at 100% current. These values maybe corrected for the natural line width of the spectrometer whose theoretical base spread is 0.16%. With these corrections the upper limit of the energy spread in the 6.0 mev beam is 22 kev at half width; 34 kev at half integrated current; 73 kev at 90% current and 110 kev at 100% current level.

3133

Western Ontario U. [Dept. of Physics] London (Canada).

TEMPERATURE MEASUREMENTS ON LASER-PRODUCED FLAMES (Abstract), by J. E. Mentall and R. W. Nicholls. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-522] and National Aeronautics and Space Administration) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 492, Apr. 26, 1965.

The interaction of a focused laser beam with a powdered solid produces highly luminous gas. Following qualitative spectroscopic observations on a number of powered solids, quantitative intensity measurements have been made on some of the molecular-band systems (C_2 Swan, CN violet, and AlO blue-green) that arise from laser excitation of carbon and aluminum in air. These measurements indicate the existence of Boltzmen distributions of relative populations of vibrational and notational energy levels to which vibrational and rotational temperatures are assigned.

3134

Western Ontario U. Dept. of Physics, London (Canada).

ENERGY SPECTRUM OF THE ELECTRON BEAM IN A RACETRACK MICROTRON, by V. Sells, H. Froelich, and E. Brannen. [1965] [3]p. incl. diagrs. refs. (AFOSR-66-2200) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-297 and National Research Council of Canada) Unclassified

Also published in Jour. Appl. Phys., v. 36: 3264-3266, Oct. 1965.

The energy spectrum of the beam of a 4-sector racetrace microtron has been measured here, using a high-resolution double focusing β-ray spectrometer. For an energy gain per orbit of 750 kev, it was found that 50% of the integrated current in the eighth orbit (6 mev) was contained in an energy interval of 34 kev and 90% of the beam current in a 73-kev interval. This narrow energy spread (±0.3%) is of particular interest in the generation of submillimeter radiation and in the use of the microtron as an injector for high-energy synchrotrons.

3135

Western Ontario U. Dept. of Physics, London (Canada)

REFLECTION GRATINGS AS ELEMENTS IN FAR INFRARED MASERS, by E. Brannen. [1965] [2]p. incl. diagr. refs. (AFOSR-66-2822) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR 65-297 and National Research Council of Canada) AD 644589 Unclassified

Also published in Proc. IEEE, v. 53: 2134-2135, Dec. 1965.

Design criteria are described for the use of plane and semiconfocal gratings for the extraction of far infrared radiation in the 0.1 to 4 mm wavelength range from a Fabry-Perot resonator. Among the design factors described are coating materials, alignment, blaze angle, minimizing effects of dominant, strong transitions, and, extraction losses.

3136

Western Ontario U. Dept. of Physics, London (Canada).

THE U.W.O. RACE-TRACK MICROTRON, by E. Brannen, H. Froelich, and V. Sells. [1965] [4]p. incl. diagr. (AFOSR-66-2850) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-297, National Research Council of Canada, and Ontario Research Foundation) AD 644574 Unclassified

Also published in Canad. Jour. Phys., v. 43: 1555-1558, Aug. 1965.

The use of a race-track design for the magnetic guide field of a microtron has a number of advantages in comparison with a conventional microtron with a homogeneous field. The energy gain per orbit can be chosen freely and can, in fact, be made variable. In addition, beam focusing by the magnetic field can be provided the size of the magnet gap can be reduced, and electron injection can be facilitated. The electron beam has a remarkably narrow energy spread (50% of the electrons in a 34-kev interval) and theoretically has unusual longitudinal bunching characteristics (50% of the 8-orbit electrons in a bunch 0.5 mm long). Race-track designs that maintain stability of the betatron oscillations by splitting the magnetic fields into 4 sectors were proposed independently by Roberts (1958) and Moroz (1957). The race-track microtron built at the University of Western Ontario (the U. W. O. microtron) (Froelich and Brannen 1963; Froelich 1962) follows these proposals. The magnetic guide field consists of 4 sectors with uniform fields. In order to achieve stability of betatron oscillations, the stray fields in the 2 short regions between sectors were reduced by using magnetic shields. The magnet gap within the sectors has a width of only 7.2 mm. The energy gain per orbit and thus the final energy can be varied continuously, and synchronism can be obtained by adjusting the width of the central region between the sectors. The electron injection system consists of a Pierce-type electron gun having a lanthanum hexaboride cathode and small deflecting pole pieces. The gun current is 400 ma, the pulsed gun voltage 25 kv, and the pulse length 1 μsec.

3137

Western Reserve U. Center for Documentation and Communication Research, Cleveland, Ohio.

ON THE LOGIC OF INFORMATION RETRIEVAL, by W. Goffman. [1965] [4]p. (AFOSR-65-2690) (AF AFOSR-64-402) AD 629801 Unclassified

Also published in Inform. Storage and Retrieval, v. 2: 217-220, 1965.

An information retrieval process may in general be characterized in terms of 2 sets Q and S with a relation R. Q represents queries, S a file of documents, and the relation R, called relevance, is a property which assigns to any q in Q a certain subset A of S called the answer to q. The classical 2-valued propositional calculus has generally been accepted as the underlying logic of an information retrieval process. However, the Boolean model has been shown inadequate for describing an information retrieval process, and it follows that the 2-valued propositional logic is also inadequate. The logical system which seems most appropriate is the probability logic suggested by Reichenbach. A theorem is proved that an infinitely valued logic cannot be represented by a finite valued system having single valued truth tables. In terms of information retrieval, this theorem implies that no finite valued logic is adequate for representing an information retrieval process.

3138

Western Reserve U. Center for Documentation and Communication Research, Cleveland, Ohio.

AN EPIDEMIC PROCESS IN AN OPEN POPULATION, by W. Goffman. [1965] [2]p. (AF AFOSR-64-403) Unclassified

Published in Nature, v. 205: 831-832, Feb. 20, 1965.

An epidemic process can be characterized as a time-dependent process of transition by the members of a population (N), where the state transitions are caused by exposure to some influence called infectious material. The members of the population can belong to one of three basic states at any given time: Infective (I), Susceptible (S), Removal (R). The epidemic process and states are explained by the author. Mathematical treatments of epidemic processes, both deterministic and stochastic, which have appeared have usually dealt with processes involving closed populations, i.e., N remains a constant throughout the development of the process. The author deterministically represents an epidemic process in which N is not open; new supplies of susceptibles and infectives are introduced into the population as the process proceeds on its course of development. Letting μ = the rate at which new susceptibles are introduced into N, ν = the rate at which new infectives are introduced, and γ = the rate of removal of both susceptibles and infectives, the system of equations indicates that $S + I = \frac{\mu + \nu}{\gamma}$ for all values of t. Hence the process (E) will reach a maximum in finite time if, and only if, the sum of susceptibles and infectives is constant.

3139

Western Reserve U. Dept. of Physics, Cleveland, Ohio.

A STUDY OF SUPERCONDUCTIVITY IN LEAD-BISMUTH ALLOYS USING ELECTRON TUNNELING TECHNIQUES, by J. G. Adler and S. C. Ng. [1965] [12]p. incl. diagrs. table, refs. (AFOSR-65-1187) (In cooperation with Dalhousie U. Halifax, Nova Scotia) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-565] and National Research Council of Canada) AD 619612 Unclassified

Also published in Canad. Jour. Phys., v. 43: 594-604, Apr. 1965.

Some of the properties of superconducting lead-bismuth alloy films have been investigated using electron tunneling techniques. The superconducting energy gaps and transition temperatures as well as the effective tunneling density of electron states near the end point of the phonon spectrum have been measured for various compositions of this alloy system. It was found that pure bismuth films as well as bismuth films containing small amounts of lead are not superconducting above 1°K. The results also indicate that for alloys with bismuch concentrations between about 35% and 75%, superconductivity is due partially to a proximity effect. (Contractor's abstract)

3140

Western Reserve U. [Dept. of Physics] Cleveland, Ohio.

MAGNETIC AND RESISTIVE BEHAVIOR OF SUPERCONDUCTING LEAD-INDIUM ALLOYS (Abstract), by D. E. Farrell, J. G. Adler, and B. S. Chandrasekhar. [1965] [1]p. [AF AFOSR-64-565] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 347, Mar. 24, 1965.

Magnetization and resistive transition measurements have been made on well-annealed alloys of lead with 10-50 at-% indium, as a function of temperature. The magnetization was measured using a Foner magnetometer with phase-sensitive detection. Excellent agreement exists for the values of H_{c2} obtained by the two methods. The magnetization curves show unusual behavior close to H_{c2} in certain ranges of frequency ω and amplitude A of vibration of the sample. The observed curves can be described by an expression of the form $M(H) = M_0(H) + M_1(H, \omega, A) \exp(i\omega t)$, where M_0 corresponds to the usual Abrikosov behavior and M_1 increases with field above H_{c1} but then goes abruptly to zero at H_{c2} in a highly reversible manner even though M_1 itself displays some irreversibility. This disappearance of M_1 provides a much clearer indication of H_{c2} than has been the case hitherto in magnetization measurements. The dependence of this anomaly on the frequency and amplitude of the specimen vibration and particularly on the temperature strongly suggests that it arises from the motion of pinned flux lines.

3141

[Western Reserve U. School of Medicine, Cleveland, Ohio.]

[VASOPRESSIN BIOSYNTHESIS, by H. Sachs.] Final scientific rept. Feb. 1963-Oct. 1964 [1965] 3p. (AFOSR-65-0282) (AF AFOSR-63-408) AD 611185 Unclassified

The objectives of the research were to study in vivo and in vitro a number of processes concerned with the biosynthesis, storage, and release of vasopressin. Previous experimental data suggested the possibility that the biosynthesis of vasopressin occurs in a bound, biologically inactive form and that the release of hormone takes place during the formation and maturation of the neurosecretory particles. Data have now been obtained which are consistent with such a 'precursor model' for vasopressin biosynthesis. The in vitro systems, capable of carrying out the biosynthesis and release of vasopressin, offer a considerable number of possibilities for studies concerned with the neurosecretory process.

3142

Western Reserve U. [School of Medicine] Cleveland, Ohio.

RELEASE OF VASOPRESSIN FROM ISOLATED GUINEA PIG POSTERIOR PITUITARIES, by E. W. Haller, H. Sachs and others. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-2853) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-408, National Heart Institute, and National Institute of Health) AD 629599 Unclassified

Also published in Amer. Jour. Physiol., v. 209: 79-83, July 1, 1965.

Isolated guinea pig posterior pituitaries, incubated in a modified Krebs-Ringer solution at 37°C, released vasopressin at a relatively constant basal rate. Electrical stimulation at a voltage gradient of 3-9 v cm (200 msec pulses of 60 cycles sec ac every 2 sec) resulted in an elevation of vasopressin output. Stimulation at lower field strengths was not effective and maximal vasopressin release was produced by stimulation at any voltage gradient between 3 and 9 v cm. Vasopressin secretion was augmented at rest and during electrical stimulation by the presence of 2 mM Ba(++) in the incubation medium (increase of Ca (++) by 2 mM had no effect). Tetracaine (0.5 mM) blocked the response to electrical stimulation. Chemical, biological, and enzymic tests indicated that the pressor material secreted by the tissue was identical with arginine vasopressin. The experimental findings support the hypothesis that conduction of action potentials along the hypothalamo-neurohypophysical tract releases vasopressin from the posterior pituitary. (Contractor's abstract)

3143

Westinghouse Electric Corp. [Defense and Space Center] Baltimore, Md.

NATURAL LANGUAGE SYNTAX ORIENTED TRANSLATORS, by P. Z. Ingerman. Final rept. [1965] [14]p. (AFOSR-65-1940) (AF 49(638)1452) Unclassified

The final report is divided into 2 major sections. The first reports the results of research performed under the contract, while the second is a discussion resulting from the monitoring of standardization activities dealing with programming languages. The major project has been the specification of a syntax-oriented translator of sufficient generality so that it can be used to translate from most of the higher-level programming languages currently in use to an assembly-type intermediate language. Subsidiary to this has been the development of an assembly-type language which can serve not only as the target for the syntax-oriented translator, but can also be used in its own right both as an assembly language and as one possible solution to the reprogramming problem.

3144

Westinghouse Electric Corp. [Defense and Space Center] Baltimore, Md.

A UNIVERSAL ASSEMBLY MAPPING LANGUAGE, by M. L. Graham and P. Z. Ingerman. [1965] [13]p. incl. diagrs. (AFOSR-65-2685) (AF 49(638)1452) AD 629371 Unclassified

Also published in Proc. Twentieth Nat'l. Conf. of the Association for Computing Machinery, Aug. 24-26, 1965, p. 409-421.

The meta-language presented is entirely devoid of machine-oriented mnemonic codes. The user must use the metalanguage to define the meanings of the set of machine-oriented mnemonic codes which he wishes to use. The assembly language itself does not exist. A source program in the assembly language which the user specifies is presented to the meta-language processor together with the description of this language in terms of the metalanguage. The processor then interprets the source code in terms of the description it has been given and generates output in the form specified by the user in his meta-language description.

3145

Westinghouse Electric Corp. Defense and Space Center, Baltimore, Md.

AN ASSEMBLY LANGUAGE FOR REPROGRAMMING, by M. L. Graham and P. Z. Ingerman. [1965] [5]p. (AF 49(638)1452) Unclassified

Presented at Assoc. for Computing Machinery Reprogramming Conf., Princeton, N. J., June 1965.

Published in Commun. Assoc. Comput. Mach., v. 8: 769-774, Dec. 1965.

Assembly languages generally provide a one-for-one translation from a symbolic to a numeric version of a program, that is, from assembly language to machine-language. The meta-language presented here can be used to specify the mapping of any language which conforms to a canonical list form into an arbitrary stream of bits. This bit stream may be treated as a machine language program, a character stream, or whatever else the user might desire. Thus, this meta-language can be used to map from one assembly language into another or from the assembly language for one machine into the machine language of another.

3146

[Westinghouse Electric Corp.] Westinghouse Research Labs, Pittsburgh, Pa.

GROWTH OF LARGE SINGLE CRYSTALS OF HEXAGONAL SELENIUM FROM THE MELT AT HIGH PRESSURES, by D. E. Harrison and W. A. Tiller. [1965] [4]p. incl. illus. diagr. (AFOSR-65-2033) (AF 49(638)1029) AD 627582 Unclassified

Also published in Jour. Appl. Phys., v. 36: 1680-1683, May 1965.

The preparation of single crystals of hexagonal selenium at ordinary pressures is hampered by the very slow rate at which crystals can be grown from the melt under these conditions. In this paper a technique is presented for preparing single crystals under pressure. As the equilibrium freezing temperature is increased by the application of pressure, crystals can be grown at rates several orders of magnitude faster than under ordinary pressures. At 5 kbar pressure, single crystals were grown up to 1 cm in diam by 10 cm long. X-ray and optical studies established that the principal cleavage surfaces were along the {1010} and {1012} planes. (Contractor's abstract)

3147

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

A STABILITY FUNCTION FOR EXPLICIT EVALUATION OF THE MULLINS-SEKERKA INTERFACE STABILITY CRITERION, by R. F. Sekerta. [1965] [5]p. incl. diagrs. (AFOSR-65-2036) (AF 49(638)1029) AD 627583 Unclassified

Also published in Jour. Appl. Phys., v. 36: 264-268, Jan. 1965.

In a previous paper by Mullins and Sekerka (Jour. Appl. Phys., v. 35: 444, 1964), a stability criterion was introduced for a planar solid-liquid interface during the unidirectional solidification of a dilute binary alloy at constant velocity. However, evaluation of the criterion proved difficult. In this paper, a stability function S for its evaluation is introduced and tabulated. The criterion is then written in terms of S and compared with the constitutional supercooling criterion for interface stability. From these results, experimental data can be analyzed and a conclusive test of the stability theory can be made.

3148

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

GRAIN REFINEMENT VIA ELECTROMAGNETIC STIRRING DURING SOLIDIFICATION, by W. C. Johnston, G. R. Kotler and others. [1965] [5]p. incl. illus. diagrs. (AFOSR-66-1603) (AF 49(638)1029) AD 638703 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 233: 1856-1860, Oct. 1965.

The grain-refinement effect of electromagnetic stirring of Sn-Pb alloys during solidification is investigated at higher field strength and in larger sized samples. It is found that the grain-refining effect is due to a crystal multiplication phenomenon rather than a nucleation phenomenon. The effect increases with sample size

for a fixed field strength and a fixed supercooling bath temperatures. The effect in other alloys was investigated. (Contractor's abstract)

3149

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

MEASUREMENT OF BRINE DROPLET MIGRATION IN ICE, by J. D. Harrison. [1965] [5]p. incl. diagrs. (AFOSR-66-1662) (AF 49(638)1029) AD 639872 Unclassified

Also published in Jour. Appl. Phys., v. 36: 3811-3815, Dec. 1965.

Migration of NaCl, KF, and KI droplets through ice was measured in the temperature interval from -6° to 0°C in the presence of a 15°C/cm thermal gradient. Normally the droplets increased in velocity and size as they approached the ice-water interface. A 30-μ-diam droplet migrating at 0.3 μ/sec at -5°C would be 65μ in diam and migrating at 1.2 μ/sec at -1/2°C. Special phenomena observed were droplet elongation, diagonal migration, and constant-velocity migrations.

3150

Westinghouse Electric Corp. [Westinghouse Research Labs.] Pittsburgh, Pa.

SOLUTE TRANSPIRATION PORES IN ICE, by J. D. Harrison. [1965] [2]p. incl. illus. refs. (AFOSR-66-1664) (AF 49(638)1029) AD 639873 Unclassified

Also published in Jour. Appl. Phys., v. 36: 326-327, Jan. 1965.

In the course of a recent study, ice was grown by progressive freezing of samples of water containing various solutes at different concentrations. Liquid-filled pores, here named solute transpiration pores, were frequently observed in ice which was not as sound as fresh-water ice but not as cellular as sea ice. The characteristic of the solute transpiration pores is set forth first by describing the morphologically similar brine drainage channels and elongated bubbles, followed by a description of the occurrence, form, and functioning of the pores themselves.

3151

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

CZOCHRALSKI GROWTH OF LOW-DISLOCATION-DENSITY ZINC TUNGSTATE CRYSTALS, by S. O'Hara and G. M. McManus. [1965] [6]p. incl. illus. diagr. refs. (AF 49(638)1029) Unclassified

Published in Jour. Appl. Phys., v. 36: 1741-1746, May 1965.

Zinc tungstate crystals were grown by the Czochralski method and the effect of growth parameters on crystal perfection was studied. Of the (010) and (100) slip planes, Berg-Barrett photographs showed that the (100) slip plane appeared to be the most active during crystal growth. Observations made on crystals grown in a steep temperature gradient showed that strain due to thermal gradients was responsible for the high dislocation densities in these crystals. Studies on seeding showed that if no widening occurred, then the perfection of the region of the crystal after seeding was much higher than the seed; the changes in temperature employed to widen the crystal gave rise to very high dislocation densities. X-ray examination verified the observations made by chemical etching. Crystals grown under nearly isothermal temperature conditions provided material with dislocation densities between 0 and 500/cm^2. These crystals propagated with facets at the solid-liquid interface which gave rise to impurity distributions similar to those observed in semiconductor crystals. The conditions for growing low-dislocation-density Czochralski of zinc tungstate are similar to those for growing low-dislocation-density semiconductor crystals. (Contractor's abstract)

3152

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

GROWTH MORPHOLOGY OF HEXAGONAL SELENIUM AT HIGH PRESSURES, by D. E. Harrison. [1965] [5]p. incl. illus. (AF 49(638)1029) Unclassified

Published in Jour. Appl. Phys., v. 36: 3150-3154, Oct. 1965.

Hexagonal selenium can be grown from the melt either in the form of spherulites or as single crystals. At normal pressures, the transition from spherulitic to single-crystal growth habit is not usually shown to be the result of the very slow growth rate of single crystals. At higher pressures, the single-crystal growth rate is enhanced sufficiently to permit observation of this transition. Examination of melt-grown crystals by Weissenberg x-ray techniques disclosed a disorder normal to the "c" axis direction. The absence of the disorder in vapor-grown needles produced at 5 kbar indicates that the disorder is built in during growth from the melt.

3153

Westinghouse Electric Corp. Westinghouse Research Labs., Pittsburgh, Pa.

HEAT CAPACITY OF ORDERED AND DISORDERED COPPER-PLATINUM BELOW 4.2°K, by J. Rayne and B. Roessler. [1965] [4]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1029 and National Science Foundation) Unclassified

An earlier investigation (J. Rayne, Phys. Rev., v. 108: 649, 1957) of the low-temperature heat capacity of Cu_3Au showed no difference in the electronic specific heat coefficient between the ordered and disordered conditions. But due to the unusual nature of the order-disorder transformation in copper-platinum, the present investigation was conducted. Results show that there is a large decrease in the value of the specific heat coefficient for the ordered alloy compared to that of the disordered alloy. An increase in the Debye temperature on ordering is observed which is consistent with that observed in Cu_3Au. The decrease in the value of the specific heat coefficient which is observed in ordered copper-platinum may be due to magnetic ordering, either ferromagnetic or antiferromagnetic; it may also be due to the Brillouin zone-Fermi surface interaction.

3154

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

ROLLING BALL VISCOMETER FOR USE AT TEMPERATURES TO 400°C UNDER PRESSURES TO 5 KILOBAR, by D. E. Harrison and R. B. Gosser. [1965] [4]p. incl. diagrs. tables. (AF 49(638)1029) Unclassified

Published in Rev. Scient. Instr., v. 36: 1840-1843, Dec. 1965.

In an earlier publication, one of the authors (Jour. Chem. Phys., v. 41: 844, 1965) gave data on the pressure dependence of the viscosity of liquid selenium up to 350°C and at 4 kbar. This paper describes the rolling ball viscometer in detail and gives data on the pressure dependence of the viscosity of glycerol at 75°C up to 5 kbar pressure. The rolling ball technique of measuring viscosity was adapted for use at temperatures up to 400°C under pressures up to 5 kbar. At 75°C, $\log_{10}$ viscosity of glycerol was found to increase linearly with pressure up to 5 kbar.

3155

[Westinghouse Electric Corp. Westinghouse Research Labs., Pittsburgh, Pa.]

[THERMAL CONDUCTIVITY AND THERMOELECTRIC POWER OF SOLIDS AT LOW TEMPERATURES, by P. G. Klemens.] Final rept. June 1, 1962-May 31, 1965, 8p. (AFOSR-65-1485) (AF 49(638)1165) AD 620270 Unclassified

Thermal conductivity and thermoelectric power of solids were investigated at low temperature. Photon-assisted scattering of electrons by the impurity atoms was first studied and the electrical resistivity of a number of gold alloys was measured from 2 to 401°K. Experiments demonstrated the reality of resistance due the phonon-assisted inelastic impurity scattering and verified the theoretical magnitude and temperature dependence of the effect. Alloys having localized lattice modes were considered and a precise determination of the temperature dependence of the electrical resistivity of gold is given. Electrical and thermal conductivities and thermoelectric power were studied in the semi-metals of tin-telluride and platinum-antimonide. The role of resonance scattering of phonons in the thermal conductivity of glasses is discussed.

3156

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

ELECTRICAL RESISTIVITY OF SOME GOLD ALLOYS: A SEARCH FOR EFFECTS DUE TO LOCAL MODES, by D. H. Damon and P. G. Klemens. [1965] [5]p. incl. diagrs. tables, refs. (AFOSR-65-1993) (AF 49(638)1165) AD 628863 Unclassified

Also published in Phys. Rev., v. 138: A1390-A1394, May 31, 1965.

If phonon-assisted electron scattering by impurities contributes appreciably to the electrical resistivity of alloys, localized modes about light impurities should lead to a resistance which increases faster than linearly at temperatures around $\theta_0/2$, where θ_0 is the characteristic temperature of the local mode. The electrical resistivity of gold alloys containing 1.8 at-% Zn, 2.4 at-% Al and 2.6 at-% Cu was measured between 80° and 500°K. In these cases local modes are expected. Measurements were also made of alloys with 1.0 and 1.6 at-% Pt, where local modes should be absent. Substantial deviations from Matthiessen's rule were found, but not the temperature variation expected from local modes. It is suggested that this effect is obscured by deviations from Matthiessen's rule arising from the zone structure of gold. An unexplained discrepancy was found in the resistance of the 1.6% Pt alloy. The resistivity of pure gold between 80° and 480°K is tabulated in 20° steps.

3157

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

SPIN-LATTICE RELAXATION OF ATOMIC HYDROGEN IN CaF_2 INVOLVING LOCAL MODES, by P. G. Klemens. [1965] [2]p. (AFOSR-65-1994) (AF 49(638)1165) AD 626860 Unclassified

Also published in Phys. Rev., v. 138: A1217-A1218, May 17, 1965.

The spin-lattice relaxation of atomic hydrogen and deuterium in CaF_2 measured previously (Phys. Rev., v. 138: A1208, 1965) shows an exponential dependence, which is ascribed to a Raman process involving local modes. The magnitude of the pre-exponential factor can be compared to the ordinary Raman process for these centers, which was also observed. This ratio is compared with the predictions of the author's theory of spin-lattice relaxation involving local modes. It appears that the theory overestimates the effect of

local modes on spin-lattice relaxation by a factor of order 5. This may arise from a comparable error in the theoretical estimate of the decay rate of a local mode by anharmonic processes, which enters the expression for the spin-lattice relaxation rate. Other possible sources of error are also discussed.

3158

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

EFFECT OF THERMAL AND PHONON PROCESSES ON ULTRASONIC ATTENUATION, by P. G. Klemens. [1965] [34]p. incl. refs. (AFOSR-66-1556) (AF 49(638)1165) AD 638698 Unclassified

Also published in Physical Acoustics, ed. by W. P. Mason, New York, Academic Press, v. IIIB: 201-234, 1965.

Ultrasonic and hypersonic waves in a solid are, in principle, the same in nature as the lattice waves which describe the thermal vibrations of the solid. Apart from a difference in frequency the main difference is one of how the properties of these waves are studied. The former are available as coherent beams, the latter are only a background of noise. The attenuation of the ultrasonic beam can be studied directly, but the attenuation or scattering of a lattice wave must be induced from observed conduction properties.

3159

[Westinghouse Electric Corp. Westinghouse Research Labs., Pittsburgh, Pa.]

DIFFUSION OF ELECTRONS ON THE FERMI SURFACE II. LONGITUDINAL MAGNETORESISTANCE OF Ib METALS, by P. G. Klemens and J. L. Jackson. [1965] [7]p. (AFOSR-66-1602) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)1165, Nederlandse Organisatie voor Zuiver Wetenschappelijk, Stichting voor Fundamenteel Onderzoek der Materie, and Westinghouse Academic Leave Program) AD 638699 Unclassified

Also published in Physica, v. 31: 1421-1427, 1965.

Following Pippard's method, the longitudinal high-field magnetoresistance is discussed in terms of belts on the Fermi sphere on which the deviation of the electron distribution from equilibrium must vanish. For the ideal resistance case the electron diffusion equation is solved with appropriate boundary conditions for a number of directions and neck radii, and the magnetoresistance is insensitive to the neck radius. The profound effect of dislocations on the magnetoresistance is pointed out.

3160

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

INELASTIC IMPURITY SCATTERING OF ELECTRONS IN GOLD ALLOYS AT LOW TEMPERATURES, by D. H. Damon and P. G. Klemens. [1965] [5]p. incl. diagrs. table. (AFOSR-66-1651) (AF 49(638)1165) AD 639875 Unclassified

Also published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LTS(Pt. B): 996-1000, 1965.

The electrical resistivity of some binary gold alloys with copper and platinum was measured from 1.5° to 40°K, in order to study deviations from Matthiessen's rule and to investigate a possible contribution of phonon-assisted impurity scattering to the resistance. This process was originally suggested by Koshino, who ascribed it to the perturbing effect of the displacement of the impurity potential by a lattice wave. This was critizied by Taylor who showed that the displacement perturbation could be transformed away, leaving only a small residual effect on the resistivity. However, there is a further effect arising from the strain on the impurity site due to a lattice wave, which should also lead to phonon-assisted scattering, and to an additional resistance of the form $\rho_i = A \quad \epsilon^2 = \beta(T)$. where ρ_0 is the residual resistivity, A a numerical constant, and $<\epsilon^2>$ the mean square thermal strain, so that $\beta(T) \alpha T^4$ at low temperatures.

3161

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

ANHARMONIC ATTENUATION OF LONGITUDINAL HYPERSONIC WAVES (Abstract), by P. G. Klemens. [1965] [1]p. [AF 49(638)1165] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 393, Mar. 24, 1965.

Momentum-conservation requirements forbid a direct 3-phonon interaction between a longitudinal ultrasonic wave and thermal phonons. Nevertheless, the low-temperature anharmonic attenuation of longitudinal waves is observed to be comparable to that of transverse waves. A mechanism is proposed whereby the longitudinal wave interacts with modes of comparably low frequency and over-populates these modes, thereby speeding up the interaction. This leads to an absorption that depends on intensity and pulse repitition rate and approaches that of transverse waves in the high-intensity limit. The results of the theory are compared with experiments on quartz by J. de Klerk and D. I. Bolef.

3162

[Westinghouse Electric Corp.] Westinghouse Research Labs. [Pittsburgh, Pa.]

LORENZ NUMBER AND THERMOELECTRIC POWER OF METALS (Abstract), by P. G. L. Klemens. [1965] [1]p. [AF 49(638)1165] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 125-126, Jan. 27, 1965.

The contribution of electrons of different energies to the conductivity $\sigma(E)d f^0/dE$ is regarded as a distribution function. The first moment about the Fermi energy gives the thermoelectric power, the second moment about the first moment the Lorenz number. Deviations from the Wiedemann-Franz law are discussed for degenerate semiconductors, semimetals, and transition metals at high temperatures.

3163

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

MIGRATION OF A LIQUID ZONE THROUGH A SOLID. PART III, by W. A. Tiller. [1965] [3]p. incl. diagrs. (AFOSR-65-1998) (AF 49(638)1177) AD 627557 Unclassified

Also published in Jour. Appl. Phys., v. 36: 261-263, Jan. 1965.

A theoretical analysis of the migration of a liquid zone through a solid is extended to include nonconservative systems where atoms are exchanged between the liquid zone and the environment. It applies to both evaporation and condensation of either the solute or the solvent species. When the vapor exchange is such as to increase or decrease the liquid temperature of the zone, the zone migration velocity increases or decreases, respectively, in a linear manner with zone size. For certain conditions it is possible to produce a zone of constitutionally supercooled liquid ahead of the freezing interface. The migration rates of gallium alloy zones through GaAs are quantitatively consistent with this treatment.

3164

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

ANOMALOUS TRANSMISSION OF X-RAYS IN Fe-3% Si CRYSTALS AND THE OBSERVATION OF FERROMAGNETIC DOMAINS (Abstract), by B. Roessler, J. J. Kramer, and M. Kuriyama. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)1177] and Advanced Research Projects Agency) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 471-472, Apr. 26, 1965.

Large sheet crystals of an iron-3% silicon alloy were grown by the surface-energy-induced recrystallization technique. These crystals, with a {100} surface, were found to anomalously transmit x-rays, revealing both dislocations and ferromagnetic domains along <100> directions. The domain structure could be made to disappear in the presence of a magnetic field and to reappear when the field was removed. The surface domain pattern, as revealed by colloidal magnetite powder patterns, was considerably different from that observed by the x-ray technique.

3165

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

DISLOCATION ARRANGEMENTS IN ZINC TUNGSTATE, by S. O'Hara, G. M. McManus, and B. Roessler. [1965] [6]p. incl. illus. diagr. refs. (AF 49(638)1177) Unclassified

Published in Jour. Appl. Phys., v. 36: 2898-2903, Sept. 1965.

Dislocation in low dislocation density ($\sim 10^2 cm^{-2}$) single crystals of $ZnWO_4$ have been analyzed by the application of standard etching techniques and by Borrmann and Berg-Barrett x-ray diffraction techniques. The majority of dislocations lying on the (010) slip planes were found to have [100] Burgers vectors, while the remainer had [001] vectors. Dislocations lying on the (100) plane had predominantly [001] Burgers vectors; dislocations with [010] Burgers vectors were present, but uncommon. In Borrmann photographs, dislocations, close to the exit surface of the crystal gave images of increased rather than decreased intensity. The effect of the oxygen atom positions on the intensities of the anomalously transmitted x-ray beams was shown to be significant in $ZnWO_4$. Also, impurity segregation, which was revealed in both transmission optical and x-ray photographs, indicates that facetting occurred on a convex growth interface.

3166

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

SHORT-RANGE ORDER IN SOME NICKEL-BASE ALLOYS, by G. M. McManus. [1965] [3]p. incl. illus. diagr. table, refs. (AF 49(638)1177) Unclassified

Published in Jour. Appl. Phys., v. 36: 3631-3633, Nov. 1965.

The first-nearest-neighbor short-range-order and size effect coefficients have been determined for the solid-solution alloys Ni + 12% Ta, Ni + 15% W, and Ni + 20% Mo by the method of x-ray diffuse scattering. In these alloys a strong preference for unlike nearest neighbors was found, with the Ni + 12% Ta, Ni + 15% W, and Ni + 20% Mo alloys having $\alpha_1 = 0.10, -0.12$, and -0.13,

respectively. The corresponding size-effect coefficients for these alloys were found to be θ_i = 0.017, 0.015, and 0.000, respectively.

3167

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

EPITAXY IN THIN FILMS OF EuS, by C. W. Chen and S. Zeitman. [1965] [2]p. incl. table, refs. (AF 49(638)1245) Unclassified

Published in Jour. Appl. Phys., v. 36: 669-670, Feb. 1965.

It is stated that for measurement of the magnetic and electrical properties of europium sulfide, large single crystals are necessary. The chemical and physical properties of the sulfide, however, make it a difficult task to grow crystals directly from the melt. This note reports the excellent properties of EuS for epitaxial growth. Experimental results show that single-crystalline films were grown epitaxially upon the (100) cleavage surface of single-crystal substrates of NaCl, NaBr, and MgO and upon the (111) cleavage surface of CaF_2. An important characteristic of the epitaxial growth of EuS is stated to be one-to-one correspondence in the growth mode. It was also found that (110) films of EuS can be grown upon artifically prepared (110) surfaces of CaF_2 crystals.

3168

[Westinghouse Electric Corp. Westinghouse Research Labs., Pittsburgh, Pa.]

GROWTH AND CHARACTERIZATION OF SINGLE CRYSTALS OF RARE EARTH COMPOUNDS. [1965] [9]p. incl. diagr. (Technical rept. no. 7) (AF 49(638) 1245) AD 614435 Unclassified

The spin disorder effect on scattering of the conduction electrons was examined together with the increases in the residual resistivity of Gd observed in various intra-rare earth alloys. It was found that the extrapolated values of the spin-disorder resistivity reported in the literature were much too small to account for the inelastic scattering with spin flip. This large discrepancy between the calculated and extrapolated value of spin-disorder resistivity has heretofore been overlooked. It may imply the existence of short-range order of spins in the paramagnetic state at temperatures considerably higher than the Curie point. Resistance measurements were conducted on a polycrystalline sample of Si-doped $CrBr_3$. The electrical data revealed that the compound became a semiconductor only in the paramagnetic state. Below the Curie temperature it remained an insulator. The excess electrons donated by the Si atoms in $CrBr_3$ thus behave markedly differently from those donated by La in EuS. Experimental work was continued on the growth of crystals of La-doped EuS. An investigation was begun on Ba-doped NdS. Further progress was made in the study of the magnetic structures of the solid solutions of CrTe and CrSb.

3169

[Westinghouse Electric Corp. Westinghouse Research Labs., Pittsburgh, Pa.]

GROWTH AND CHARACTERIZATION OF SINGLE CRYSTALS OF RARE EARTH COMPOUNDS. [1965] 8p (Technical rept. no. 9) (49(638)1245) AD 622796 Unclassified

The electrical resistivities of the intra-rare-earth alloys of dysprosium have been determined at 4.2, 77°, and 296°K for a continued study of the impurity scattering of the conduction electrons. The resistivity data reveal that substitution of La, Ce, Pr, Nd, and Sm in Dy leads to considerable increases in the residual resistivity of Dy at low temperatures, but the increases, disappear at 296°K. The impurity-induced resistivities are predominantly due to the exchange scattering of the electrons via the Ruderman-Kittel type exchange interaction between the 4f and conduction electrons. The exchange scattering is shown to depend only on the difference between the atomic spins of the solvent and solute ions, with the spin-orbit coupling playing an insignificant role. Neutron diffraction studies of the CrTe-CrSb solid solutions have revealed the formation of a canted spin structure in the pseudo-binary system with cosine of the cant angle varying as a linear function of the composition.

3170

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

INFRARED LATTICE ABSORPTION BY GAP MODES AND RESONANCE MODES IN KI, by A. J. Sievers, A. A. Maradudin, and S. S. Jaswal. [1965] [4]p. incl. diagrs. refs. (In cooperation with Michigan State U., East Lansing [AF AFOSR-62-37] and Cornell U., Ithaca, N. Y.) (Sponsored jointly by Advanced Research Projects Agency; Air Force Office of Scientific Research under AF 49(638)1245, and Atomic Energy Commission) Unclassified

Published in Phys., Rev., v. 138: A272-A275, Apr. 5, 1965.

Impurity-induced infrared absorption in KI containing Cl^- ions as substitutional impurities has been observed. A sharp line appears in the absorption spectrum in the neighborhood of 77 cm^{-1}, and at least 3 broad lines are observed near 61 cm^{-1}. The results of a theoretical calculation show that the identification of the former absorption peak with a localized mode whose frequency lies in the gap in the frequency spectrum of KI between the acoustic and optical branches is compatible with the experimental results. Similarly, the broad absorption peaks near 61 cm^{-1} can be identified with resonance modes in the acoustic continuum. (Contractor's abstract)

3171

[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

SPIN DEPENDENCE OF THE ELECTRICAL RESISTIVITIES OF GADOLINIUM ALLOYS, by C. W. Chen. [1965] 8p. incl. diagrs. refs. (Bound with its AFOSR-65-1917; AD 627226) (AF 49(638)1245) Unclassified

Published in Fifth Rare Earth Research Conf., Iowa State U., Ames, Aug. 30-Sept. 1, 1965, Book 6, p 43-49.

The electrical resistivities of various intra-rare-earth alloys of gadolinium at 4.2°, 77°, and 298°K are discussed with respect to the theory. Two spin effects are shown in the scattering of the conduction electrons. (Contractor's abstract)

3172

Westinghouse Electric Corp. Westinghouse Research Labs., Pittsburgh, Pa.

SURFACE CONTRIBUTION TO THE SPECIFIC HEAT OF CRYSTALS AT LOW TEMPERATURES, by A. A. Maradudin and M. Ashkin. [1965] [4]p. (Sponsored jointly by Advanced Research Projects Agency; and Air Force Office of Scientific Research under AF 49(638)1245) Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio, (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. B) 1126-1129, 1965.

A lattice dynamical calculation of the low-temperature specific heat of a crystal possessing free surfaces is presented. A pair of adjacent free surfaces is created in a nearest and next-nearest neighbor central force model of a simple cubic crystal by setting all atomic interactions which link to 2 planes equal to zero. The negatives of these interactions are treated as a perturbation on the Hamiltonian of the uncut crystal. The change in the specific heat of the crystal resulting from the introduction of the pair of free surfaces is expressed as a contour integral over the Green's function of the perturbed crystal. In the limit of low temperatures, only the long wavelength components of the Fourier transform of the Green's function are required, and these can be evaluated analytically if the relation on the atomic force constants which corresponds to elastic isotropy is imposed. The result for the surface contribution to the specific heat C_s has the form $C_s = bST^2$, where S is the surface area, T is the absolute temperature, and b is a numerical constant. The value for b obtained in the present calculation differs somewhat from the value obtained earlier by Dupuis, Mazo, and Onsager, who studied a semi-infinite isotropic elastic continuum.

3173

West Virginia U. Dept. of Aerospace Engineering, Morgantown.

THE RELATION BETWEEN ABSOLUTE INTERATION AND NEWTON'S METHOD, by W. Squire. [1965] [4]p. incl. tables. (AFOSR-66-1508) (AF AFOSR-63-113) AD 641491 Unclassified

Also published in Proc. West Virginia Acad. Sci., v. 37: 262-265, 1965.

Kowel's iterative method for solving transcendental equations is modified by introducing an adjustable parameter. The solution of an example shows considerable improvement. It is then shown when the approximate value is sufficiently close to the root the method is equivalent to Newton's method. (Contractor's abstract)

3174

Windsor U. [Dept. of Physics] Ontario (Canada).

HIGH-INTENSITY LIGHT SOURCES FOR THE EXCITATION OF RESONANCE FLUORESCENCE IN POTASSIUM AND RUBIDIUM (Abstract), by R. J. Atkinson, G. D. Chapman, and L. Krause. [1965] [1]p. (AFOSR-65-0408) [AF AFOSR-63-361] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Also published in Bull. Amer. Phys. Soc., Series II, v. 10: 49, Jan. 27, 1965.

A description is given of 2 RF light sources that produce intense potassium and rubidium resonance radiation. Their properties have been systematically investigated in relation to their operating parameters. A comparison is made with 2 commercially available lamps (Osram and Varian) with respect to integrated intensity, peak intensity, half-width, and degree of self-reversal of the resonance lines. It is found that the RF sources, developed in this laboratory, emit resonance lines of significantly higher peak intensities, smaller half-widths, and smaller self-reversal than those produced by the other lamps. Typical half-widths of the potassium and rubidium D lines, produced by the lamps, are 0.15 and 0.37 cm^{-1}, respectively, compared with the corresponding half-widths of 0.34 and 1.5 cm^{-1}, respectively, emitted by the Osram lamps.

3175

Windsor U. [Dept. of Physics] Ontario (Canada).

TRANSFER OF EXCITATION IN COLLISIONS BETWEEN CAESIUM ATOMS (Abstract), by M. Czajkowski and L. Krause. [1965] [1]p. (AFOSR-65-0409) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-63-361] and National Research Council of Canada) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Also published in Bull. Amer. Phys. Soc. Series II, v. 10: 49, Jan. 27, 1965.

The cross sections for the transfer of excitation between $6^2P_{1/2}$ and $6^2P_{3/2}$ resonance states in cesium, induced by inelastic collisions with cesium atoms in the ground state, have been determined using the method of sensitized fluorescence. The experiments were carried out at cesium-vapor pressures in the range of 10^{-6} - 10^{-4} Torr, where multiple scattering of resonance radiation is no longer effective. The fluorescence was excited with 1 component of the resonance doublet at a time, and the 2 components present in the fluorescent spectrum were separated by means of interference filters, detected with an ITTFW118 photomultiplier and recorded using photon-counting techniques. The total cross sections for the processes $^2P_{1/2} \rightarrow {}^2P_{3/2}$ and $^2P_{1/2} \rightarrow {}^2P_{3/2}$ are 6.5×10^{-14} and 2.0×10^{-13} cm^2, respectively, compared with the values of 6×10^{-16} and 1.3×10^{-15} cm^2 obtained by Seiwert, who corrected experimental results obtained at higher vapor pressures, using a modified Holstein theory of radiation diffusion. The reported results are consistent with those previously obtained for similar processes in potassium and rubidium.

3176

Windsor U. Dept. of Physics, Ontario (Canada).

EXCITATION TRANSFER BETWEEN THE $^2P_{1/2}$ AND $^2P_{3/2}$ RESONANCE LEVELS IN ALKALI ATOMS INDUCED BY INELASTIC OLLISIONS, by G. D. Chapman, M. Czajkowski and others. [1965] [5]p. incl. diagrs. table, refs. (AFOSR-65-2060) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-65-361 and National Research Council of Canada) AD 627629 Unclassified

Also published in Fourth Internat'l. Conf. on Physics of Electronic and Atomic Collisions: Abstracts of Papers, Laval U., Quebec (Canada) (Aug. 2-6, 1965), New York, Science Bookcrafters, Inc. [1965] p. 55-59.

Experiments are reported in which a determination is made of the total cross sections for collisions of the second kind leading to transfer of excitation between $^2P_{1/2}$ and $^2P_{3/2}$ resonance levels in potassium, rubidium, and cesium. These transitions give rise to sensitized fluorescence which may be observed when alkali vapor at low pressure, either pure or in the presence of an inert gas, is irradiated with one component of the resonance doublet. Sensitized fluorescence also results if inert gas atoms take part in the collisions instead of the alkali atoms in the ground state. The arrangement of apparatus used in these experiments is shown. Results are plotted and tabulated.

3177

Windsor U. Dept. of Physics, Ontario (Canada).

SENSITIZED FLUORESCENCE IN VAPORS OF ALKALI METALS. III. ENERGY TRANSFER IN CESIUM-CESIUM COLLISIONS, by M. Czajkowski and L. Krause. [1965] [10]p. incl. diagrs. tables, refs. (AFOSR-65-2819) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-361 and National Research Council of Canada) AD 629065 Unclassified

Also published in Canad. Jour. Phys., v. 43: 1259-1268, July 1965.

Collisions of the second kind leading to the transfer of excitation between $6^2P_{1/2}$ and $6^2P_{3/2}$ states in cesium have been investigated by studying sensitized fluorescence in cesium vapor at pressures in the range 2×10^{-6} to 7×10^{-5}mm Hg, which were not accessible previously to such experiments and at which trapping of resonance radiation is virtually absent. The use of an improved fluorescence tube and of high-resolution interference filters in conjunction with a liquid-air-cooled photomultiplier tube permitted accurate measurements of extremely low fluorescent light intensities. The total cross sections for the processes $6\,^2P_{1/2} \rightarrow 6^2F_{3/2}$ and $6\,^2P_{1/2} \rightarrow 6\,^2P_{3/2}$ equal 0.64×10^{-15} cm^2 and 3.1×10^{-15} cm^2 respectively and are in a ratio of 0.20, which agrees well with the value predicted by the principle of detailed balancing. (Contractor's abstract)

3178

Windsor U. Dept. of Physics, Ontario (Canada).

SENSITIZED FLUORESCENCE IN VAPORS OF ALKALI METALS IV. ENERGY TRANSFER IN RUBIDIUM-RUBIDIUM COLLISIONS, by A. G. A. Rae and L. Krause. [1965] [15]p. incl. diagrs. tables, refs. (AFOSR-65-2861) (AF AFOSR-65-361) AD 628744 Unclassified

Also published in Canad. Jour. Phys., v. 43: 1574-1588, Sept. 1965.

Sensitized fluorescence in rubidium vapor has been investigated in order to determine total cross sections for collisions of the second kind between rubidium atoms, leading to the transfer of excitation between the $5^2P_{1/2}$ and $5^2P_{3/2}$ resonance levels. The experiments were carried out at vapor pressures below 0.00001 mm Hg, where there is virtually no imprisonment of resonance radiation. The exceedingly low fluorescent intensities were registered in an automatically programmed sequence of measurements, using photon counting techniques. (Contractor's abstract modified)

3179

Windsor U. Dept. of Physics, Ontario (Canada).

LIGHT SOURCES FOR THE EXCITATION OF ATOMIC RESONANCE FLUORESCENCE IN POTASSIUM AND RUBIDIUM, by R. J. Atkinson, G. D. Chapman, and L. Krause. [1965] [6]p. incl. diagrs. refs. (AFOSR-66-0384) (AF AFOSR-63-361) AD 630216
Unclassified

Also published in Jour. Opt. Soc. Amer., v. 55: 1269-1274, Oct. 1965.

A description is given of radio frequency light sources which produce potassium and rubidium resonance radiation of high intensity. The properties of the spectral lamps have been systematically investigated in relation to their operating parameters. The rf lamps emit resonance lines of much higher peak intensities, smaller halfwidths and smaller degrees of self-reversal than do commercially available lamps. Typical half widths of the resonance lines of potassium and rubidium produced by the rf sources were found to be 0.15/cm and 0.37 cm^{1}, respectively, compared with the corresponding widths of 0.34/cm and 1.5 cm^{-1} respectively, emitted by Osram spectral lamps operated at low currents. (Contractor's abstract)

3180

Wisconsin U., Madison.

SURFACE STUDIES BY SLOW ELECTRON DIFFRACTION, by M. B. Webb. Final rept. [1965] 45p. incl. diagrs. table, refs. (AFOSR-65-2726) (AF AFOSR-63-51) AD 628026 Unclassified

The low energy electron diffraction from the surface of silver and its temperature dependence have been measured. From measurement of the Debye-Waller factor, it has been determined that the mean square thermal displacement normal to the surface of the surface atoms is 2.0 ± 0.2 times that for the bulk atoms and that this excess amplitude falls to the bulk value approximately as e^{-n} where n indexes the atomic plane. These results agree with the model calculations. However, these experiments indicate the excess thermal amplitude is nearly isotropic in disagreement with simple arguments and model calculations. This discrepancy may be due to non-ideal experimental surfaces. The diffuse scattering in the vicinity of the diffraction maximum has been identified as the thermal diffuse scattering. The expected thermal diffuse scattering for low energy electrons is calculated for a simple model. Experiments show the angular dependence, temperature dependence, dependence on the diffraction vector and the integrated intensity are those expected. The temperature measurements lead to independent determinations of the penetration of the electrons into the crystal. The penetration may be described by a linear absorption coefficient which is approximately proportional to the electron energy to the minus one-half power for energies between 50 and 300 e.v. The measurement of the diffuse scattering leads to the possibility of measuring the angular dependence of the atomic structure factor.

3181

Wisconsin U., Madison.

TEMPERATURE DEPENDENCE OF THE LOW-ENERGY ELECTRON DIFFRACTION FROM SILVER (Abstract), by E. R. Jones, J. T. McKinney, and M. B. Webb [1965] [1]p. [AF AFOSR-63-51]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 324, Mar. 24, 1965.

The low-energy electron diffraction from (111) surfaces of silver has been studied. The apparatus uses both visual and Faraday cage detection. The diffraction maxima generally broaden from the instrumental limit of 1/2° to a few degrees colatitude going from 300° to 600°K. The broadening is not observed for (0h) reflections from the best crystals. The intensity decreases exponentially. Since the shape is changing, it is not straightforward to extract Debye-Waller factors, but to summarize the data, apparent Debye temperatures from 130° to 158°K are observed. Under the peaks, there are $1/\theta$ wings, which we suggest are the surface thermal diffuse scattering. They become relatively more intense with increasing temperature, as expected within experimental accuracy. For diffraction from a 2-dimensional array, at any point in reciprocal space there will be contributions to the scattering from all those phonons with wave vectors reaching the reciprocal lattice rod. This gives, for a Debye spectrum at high temperatures, a $1/\theta$ dependence instead of the usual $1/\theta^2$.

3182

Wisconsin U., Madison.

MECHANISMS OF TRANSGRANULAR STRESS CORROSION CRACKING OF SOLID SOLUTION ALLOYS, by N. Ohtani and R. A. Dodd. [1965] [12]p. incl. illus. diagrs. table, refs. (AFOSR-65-1903) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-221 and American Chemical Society) AD 625554 Unclassified

Also published in Corrosion, v. 21: 161-172, May 1965.

Effects of structure and electrochemical properties on transgranular stress corrosion susceptibility of various copper and silver alloys and austenitic stainless steels are examined. Results suggest that the alloys be classified in 3 groups according to their postulated mode of failure: (1) Those of the (base solvent) (noble solute) type, e.g., Cu(Au), Cu(Pt), Cu(Pd), single crystals which are generally very susceptible to stress corrosion cracking, due to solute diffusion to dislocations and the accompanying local galvanic corrosion; (2) Those of the (base solvent) (base solute) type, e.g., Cu(Zn), which are not very susceptible to stress corrosion cracking when in single crystal form and in the particular environments studied; transgranular

cracking in polycrystals is believed to be mechanical in nature; and (3) Austenitic stainless steels, transgranular stress corrosion susceptibility of which may be due to nucleation of σ phase at stacking faults, or to formation of passive surface films, or to a combination of both effects, thus; unlike (1) and (2) above, the stress corrosion behavior of these alloys may depend on stacking fault energy. (Contractor's abstract)

3183

Wisconsin U., Madison.

MECHANISM OF STRESS CORROSION CRACKING IN FACE-CENTERED-CUBIC METALS, by R. A. Dodd. Final technical rept. [1965] 4p. (AFOSR-65-2702) (AF AFOSR-83-221) AD 628085 Unclassified

The work was designed firstly to examine the possibility of the existence of a universal mechanism of transgranular stress corrosion cracking, originally postulated by Robertson and Tetelman, and later, when such a mechanism was substantially disproved, to examine possible cracking mechanisms in various alloy systems of interest. The experimental techniques employed included the determination of times to complete fracture under stress corrosion conditions, potentiostatic studies of polarization phenomena, etc., and electron microscope investigations of dislocation configurations and estimates of the related stacking fault energies.

3184

Wisconsin U. Dept. of Bacteriology, Madison.

POLYSOMES FROM YEAST: DISTRIBUTION OF MESSENGER RNA AND CAPACITY TO SUPPORT PROTEIN SYNTHESIS IN VITRO, by L. Marcus, R. Bretthauer and others. [1965] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)314, National Institutes of Health and National Science Foundation) Unclassified

Published in Science, v. 147: 615-617, Feb. 5, 1965.

Individual fractions of polysomes were isolated from yeast. Pulse labeling experiments in vivo show constant specific activity of messenger RNA in each polysome peak; this suggests a uniform density of ribosomes per unit length of messenger RNA. In the cell-free incorporating system, the amount of peptide per ribosome unit increased with the size of polysome.

3185

Wisconsin U. Dept. of Chemistry, Madison.

LEWIS ACID ADDUCTS OF GROUP IV-A AZIDES, by J. S. Thayer and R. West. [1965] [2]p. incl. diagr. tables, refs. (AFOSR-65-0533) [AF AFOSR-62-244] AD 613920 Unclassified

Also published in Inorg. Chem., v. 4: 114-115, Jan. 1965.

The previous isolation of complexes having the formula $(C_6H_5)_3MN_3 \cdot P(C_6H_5)_3$ [3-5] and the lability of $(CH_3)_3SiN_3$ in the presence of $AlCl_3$ suggested that group IV-A azides might act as Lewis bases. It was found that the Lewis acids $SnCl_4$, BBr_3 and Sb_{15} form stable 1:1 adducts with azides of Si, Ge, and Sn. All of the complexes isolated, except for $CH_3(C_6H_5)_2SiN_3 \cdot BBr_3$ were white solids that decomposed without melting. They dissolve without appreciable dissociation in dichloromethane, chloroform, carbon tetrachloride, and benzene; contact with water, alcohols, or acetone causes immediate decomposition. Azide band positions in the complexes differ markedly from those of the free azides. In addition, all silyl azide complexes show a strong band at about 980/cm^{-1} not present in other complexes.

3186

Wisconsin U. Dept. of Chemistry, Madison.

THE RADICAL ANION OF DODECAMETHYLCYCLOHEXASILANE, by G. R. Husk and R. West. [1965] 2p. incl. table, and refs. (Air Force Office of Scientific Research under [AF AFOSR-62-244] and Atomic Energy Commission) Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 3993-3994, Sept. 5, 1965.

The discovery of radical anions of saturated systems led into the investigation of the possibilities of radical-anion formation from alkylpolysilanes. In these experiments the low-lying d orbitals played an important role in accepting electrons. The reduction of dodecamethylcyclohexasilane gave a paramagnetic species. It is suggested from the e.s.r. spectrum that the unpaired electron was delocalized over all six silicon atoms.

3187

Wisconsin U. Dept. of Chemistry, Madison.

THE TETRALITHIUM DERIVATIVE OF PROPYNE AND ITS USE IN SYNTHESIS OF POLYSILICON COMPOUNDS, by R. West, P. A. Carney, and I. C. Mineo. [1965] 2p. [AF AFOSR-62-244] Unclassified

Published in Jour. Amer. Chem. Soc., v. 87: 3788-3789, Aug. 20, 1965.

A discussion was presented for the preparation of tetralithium compound (C_3Li_4) by the reaction of propyne on n - butyllithium in hexane. Derivatization of the polylithiated propyne with trimethylchlorosilane led to a mixture of mostly tri and tetrasilyl derivatives. Studies are being continued on the synthesis of other organometallic and organic derivatives from lithium compounds.

3188

Wisconsin U. Dept. of Chemistry, Madison.

THE MOLECULAR STRUCTURE OF A TRICYCLIC COMPLEX, $[SFe(CO)_3]_2$, by C. H. Wei and L. F. Dahl. [1965] 11p. incl. diagrs. tables, refs. (AFOSR-65-0681) (AF AFOSR-64-516) AD 615676 Unclassified

Also published in Inorg. Chem., v. 4: 1-11, Jan. 1965.

A 3-dimensional single-crystal x-ray determination of $[SFe(CO)_3]_2$ has revealed the first known example of a transition metal μ-dithio complex with a disulfide group symmetrically bonded to 2 iron tricarbonyl fragments. The structure thereby respresents a new type of transition metal carbonyl complex in which 2 fonding metals and 2 nonmetal bridging groups are fused along the bridged atoms to give a heterotricyclic system containing 4 three-membered rings. The compound contains 2 dimeric molecules in a triclinic unit cell. An analysis of the structure and bonding of $[SFe(CO)_3]_2$ is given and a comparison of its molecular configuration with that of $[C_2H_5SFe(CO)_3]_2$ is made. (Contractor's abstract)

3189

Wisconsin U. Dept. of Chemistry, Madison.

A NEW TYPE OF CYCLIC TRANSITION METAL COMPLEX, $[Ni(SC_2H_5)_2]_6$, by P. Woodward, L. F. Dahl and others. [1965] [3]p. incl. diagr. (AFOSR-67-0724) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-518 and Sloan Foundation) AD 649136 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 5251-5253, Nov. 20. 1965.

This paper reports the structure and sterochemistry of a nickel mercaptide hexamer which has been definitely established by a single-crystal x-ray analysis as the first representative of a new type of transition metal cluster. The crystals are monoclinic with twelve $Ni(SC_2H_5)_2$ species in a unit cell of dimensions a = 12.32, b = 16.10, c = 11.76A., β = 101°00, and of space group symmetry $P2_1/n$. Solid bis(ethylthio)nickel(II) consists of cyclic hexamers. The six nickel(II) atoms form a regular planar hexagon by linkage with twelve symmetrically bridging mercaptan groups. Pairs of sulfur atoms are uniformly situated above and below the plane of the nickel ring, but equidistant from each pair of adjacent nickel atoms so as to give each similarly coordinated nickel (II) an approximately square-planar environment of four sulfur atoms. The hexanuclear nickel complex can be considered to arise from the intersection of these planes of sulfur atoms at the nonbonded S-S edges with a dihedral angle of 120°. Within experimental error the nickel and four surrounding sulfur atoms are coplanar; the presumably nonbonded Ni-Ni distances around the hexagon are all equivalent and the Ni-S bond distances likewise. The Ni-S-Ni and S-Ni-S angles in the fragment are all about 83°.

3190

Wisconsin U. Dept. of Chemistry, Madison.

THREE-DIMENSIONAL CRYSTAL STRUCTURE OF BENZENECHROMIUM TRICARBONYL WITH FURTHER COMMENTS ON THE DIBENZENECHROMIUM STRUCTURE, by M. F. Bailey and L. F. Dahl. [1965] [6]p. incl. diagrs. tables, refs. (AFOSR-67-0725) (AF AFOSR-64-518) AD 649138 Unclassified

Also published in Inorg. Chem., v. 4: 1314-1319, Sept. 1965.

As part of a systematic investigation of possible threefold distortion of arene rings on π-bonding to chromium, a 3-dimensional single crystal x-ray analysis of benzenechromium tricarbonyl, $C_6H_6Cr(CO)_3$, has been carried out. Crystals of benzenechromium tricarbonyl contain 2 molecules in a monoclinic unit cell of symmetry $P2_1/m$ and dimensions a = 6.17 ± 0.02 A, b = 11.07 ± 0.04 A, c = 6.57 ± 0.02 A., and β = 101.5 ± 0.1°. A final anisotropic least-squares refinement with the hydrogen atoms included in the structure factor calculations has resulted in discrepancy factors of R_1 = 4.2% and R_2 = 4.1% for 518 observed reflections. Benzenechromium tricarbonyl possesses essentially C_{3v} molecular symmetry in agreement with the approximate molecular structure obtained from previous two-dimensional x-ray work. The π-bonded benzene ring, however, shows no significant distortion from the sixfold (D_{6h}) symmetry of free benzene, which is indicative of a completely delocalized benzene-chromium interaction. A comparison of the molecular parameters of benzenechromium tricarbonyl, hexamethylbenzenechromium tricarbonyl, and dibenzenechromium is made, and the crystallographic isomorphism of $C_6H_6Cr(CO)_3$ and $C_4H_4SCr(CO)_3$ is discussed. (Contractor's abstract)

3191

Wisconsin U. Dept. of Chemistry, Madison.

STRUCTURE OF THIOPHENECHROMIUM TRICARBONYL, $C_4H_4SCr(CO)_3$, by M. F. Bailey and L. F. Dahl. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-67-0726) (AF AFOSR-64-518) AD 649141 Unclassified

Also published in Inorg. Chem., v. 4: 1306-1314, Sept. 1965.

A three-dimensional x-ray analysis of $C_4H_4SCr(CO)_3$ has revealed a 3-fold orientation disorder of the thiophene ring. The crystals contain 2 molecules in a unit cell of symmetry $P2_1/m$ and dimensions a = 6.06 ± 0.02 A, b = 10.79 ± 0.03 A, c = 6.65 ± 0.02 A, and β = 102.2 ± 0.1°. Fourier syntheses and an isotropic rigid-body least-squares refinement based on a disordered model, in which the thiophene rings are randomly distributed in one of 3 orientations, have yielded an unweighted discrepancy factor of 13.2% for 653 observed reflections. The molecular configuration with the thiophene sulfur atom always trans to one of the

3 carbonyl groups is invarient to the crystalline disorder. However, the disordered structure has made impossible a detailed comparison of the molecular parameters of the metal-complexed thiophene with those of "free" thiophene. A comparison of the crystal structures of $C_4H_4SCr(CO)_3$ and $C_6H_6Cr(CO)_3$ is given.

3192

Wisconsin U. Dept. of Chemistry, Madison.

CRYSTAL STRUCTURE OF A 1: 1 MIXTURE OF TWO IRON CARBONYL SULFUR COMPLEXES, $S_2Fe_3(CO)_9$ AND $S_2Fe_2(CO)_6$, by C. H. Wei and L. F. Dahl. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-67-0727) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-518 and Atomic Energy Commission) AD 649142 Unclassified

Also published in Inorg. Chem., v. 4: 493-499, Apr. 1965.

The structure of $[S_2Fe_3(CO)_9]$ $[S_2Fe_2(CO_6]$ (previously formulated incorrectly as $S_2Fe_3(CO)_9$) has been determined by x-ray diffraction. Three-dimensional isotropic least-squares refinement of all atoms yielded a final unweighted reliability index of $R_1 = 8.9\%$. The crystals contain four formula species in an orthorhombic unit cell of dimensions a = 13.23 ± 0.01 A., b = 11.08 ± 0.01 A., c = 17.95 ± 0.01 A. and of symmetry Pnma. The structure consists of an ordered array of 2 different molecular species of formulas $S_2Fe_3(CO)_9$ and $S_2Fe_2(CO)_6$, both which possess crystallographic C_8-m symmetry. The molecular configuration of the $S_2Fe_2(CO)_6$ molecule is in close agreement with that of triclinic $S_2Fe_2(CO)_6$, prepared by the Hieber-Gruber reaction. The $S_2Fe_3(CO)_9$ molecule is found to be a conformer of the isomorphous Hieber-Gruber compounds $X_2Fe_3(CO)_9$ (X = S, Se).

3193

Wisconsin U. Dept. of Chemistry, Madison.

THE STRUCTURE OF HEXAMETHYLBENZENECHROMIUM TRICARBONYL WITH COMMENTS ON THE DIBENZENECHROMIUM STRUCTURE, by M. F. Bailey and L. F. Dahl. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-67-0741) (AF AFOSR-64-519) AD 648890 Unclassified

Also published in Inorg. Chem., v. 4: 1298-1306, Sept. 1965.

The controversy concerning the molecular symmetry of dibenzenechromium has a three-dimensional x-ray investigation of the molecular configuration of hexamethylbenzenechromium tricarbonyl, $(H_3C)_6C_6Cr(CO)_3$, which has produced results pertinent to the nature of arene complexes. Hexamethylbenzenechromium tricarbonyl crystallizes with 8 molecules in an orthorhombic unit cell of symmetry Pbca and dimensions a = 13.67 ± 0.03 A, b = 13.53 ± 0.03 A, and c = 15.27 ± 0.03 A. The structural determination including rigid-body analysis and anisotropic least-squares refinement has resulted in final discrepancy factors $R_1 = 10.5\%$ and $R_2 = 10.0\%$ for 1447 observed reflections. In each molecule the carbonyl groups occupy 3 trigonal coordination sites of the chromium atom; the hexamethylbenzene ring lies on the opposite side of the chromium atom, parallel both to the plane of the 3 oxygen atoms. The $Cr(CO)_3$ fragment is oriented such that (for a valence bond model with localized octahedral-type chromium orbitals) 3 assumed chromium orbitals (which can be delocalized in an MO formulation) point toward the midpoints of the alternate C-C bonds of the hexamethylbenzene ring. The methyl carbon atoms of the hexamethylbenzene ring are essentially coplanar with the benzene carbon atoms. The trigonal field of the $Cr(CO)_3$ moiety produces no evidence of a threefold distortion of the ring. Instead, a twofold deformation of both the benzene carbon and methyl carbon atoms is indicated which is attributable to asymmetric crystal forces and to a possible absence of the sixfold symmetry of the carbon skeletal structure in "free" hexamethylbenzene due to intramolecular steric interactions of the methyl groups. (Contractor's abstract)

3194

Wisconsin U. Dept. of Sociology, Madison.

DIFFICULTY FACTORS AND THE USE OF r PHI by E. F. Borgatta. [1965] [17]p. diagrs. tables. (AFOSR-66-0287) (AF AFOSR-62-16) AD 640202 Unclassified

Also published in Jour. Gen. Psychol., v. 73: 321-337, 1965.

In the utilization of factor analysis, one guideline that appears to occur often refers to the type of correlation coefficient (r_{phi}) utilized in the analysis. In particular, since the difficulties of items defined as dichotomous place restrictions on the magnitudes of correlations in computing r_{phi}, it has been assumed that utilization of such coefficients leads to spurious factors. Experience by the author with matrices that have involved dichotomies have not supported Fruchter's notion that "The phi coefficient (fourfold point correlation) should not be used unless some correction is made to avoid spurious factors due to differences in splits of the dichotomized variables." A direct empirical test is reported in which a principal-components solution, with all factors retained in the varimax rotation, was used. Extraction was stopped when the eigen-values became zero. The communality estimate is the square of the multiple-regression

coefficient. The paper demonstrates (in a complex factorial situation) the stability of factorial structures with changing difficulties of items and the fact that no difficulty factors can be found to develop. In one sector, however, it can be shown that differences in meaning and grouping of variables can arise by altering the cutting points of the variables utilized in these two factorial areas.

3195

Xavier U. Seismological Observatory, Cincinnati, Ohio.

EARTHQUAKE HISTORY OF OHIO, by E. A. Bradley and T. J. Bennett. [1965] [8]p. incl. diagrs. table, refs. (AFOSR-65-2905) (AF AFOSR-64-677)
AD 629073 Unclassified

Also published in Bull. Seismol. Soc. Amer., v. 55: 745-752, Aug. 1965.

Some 78 earthquakes occurring in Ohio in the years 1776 through 1964 have been tabulated. A literature search of newspapers and scientific journals was undertaken and a reasonably complete history from 1900 to the present may be assumed. The most prominent feature of the catalogue is the high concentration of shocks in the Anna region. Certain geological trends are indicated, but evidence is inadequate to establish a definite correlation. (Contractor's abstract)

3196

Yale U. [Dept. of Astronomy] New Haven, Conn.

SPECIAL ORBITS FOR THE EXPLORATION OF MARS AND VENUS, by V. G. Szebehely. [1965] 12p. incl. diagrs. tables, refs. (AFOSR-66-2658) [AF AFOSR-65-397] AD 643037 Unclassified

Also published in Proc. AFCRL-NASA-VPI Conf. on Exploration of Mars and Venus, Virginia Polytechnic Inst., Blacksburg, Va. (Aug. 23-27, 1965), p. VIII-1-VIII-12.

Two unusual trajectory problems are presented. The first is swing-by trajectories, which use the gravitational forces of bodies in the solar system to accomplish a mission. Existence is not obvious, but numerical experiments verify the expectations. The second problem is that of capture orbits. A numerical method for treating both problems is described and examples given.

3197

Yale U. [Dept. of Mathematics] New Haven, Conn.

INVERSE LIMIT SEQUENCES WITH COVERING MAPS, by M. C. McCord. [1965] [13]p. incl. refs. (AFOSR-65-2609) (AF AFOSR-63-407) AD 629143 Unclassified

Also published in Trans. Amer. Math. Soc., v. 114: 197-209, Jan. 1965.

A class of spaces called solenoidal spaces, which generalize the solenoids of van Dantzig, are defined and their structure is studied. Then part of the structure developed is used to prove a theorem on the homogeneity of certain solenoidal spaces. A solenoidal space is the limit of an inverse limit sequence of "nice" spaces where the bonding maps are regular covering maps. It is shown that these spaces still have many of the properties of the classical solenoids.

3198

Yale U. [Dept. of Mathematics] New Haven, Conn.

NORM DECREASING HOMOMORPHISMS OF GROUP ALGEBRA, by F. P. Greenleaf. [1966] [32]p. incl. refs. (AFOSR-66-2026) (AF AFOSR-63-407)
AD 643446 Unclassified

Also published in Pacific Jour. Math., v. 15: 1187-1219, 1965.

The homomorphisms φ of the group algebra $L^1(F)$ into the algebra M(G) of measures, where F and G are locally compact groups, has been completely determined when both groups are abelian by P. J. Cohen, and when G is compact and the homomorphism is norm decreasing and order-preserving by Glicksberg. In this paper the structure of norm decreasing homomorphisms φ is determined for arbitrary locally compact F and G. As an application the special structure of all norm decreasing homomorphisms mapping $L^1(F)$ onto $L^1(G)$. The analysis is effected by finding all multiplicative subgroups of the unit ball of measures on a locally compact group, for as we show, each extends to a norm decreasing homomorphism φ: M(F) → M(G), and is determined by the image under φ of the group of point masses on G, a multiplicative subgroup of the unit ball in M(G).

3199

Yale U. Dept. of Mathematics, New Haven, Conn.

BOUNDARY PROPERTIES OF FUNCTIONS OF SEVERAL COMPLEX VARIABLES, by W. Rudin and E. L. Stout. [1965] [15]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-63-407 and National Science Foundation) Unclassified

Published in Jour. Math. and Mech., v. 14: 991-1005, Nov. 1965.

For every set S, let S^n be the n-fold cartesian product. Let U be the open unit disk in the complex plane C and let $T = \overline{U} - U$ be the unit circle. If Ω is open in C^n and $E \subset \overline{\Omega} - \Omega$, let $H(\Omega, E)$ be the algebra of continuous functions on $\Omega \cup E$ which are holomorphic on Ω. Define $A(U^n) = H(U^n, T^n)|T^n$. Of course, the restriction map $\rho: H(U^n, T^n) \to A(U^n)$ is bijective. Let m_p be the p-dimensional measure in T^n. The following theorem is proved. Let $a_1, \cdots, a_n$ be integers and let Ω be an open connected subset of C^n. Let the compact subset E of $\overline{\Omega} - \Omega$ be a D-set for the polynomials on C^n. Suppose that $(z_1, \cdots, z_n) \in E$ implies $(\lambda^{a_1} z_1, \cdots, \lambda^{a_n} z_n) \in \Omega$ if $\lambda \in U$ and $(\lambda^{a_1} z_1, \cdots, \lambda^{a_n} z_n) \in E$ if $\lambda \in T$. Take $f \in H(\Omega, E)$ such that $|f|$ is constant on the set $\{(\lambda^{a_1} z_1, \cdots, \lambda^{a_n} z_n) | \lambda \in T\}$ for every $(z_1, \cdots, z_n) \in E$; then f is rational. Polynomials M P, Q exist such that P and Q are coprime, $Q(z) \neq 0$ if $z \in \Omega$, $Q \cdot f = P$ on $\Omega \cup E$, and $M\overline{Q}|E = P|E$. If in addition $E \subset T^n$, then this theorem can be improved to: A monomial M and polynomials

Q, Q^* exist such that $\overline{Q^*(z_1, \cdots, z_n)} = Q(\bar{z}_1, \cdots, \bar{z}_n)$ and such that $Q \cdot f = R$ is a polynomial with $R(z_1, \cdots, z_n) = M(z_1, \cdots, z_n) \cdot Q^*\left(\frac{1}{z_1}, \ldots, \frac{1}{z_n}\right)$.

3200

Yale U. Dept. of Physics, New Haven, Conn.

QUENCHING OF Na RADIATION BY He, by J. H. Stamper. [1965] [2]p. incl. diagr. (AFOSR-65-1950) (AF AFOSR-64-249) AD 629072 Unclassified

Also published in Jour. Chem. Phys., v. 43: 759-760, July 15, 1965.

According to Demtröder (Z. Physik, v. 166: 42, 1962) the effective cross section for the quenching of Na D resonance lines by He gas at a temperature of 200°C is 0.34×10^{-16} cm^2. This result contradicts those of previous researchers who found no such effect. An attempt is made to explain Demtröder's findings theoretically. The implications of this experiment are viewed with some skepticism and it is concluded that quenching the Na D lines was not accomplished to the extent reported.

3201

Yale U. [Dept. of Physics] New Haven, Conn.

ATOMIC INTERACTIONS OF MUONIUM, by R. M. Mobley, J. M. Bailey and others. [1965] [4]p. incl. diagrs. [AF AFOSR-64-249] Unclassified

Published in Fourth Internat'l. Conf. on Physics of Electronic and Atomic Collisions: Abstracts of Papers, Laval U., Quebec (Canada) (Aug. 2-6, 1965), New York, Science Bookcrafters, Inc. [1965] p. 194-197.

Powerful tools for the study of muonium are provided by the parity nonconservation in the weak interactions responsible for the decays of the pi meson and the muon. Thus from the decay of π^+ mesons, polarized positive muons with their spins oppositely directed to their momenta are produced; and in the decay of the positive muon into positrons and neutrinos, the positrons are emitted preferentially in the direction of the muon spin. With the availability of polarized muons and of a means for detecting the muon spin direction, magnetic-resonance-type experiments involving the muon and muonium can be performed. It has been learned that there is a shift in the muonium-hyperfine-structure interval due to collisions with other atoms. The direct interactions of muonium with various molecules can be studied by either detecting the reduction in the muonium resonance signal for the hfs transition in an external magnetic field caused by admixture of the molecules as impurities to the argon gas, or by measurement of the polarization of the muons as a function of time and of impurity concentration by use of a precision digital time analyzer following the scintillation counters for the positrons.

3202

[Yale U. Dept. of Physics, New Haven, Conn.]

COLLECTIVE OSCILLATIONS IN A DENSE ELECTRON GAS CONTAINING A FIXED POINT CHARGE, by E. ... Sziklas. [1965] [13]p. incl. diagrs. refs. [AF AFOSR-64-249] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 10: 116, Jan. 30, 1965.

Published in Phys. Rev., v. 138: A1070-A1082, May 17, 1965.

The collective excitations of a dense electron gas containing a fixed point charge with neutralizing positive background are investigated. A dielectric formulation, evaluated in a self-consistent-field approximation, yields a single-particle Schrödinger equation describing the collective modes. This equation has solutions belonging to the continuous spectrum (free plasmons) and to the discrete spectrum (bound plasmons). A cross section is derived for scattering of free plasmons by the point charge. The bound plasmon, representing a density wave trapped at the impurity site, has no counterpart in the uniform gas; it exists only for negative impurity charge and has an excitation frequency lying in the range $\omega_p/\sqrt{2} \leq \omega < \omega_p$, where ω_p is the plasma frequency. The bound plasmon appears to be a reasonably well-defined excitation with a lifetime $\sim 10^{-15}$ sec in metals. A simple hydrodynamic model provides further physical insight. The experimental detection of bound and free plasmons in metals and the relationship between surface plasmons, experimentally observed in many metals, and the predicted bound plasmon are discussed.

3203

Yale U. [Dept. of Physics] New Haven, Conn.

DETERMINATION OF THE RATIO $g_j(Rb^{85,87})/g_j(H)$ BY SPIN-EXCHANGE OPTICAL PUMPING (Abstract), by G. S. Hayne, E. S. Ensberg, and H. G. Robinson. [1965] [1]p. [AF AFOSR-64-249] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 28, Jan. 27, 1965.

The $\Delta F = 0$, $\Delta m_F = \pm 1$ transitions between ground-state Zeeman sublevels in optically pumped $Rb^{85,87}$ have been observed at about 7 and 14 G by monitoring the transmitted light. The dc magnetic field was stabilized by an optically pumped magnetometer, and lineshapes (width ~ 100 cps) were displayed by sweeping the center frequency of the frequency-modulated rf magnetic field. Corresponding Zeeman transitions in atomic hydrogen, which was admitted from a discharge through an aperture into the continuously evacuated

dotriacontane-coated Rb absorption cell, were detected through hydrogen-rubidium spin-exchange collisions. With the Breit-Rabi formula, the experimental frequencies led to the result $g_J(Rb^{85,87})/g_J(H) = 1 + (23.5 \pm 1.) \times 10^{-6}$. The theoretical value for this ratio is $1 + 3 \times 10^{-5}$. This result may be compared with Driscoll's measurement of g_J (Rb)/g_p, which combined with a value of $g_J(H)/g_p$ yields $g_J(Rb)/g_J(H) = 1 + (25 \pm 1) \times 10^{-6}$. Efforts to avoid possible systematic errors are discussed.

3204

Yale U. [Dept. of Pnysics] New Haven, Conn.

HYPERFINE STRUCTURE OF THE J = 1, v = 0 STATE IN $Rb^{87}F^{19}$ AND $Rb^{85}F^{19}$ (Abstract), by P. A. Banczyk and V. W. Hughes. [1965] [1]p. [AF AFOSR-64-249] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 101, Jan. 27, 1965.

Radiofrequency transitions between hfs levels of the J = 1, v = 0 state in $Rb^{87}F^{19}$ have been observed in near-zero electric field and zero magnetic field with a molecular-beam electric-resonance apparatus described earlier. The resolved transitions exhibit the natural linewidth of 1.4 kc/sec. Analysis of the spectra was done in accordance with a procedure previously described, except that the constant c_3 of the nuclear spin-spin tensor interaction is measured from the spectra. The results for the $Rb^{87}F^{19}$ hfs constants are $(eq_1Q_1) = -(34.0313 \pm 0.0010)$ mc/sec; $c_1 = +(1.595 \pm 0.050)$ kc/sec; $c_2 = +(10.51 \pm 0.08)$ kc/sec; $c_3 = +(3.16 \pm 0.18)$ kc/sec; $c_4 = +(0.66 \pm 0.10)$ kc/sec. Further analysis of similar $Rb^{85}F^{19}$ data allows a measurement of c_3 and a slightly better determination of measurements previously reported. The final results for the $Rb^{85}F^{19}$ hfs constants are $(eq_1Q_1) = -(70.3405 \pm 0.0004)$ mc/sec; $c_1 = +(0.525 \pm 0.010)$ kc/sec; $c_2 = +(10.53 \pm 0.07)$ kc/sec; $c_3 = +(0.93 \pm 0.05)$ kc/sec; $c_4 = +(0.23 \pm 0.06)$ kc/sec. The ratio of the electrical-quadrupole interaction constants is $(eq_1Q_1)^{85}/(eq_1Q_1)^{87} = +(2.06694 \pm 0.00006)$.

3205

Yale U. [Dept. of Physics] New Haven, Conn.

MODE COMPETITION AND FREQUENCY SPLITTING IN MAGNETIC-FIELD-TUNED OPTICAL MASERS, by R. L. Fork and M. Sargent, III. [1965] [2]p. incl. refs. [AF AFOSR-64-249] Unclassified

Published in Phys. Rev., v. 139: A617-A618, Aug. 2, 1965.

Equations are given describing the beat-frequency variation and mode competition in a gaseous optical maser operated in a magnetic field parallel to the maser axis. The equations include only lowest order nonlinear terms. Important terms in the amplitude- and frequency-determining equations are shown to arise from an induced atomic precession. These terms have a character similar to those describing the effects of selective depletion of the velocity distribution or "hole burning." It is shown that the induced atomic precession causes parametric conversion of an optical field of one circular polarization into one of the other polarization with a frequency shift equal to the rate of precession. This process tends to make the competition between modes of different polarizations important. An additional feature, not found in the scalar theory, is that, for sufficiently large magnetic fields, competition can be important between modes separated in frequency by several Doppler-broadened linewidths. (Contractor's abstract)

3206

Yale U [Dept. of Physics] New Haven, Conn.

MUONIUM CHEMISTRY (Abstract), by J. M. Bailey, W. E. Cleland and others. [1965] [1]p. (In cooperation with Columbia U., New York) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-249] and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 80, Jan. 27, 1965.

Experiments have been carried out to investigate the interactions of muonium atoms (μ^+e^-) with several molecules including NO, O_2, NO_2, C_2H_4, H_2, and N_2. Polarized muonium is formed by stopping polarized positive muons from the Nevis synchrocyclotron in high-pressure argon gas in a longitudinal magnetic field. Quenching of the ground-state hyperfine resonance signal in muonium has been observed as a function of concentration of NO, O_2, NO_2, and C_2H_4; no quenching was observed due to H_2 or N_2. In addition, the time dependence of the muon depolarization has been measured, using a digital time analyzer. Depolarization rates have been measured at several concentrations of each of the impurity molecules. The data on NO are consistent with depolarization due to electron-exchange collisions. Molecular formation is believed to take place in the muonium $-C_2H_4$ system. Cross sections are presented.

3207

Yale U. [Dept. of Physics] New Haven, Conn.

NEW METHODS FOR MEASURING HYDROGENIC FINE

STRUCTURE (Abstract), by M. Leventhal, W. E. Lamb, Jr. and others. [1965] [1]p. [AF AFOSR-64-249] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 458, Apr. 26, 1965.

New experimental arrangements are being investigated for the purpose of studying fine-structure resonances in excited states of simple atoms. In one form of the apparatus, metastable n = 2, $^2S_{\frac{1}{2}}$ hydrogen atoms are created by electron bombardment of molecular hydrogen at a pressure of about 1 μ. The metastables move a short distance from the electron gun into a microwave quench region. The Lyman-α radiation emitted when the metastables undergo resonant transitions to the short-lived ^2P term is collected by a light pipe that points at the quench region. An ultraviolet photodetector receives the radiation, and the photosignal is amplified and fed to a lock-in detector. The gun and quench region are situated in a variable magnetic field, which enables resonances to be scanned. All allowed transitions between the n = 2, $^2S_{\frac{1}{2}}$, and $^2P_{\frac{1}{2}}$ levels have been observed. A preliminary low precision measurement of the $^2S_{\frac{1}{2}}$ to $^2P_{\frac{1}{2}}$ separation has been made and is compatible with previous atomic-beam results.

3208

Yale U. [Dept. of Physics] New Haven, Conn.

OBSERVATION OF SHARP RESONANCES AT LEVEL CROSSINGS IN HYDROGEN (Abstract), by K. R. Lea, W. E. Lamb, Jr. and others. [1965] [1]p. [AF AFOSR-64-249] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 458, Apr. 26, 1965.

Employing the apparatus previously described, the 2 resonance transitions αe and αf in hydrogen have been observed at magnetic fields near 575 and 1190 G, respectively. In these regions, the β state is degenerate with the e and f levels, respectively. A small electric field in the appropriate direction couples the degenerate levels. The coupling is demonstrated by the appearance of narrow resonance lines, superimposed on the much broader resonances αe, αf. The sharp resonances occur when the radio frequency matches the $\alpha\beta$ separation. Previous observations of these sharp resonances have been restricted to the vicinity of the βe crossing only.

3209

Yale U. [Dept. of Physics] New Haven, Conn.

THE ONE DIMENSIONAL SOLUBLE PARTICLE TRANSFER PROBLEM AND THE MODIFIED ENERGY MATRIX METHOD, by Y. Nishida. [1965] [9]p. incl. tables. (AFOSR-65-2688) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-394 and Atomic Energy Commission) AD 627773 Unclassified

Also published in Ann. Phys., v. 34: 415-423, Oct. 1965.

The comparison of the modified energy matrix treatment of the particle transfer problem with the exact solution available in a special one dimensional case which has been made by Breit is analyzed and carried out by an alternative procedure with the same conclusion. The analysis includes the consideration of effects of the continuum of the energy spectrum of each of the 2 δ-function potentials and of the effects of these parts of the spectra on the transition probability. These effects are found small in the case considered. The exact solutions are put into a form especially suitable for the comparisons made. The modified energy matrix method is made use of to estimate the effect of the finiteness of the range of force and to analyze the location in space of contributions to the transfer amplitude. (Contractor's abstract)

3210

Yale U. [Dept. of Physics] New Haven, Conn.

A SOLUBLE SEMICLASSICAL PARTICLE TRANSFER PROBLEM, by G. Breit. [1965] [23]p. incl. diagrs. (AFOSR-65-2689) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-394, Army Research Office (Durham), and Atomic Energy Commission) AD 624638 Unclassified

Also published in Ann. Phys., v. 34: 377-399, Oct. 1965.

The one dimensional semiclassical transfer problem presented by 2 δ-function potentials approaching each other with uniform velocities before a certain time and receding from each other again with uniform velocities in the infinite future admits of an exact solution. A systematic iterative construction is described and the properties of the solution are compared with those of solutions obtained by 2 approximate methods. The first of these is the 'energy matrix' approximation used by Breit and Ebel in calculations on the $N^{14}(N^{14}, N^{13})N^{15}$ reaction. The second is similar to it in that only 2 out of an infinity of expansion functions are used in the expansion of the time dependent wave function. Instead of employing linear combinations of adiabatic wave functions, however, the second method of approximation employs expansion functions which are eigenfunctions for each of the 2 potentials in its own Galilean frame. The exact solution gives transition probabilities in reasonable agreement with the approximations within limits explicable by the character of the approximations.

3211

Yale U. [Dept. of Physics] New Haven, Conn.

INFLUENCE OF MULTIPLE VIRTUAL TRANSITIONS

ON THE REORIENTATION EFFECT IN COULOMB EXCITATION, by J. F. Masso and D. L. Lin. [1965] [9]p. incl. diagrs. tables, refs. (AFOSR-66-0446) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-394], Army Research Office (Durham), and Atomic Energy Commission) AD 628650
Unclassified

Also published in Phys. Rev., v. 140: B1182-B1190, Dec. 8, 1965.

Calculations of the reorientation effect in Coulomb excitation of the first 2^+ state of even-even nuclei are extended by employing the semiclassical approximation to take into account second- and third-order virtual E2 transitions to higher excited states. Deviations from first-order perturbation theory in the excitation probability are investigated numerically as a function of the bombarding energy and the scattering angle for heavy-ion projectiles. Results are presented for rotational and vibrational nuclei as a guide in the selection of conditions suitable for the determination of the static quadrupole moment of the lowest 2^+ state. Conditions for the practical convergence of the perturbation expansion are discussed.

3212

Yale U. [Dept. of Physics] New Haven, Conn.

CORRECTIONS TO THE REORIENTATION EFFECT DUE TO VIRTUAL EXCITATION OF HIGHER STATES (Abstract), by J. F. Masso and D. L. Lin. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-394] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 468, Apr. 26, 1965.

Calculations of the reorientation effect in Coulomb excitation of the 1st 2^+ state of even-even nuclei are extended by employing the semi-classical approximation to take into account 2nd- and 3rd-order virtual E2 transitions to higher excited states, which can populate the 2^+ level. Deviations from 1st-order perturbation theory in the excitation probability are investigated numerically as a function of the bombarding energy and the scattering angle for heavy-ion projectiles. Results are presented for selected rotational and vibrational spectra as a guide to the determination of the static quadrupole moment of the lowest 2^+ state. Conditions for the practical convergence of the perturbation expansion are discussed.

3213

Yale U. [Dept. of Physics] New Haven, Conn.

CROSS SECTION AND POLARIZATION IN THE PHOTODISINTEGRATION OF THE DEUTERON (Abstract), by R. G. Brandt, W. Zickendraht and others. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-394], Army Research Office (Durham), and Atomic Energy Commission)
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 448, Apr. 26, 1965.

Employing the theoretical development given elsewhere, calculations are performed including electromagnetic multipoles up to E4 and M4 in the nonretarded approximation employing the Yale potential. Cross sections and polarizations for unpolarized γ-rays and deuterons are compared with values using an earlier potential, with experimental data, and with other calculations. It is shown that multipoles of higher order than E2 and M1 produce a nonnegligible change in the cross section above a γ-ray energy of about 40 mev. This can be of the order of 30%-50% at certain angles above an energy of 100 mev. A method is developed whereby photodisintegration calculations are performed making use more directly of phenomenological phase parameters. Differences between these results and those obtained employing the Yale potential are small.

3214

Yale U. [Dept. of Physics] New Haven, Conn.

HIGH-PRECISION MEASUREMENT OF THE 2^3P_1-2^3P_2 FINE STRUCTURE OF He^4 (Abstract), by R. D. Swift, F. M. J. Pichanick, and V. W. Hughes. [1965] [1]p. (Sponsored jointly by Advanced Research Projects Agency and Air Force Office of Scientific Research under [AF AFOSR-64-394]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10: 455, Apr. 26, 1965.

A report of the results of a series of high-precision measurements on the fine structure of helium using the microwave-optical atomic-beam technique is made. The standard deviation of 34 runs on the ($J = 1$, $M_J = 0 \longleftrightarrow J = 2$, $M_J = 0$) transition was 2.7 kc/sec or about 1 ppm of the fine-structure interval. Several corrections had to be applied to the experimental data prior to the evaluation of the fine structure. The most important correction was an allowance for the variation of optical matrix elements as a function of magnetic field. This effect could be estimated both theoretically and experimentally, the 2 results differing by some 15%. The discrepancy corresponds to about 3 ppm in the corrected fine structure. In view of this uncertainty and other possible systematic effects, we are currently quoting 2291.170 ± 0.018 mc/sec for the 2^3P_1 to 2^3P_2 fine-structure interval. This experimental value is more accurately known than the theoretical value, but calculations of higher-order theoretical corrections are in progress.

3215

Yale U. [Dept. of Physics] New Haven, Conn.

INTERACTION OF NUCLEI WITH ELECTROMAGNETIC MULTIPOLES (Abstract), by G. Breit and M. L. Rustgi. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-394], Army Research Office (Durham), and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10. 447, Apr. 26, 1965.

Employing the classification of Franz and Stech as presented in Blatt and Weisskopf, the interaction of nuclei with electromagnetic multipoles is written in such a way that different terms involve physical uncertainties of different types. In the nonretarded approximation, the electric field due to the electric multipoles is expressible as the gradient of a potential and therefore the corresponding interaction energy can be written in a somewhat definitive way. The interaction with the magnetic moment in the nonretarded approximation is treated in the same fashion. An expression for the interaction energy without neglecting the retardation effects is also derived and the way in which equivalent operators in such a treatment may be introduced is pointed out. The elimination of the coordinates of the center of mass and underlying assumptions are discussed.

3216

Yale U. [Dept. of Physics] New Haven, Conn.

SIMPLIFIED DERIVATION OF THE AMPLITUDES FOR THE PHOTODISINTEGRATION OF THE DEUTERON WITH ARBITRARY NUMBER OF ELECTROMAGNETIC MULTIPOLES (Abstract), by R. Botzian, M. L. Rustgi and A. J. Torruella. [1965] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-394] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-29, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 448, Apr. 26, 1965.

Employing the interaction Hamiltonian in the operator form as derived by Breit and Rustgi, a simplified derivation of the amplitudes for the photodisintegration of the deuteron is reported and the same expressions as given earlier are obtained. In this derivation, use is made of the Wigner-Eckart theorem, and the commutation relations between the spin matrices but the Racah coefficients are not employed. As in the earlier papers, the nonretarded approximation has been used, the final-state interaction of the outgoing neutron and proton is included and the effect of the magnetic moments on the electric multipoles is not considered.

3217

Yale U. [Dept. of Physics] New Haven, Conn.

CORRECTION TO THE ($He^3, 2^3S_1$) TO (He^{3+}, $2^2S_{1/2}$) HYPERFINE-STRUCTURE RATIO, by M. M. Sternheim. [1965] [2]p. incl. refs. (AFOSR-66-0369) [AF AFOSR-65-249] AD 630226 Unclassified

Also published in Phys. Rev. Ltrs., v. 15. 336-337, Aug. 1965.

There has been a discrepancy in the ratio of the 2-trip-2^3S_1 hfs of the He^3 atom to the $2^2S_{\frac{1}{2}}$ state hfs of the He^{3+} ion, the calculated value being too large by 10 ppm. The purpose of this note is to point out the omission of a correction of -4 ppm in this theoretical ratio.

3218

Yale U. [Dept. of Physics] New Haven, Conn.

VACUUM POLARIZATION CORRECTIONS TO HYPERFINE STRUCTURE IN MUONIC ATOMS, by M. M. Sternheim. [1965] [3]p. incl. table, refs. (AFOSR-66-0372) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-249] and Atomic Energy Commission) AD 630232 Unclassified

Also published in Phys. Rev., v. 138: B430-B432, Apr. 26, 1965.

Measurement of the hyperfine-structure splitting in muonic atoms would be interesting in view of the discrepancies in electronic atoms. In muonic atoms, nuclear-structure effects are much larger than the uncertainty in the fine-structure constant and may therefore be observed unambiguously. The various corrections are briefly discussed, and the large vacuum polarization correction is calculated.

3219

Yale U. Dept. of Physics, New Haven, Conn.

MEASUREMENT OF THE QUANTUM-ELECTRODYNAMIC LEVEL SHIFT IN THE n = 3 STATE OF $(He^4)^+$, by M. Leventhal, K. R. Lea, and W. E. Lamb, Jr. [1965] [3]p. incl. diagrs. refs. (AFOSR-67-1222) [AF AFOSR-65-249] AD 653300 Unclassified

Also published in Phys. Rev. Ltrs., v. 15 1013-1015, Dec. 27, 1965.

Precision measurements of the level shift in hydrogenic systems have provided a fundamental test of the theory of quantum electrodynamics. However, at the present writing experimental results have been reported for relatively few levels. In this letter we report the first observation of microwave resonances between n = 3 states of He^+ and the results of an initial low-precision measurement of the level shift $S\text{-}E(3^2S_{\frac{1}{2}})\text{-}E(3^2P_{\frac{1}{2}})$.

It is felt that a new test of the n and Z dependence of the theory will eventually be provided.

3220

Yale U., [Dept. of Physics] New Haven, Conn.

TECHNIQUE FOR FORMING PRESSURE WINDOWS FROM THIN METAL SHEETS, by W. E. Cleland and R. Prepost. [1965] [3]p. incl. diagrs. table. (In cooperation with Columbia U., New York) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-249] and Office of Naval Research) Unclassified

Published in Rev. Scient. Instr., v. 36· 1881-1883, Dec. 1965.

Hydrostatic forming was used to produce thin metallic end windows. The approach is considered to be a simple and economical method of fabricating a pressure vessel with thin walls to meet requirements of experimental physics. Aluminum alloys and Type 310 stainless steel were used to form a vessel which could safely contain gas at pressures up to 70 atm. An essential feature of the deforming apparatus is the die, which forms the clamp which applies pressure uniformly around the sheet.

3221

Yale U. Dept. of Physics, New Haven, Conn.

PHONON-COUPLED PAIR SPECTRA OF K_2ReCl_6 IN SINGLE CRYSTALS OF K_2PtCl_6, by P. B. Dorain and R. G. Wheeler. [1965] [3]p. incl. diagrs. table. (AFOSR-66-1633) [AF AFOSR-65-873] AD 641223 Unclassified

Also published in Phys. Rev. Ltrs., v. 15· 968-970, Dec. 20, 1965.

The optical spectra of dilute single crystals of K_2PtCl_6 containing Re^{+4} show absorption peaks which may be assigned to ion pairs of Re^{+4} in addition to lines arising from the single ion. The spectrum reported in this note arises from the free-ion transition from $^4A_{2g}(\Gamma_8)$ to $^2T_{2g}(\Gamma_7)$ and the associated pair transitions. The results show that (1) the coupling of rhenium pairs in K_2PtCl_6 crystals in the ground state is antiferromagnetic, and (2) the excited-state coupling parameters are strongly dependent upon the associated vibrational states but are predominantly antiferromagnetic.

3222

Yale U. [Sloane Physics Lab.] New Haven, Conn.

ANTIFERROMAGNETIC RESONANCE IN K_2ReCl_6, K_2ReBr_6, AND K_2IrCl_6 (Abstract), by R. G. Wheeler and P. B. Dorain. [1965] [1]p. [AF AFOSR-62-186] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 329, Mar. 24, 1965.

Using interferometric far-infrared spectroscopic techniques, the zero magnetic-field antiferromagnetic resonance of the fcc crystals K_2ReCl_6, K_2ReBr_6, and K_2IrCl_6 has been observed at 1.5 K. In K_2ReBr_6, 2 lines at 35.0 and 33.0 cm^{-1}, each of width less than 0.5 cm^{-1} are observed. In K_2ReCl_6, a single line of approximate width of 3 cm^{-1} is observed at 43.75 cm^{-1}. A single line at 11.5 cm^{-1} is observed in K_2IrCl_6. The last observation appears to confirm type 3A ordering suggested by Ter Haar and Lines. Since there is evidence that little or no lattice distortion occurs in the cubic rhenium compounds, the doublet-line structure suggests a significant next-nearest-neighbor anisotropy if the ordering is type 3A. The diamagnetic crystal K_2PtCl_6 was used to locate vibronic and lattice modes.

3223

Yale U. [Sloane Physics Lab.] New Haven, Conn.

OPTICAL SPECTRA OF DILUTE AND CONCENTRATED SINGLE CRYSTALS OF K_2ReCl_6 AT 4.2 K (Abstract), by P. B. Dorain and R. G. Wheeler. [1965] [1]p. [AF AFOSR-62-186] Unclassified

Presented at meeting of the Amer. Phys. Soc., Kansas City, Mo., Mar. 24-27, 1965.

Published in Bull. Amer. Phys. Soc., Series II, v. 10 329, Mar. 24, 1965

The optical spectra of single crystals of dilute and concentrated K_2ReCl_6 and K_2ReBr_6 exhibit sharp lines at T = 4.2 K for the transitions from the $^4A_2$ to the ^2E, $^2T_1$, and $^2T_2$ states arising from the t_{2g}^3 configuration. The diluted crystal of K_2ReCl_6 in K_2PtCl_6 shows a particularly simple vibronic structure of 124, 166, and 320 cm^{-1} for all electronic transitions and may be associated with the ν_6, ν_5 and ν_2 modes of the complex The small splitting (2 cm^{-1}) of the $^2T_2\Gamma_8$ state arises from the very small distortion caused by poor packing The pure crystals show similar vibronic lines The $^2T_2\Gamma_8$ state shows no splitting and therefore the crystals are good cubic lattices. Zeeman effects also show that the ground state of the concentrated crystal is a singlet. From the observed splitting of the $^2T_2\Gamma_7$ state in the concentrated crystal the local antiferromagnetic field is found to be 30 kG. Several other lines in the concentrated crystal are discussed.

3224

Yale U Sloane Physics Lab., New Haven, Conn.

MEASUREMENT OF EXCITED STATE RELAXATION RATES, by W. R. Bennett, Jr., P. J. Kindlmann, and G. N. Mercer. [1965] [24]p. incl. illus. diagrs. tables, refs. (AFOSR-65-1122) [AF AFOSR-64-626] AD 620469 Unclassified

Also published in Appl. Opt., Suppl. 2, Chem. Lasers, p 34-57, 1965

A detailed review is given of methods for the measurement of radiative decay rates and total inelastic destructive cross sections of short-lived excited states. The paper is divided into 6 main sections, dealing with methods of approximate calculation and interpretation of radiative and collision processes, previous methods of measurement, a review of delayed multichannel coincidence techniques, properties of the vernier chronotron; methods of statistical analysis, and a summary and analysis of data pertinent to laser transitions in helium, neon, and singly ionized argon. The main emphasis is given to experimental techniques for the measurement of excited state lifetimes in the 4-nsec to 1000-nsec range and the analysis of data taken in the noble gases with this system.

3225

Yale U. Sloane Physics Lab., New Haven, Conn.

A QUANTUM MECHANICAL EVALUATION OF LINE BREADTHS INVOLVED IN TUNED-LASER ABSORPTION AND STIMULATED EMISSION SPECTROSCOPY, by W. R. Bennett, Jr. [1965] [3]p. (AFOSR-65-2874) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-64-626] and Army Research Office (Durham)) AD 614383 Unclassified

Also published in Appl. Opt., Suppl. 2, Chem. Lasers, p. 78-80, 1965.

An analysis is given of collision- and power-broadening effects in tuned-laser absorption spectroscopy using time-dependent perturbation theory. The results are compared with the earlier analysis based on the Lorentz theory of collision broadening given by Gerritsen and Heller. Finally, the analysis is extended to include similar broadening effects on the net gain coefficient when both stimulated emission and absorption are involved. (Contractor's abstract)

3226

Yale U. Sloane Physics Lab., New Haven, Conn.

EXCITATION AND INVERSION MECHANISMS IN GAS LASERS, by W. R. Bennett, Jr. [1965] [17]p. incl. illus. diagrs. refs. (AFOSR-65-2965) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-626] and Army Research Office (Durham)) AD 627690 Unclassified

Also published in Ann. New York Acad. Sci., v. 122: 579-595, May 28, 1965.

Recent developments up to 1965 in the field of gas lasers are reviewed. Two excitation mechanisms, optical pumping by stimulated emission and electron impact, have made considerable progress. For most cw gas lasers, which are 4-level systems, a buildup of the metastable level with increasing excitation produces a saturation bottleneck that severely limits the power output of the system. It is possible that this problem may be overcome by a 3-level gas laser system. Pulsed and continuous laser oscillation in singly ionized states of the noble gases are considered.

3227

Yale U. [Sloane Physics Lab.] New Haven, Conn.

INVERSION MECHANISMS IN GAS LASERS, by W. R. Bennett, Jr. [1965] [31]p. incl. diagrs. tables, refs. (AFOSR-65-2065) (Sponsored jointly by Air Force Office of Scientific Research under [AF AFOSR-65-626] and Army Research Office (Durham)) AD 627489 Unclassified

Also published in Appl. Opt., Suppl. 2, Chem. Lasers, p. 3-33, 1965.

A review is presented of recent developments in the gas laser field which is intended to supplement a previous, more detailed paper on the same subject (Appl. Opt., Suppl. 1: 24, 1962). In addition, a number of new results are described. The present work has 6 main sections dealing with: a summary of general laser conditions, inversion saturation mechanisms in 4-level systems, possible 2- and 3-level collision lasers, stimulated emission pumping, transient inversions, and ion lasers. Emphasis is placed on atomic systems, and a summary of currently known gas laser transitions is included as an appendix.

3228

Yale U. [Sterling Chemistry Lab.] New Haven, Conn.

DECOMPOSITION OF BENZENEDIAZONIUM-3-CARBOXYLATE: TRANSIENT 1,3-DEHYDROBENZENE, by R. S. Berry, J. Clardy, and M. E. Schafer. [1965] [7]p. incl. diagrs. (AFOSR-65-1251) [AF AFOSR-63-183] AD 622852 Unclassified

Also published in Tetrahedron Ltrs., No. 15: 1011-1017, Apr. 1965.

The mass spectrum and the optical spectrum were studied as functions of time for the process and products of flash-initiated decomposition of benzenediazonium-3-carboxylate. The products of decomposition include a transient parent C_6H_4 species of mass 76. The fragmentation pattern and its time dependence show that the mass 76 species is different from either of those obtained from the ortho or para isomers of the precursor. Comparison of the fragmentation pattern with model compounds suggests that 1,3-dehydrobenzene probably

in a singlet state, is the most likely assignment of the species. Two structural representations are proposed.

3229

Yale U. [Sterling Chemistry Lab.] New Haven, Conn.

1, 4 DEHYDROBENZENE: A STABLE SPECIES, by R. S. Berry, J. Clardy, and M. E. Schafer. [1965] [8]p. incl. diagrs. (AFOSR-65-1252) [AF AFOSR-63-183] AD 620595 Unclassified

Also published in Tetrahedron Ltrs., No. 15: p. 1003-1010, Apr. 1965.

The mass spectrum and the optical spectrum as functions of time were studied for the process and products of flash-initiated decomposition of benzenediazonium-4-carboxylate. The products of decomposition include a relative stable C_6H_4 species, mass 76. The most likely assignment of the species is 1, 4-dehydrobenzene, probably in a singlet state. Two structural representations are proposed.

3230

Yale U. [Sterling Chemistry Lab.] New Haven, Conn.

THRESHOLD SHAPES AND RESONANCES IN THE PHOTODETACHMENT CROSS SECTIONS OF CHLORIDE, BROMIDE, AND IODIDE, by R. S. Berry, C. W. David, and J. C. Mackie. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-1254) (AF AFOSR-63-183) AD 622855 Unclassified

Also published in Jour. Chem. Phys., v. 42: 1541-1546, Mar. 1, 1965.

The photodetachment curves of Cl^-, Br^-, and I^- have been examined in their threshold regions by absorption spectroscopy of shock-heated alkali halide vapors. The chloride curve appears smooth and normal in terms of threshold laws, but the bromide and iodide curves show maxima about 500 cm^{-1} above the thresholds, with widths of about 200 cm^{-1} at half-height. The threshold positions are not affected by changes in conditions. The anomalously large absorption or resonances seem to be due to the halide ions, but to be influenced to some degree by the alkali atoms or ions. Three explanations, none entirely satisfactory, are put forth for the maxima; these are: (1) near-resonant transfer of energy from $X + e^-$ to M, giving $X^- + M^*$; (2) metastable autodetaching states of the halides; and (3) mixing of vacant alkali ion orbitals with continua of the halides. The third is considered most plausible.

3231

Yale U. [Sterling Chemistry Lab.] New Haven, Conn.

CARBALKOXYNITRENES. THE PHOTOLYTIC DECOMPOSITION OF GASEOUS ALKYL AZIDOFORMATES, by D. W. Cornell, R. S. Berry, and W. Lwowski. [1965] [4]p. incl. diagr., tables, refs. (AFOSR-65-2202) [AF AFOSR-63-183] AD 625537 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87 3626-3629, Aug. 20, 1965.

The photolytic decomposition of gaseous ethyl and methyl azidoformates has been studied with regard to carbalkoxynitrene formation and other modes of decomposition. Chemical trapping and product analysis show that the nitrenes are produced when light is used whose energy is above about 95 kcal /mol , but below 130 kcal. Transient spectra show absorption by NCO. From the appearance time of NCO and the dependence of the NCO spectrum on partial pressure of a chemical trapping agent, limits on the nitrene lifetime are set at about 3×10^{-7} and 10^{-5} sec. At higher photolysis energies transient N_3 is also observed, and the product pattern indicates that a transient but unobserved CO_2N_3 may be present.

3232

Yale U. [Sterling Chemistry Lab.] New Haven, Conn.

THE DIMERIZATION OF GASEOUS BENZYNE, by M. E. Schafer and R. S. Berry. [1965] [5]p. incl. illus. diagrs. table, refs. (AFOSR-66-0058) (AF AFOSR-63-183) AD 629681 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 87: 4497-4501, Oct. 20, 1965.

Benzyne is the primary organic product of the photoinitiated decomposition of benzenediazonium 2-carboxylate. Its presence and its ultraviolet absorption spectrum are established by the coincident results of time-resolved optical and mass spectra. The integrated intensity of the ultraviolet absorption spectrum, and the intensity of mass peak 76, both measured as functions of time, lead to a rate constant for the dimerization of benzyne to biphenylene. The second-order constant has a value greater than or equal to 7×10^8 l /mol sec, and corresponds to a minimum reaction probability, per collision of 7×10^{-3}.

3233

Yale U., Sterling Chemistry Lab., New Haven, Conn.

EFFECT OF PRESSURE ON CONDUCTANCE. I. TETRAISOAMYLAMMONIUM PICRATE IN DIETHYL ETHER AND IN BENZENE, by J. F. Skinner and R. M. Fuoss. [1965] [7]p. incl. diagrs. tables, refs. (AFOSR-65-2382) (AF AFOSR-63-244) AD 626519 Unclassified

Also published in Jour. Phys. Chem., v. 69 1437-1443, May 1965.

The conductance of tetraisoamylammonium picrate (TIAPi) has been measured in diethyl ether at five

concentrations from 3×10^{-6} to 3×10^{-4} M at 30 to 5000 kg/cm^2 and in benzene at four concentrations from 3×10^{-4} to 3×10^{-3} M at 25 to 750 kg/cm^2. The change in conductance with increasing pressure in both solvents has been explained in terms of decreased ionic mobility owing to increased solvent viscosity and shifts in the ion pair and triple ion association equilibria as a result of increased dielectric constant of the solvent. In the highly compressible ether, at concentrations below the conductance minimum, the conductance increased by about one order of magnitude while in benzene, at concentrations above the minimum, a small decrease in conductance appeared as predicted. A value of Λ_0 = 190 for TIAPi in ether and values of the center-to-center contact distances for ion pairs (4.9 A) and triple ions (15 A) were obtained from the data. The corresponding Walden product for TIAPi in diethyl ether is 0.39, in good agreement with values of 0.42 in water, 0.47 in nitrobenzene, and 0.43 in ethylene dichloride. (Contractor's abstract)

3234

Yeshiva U., New York.

TRIAL AND ERROR PREDICATES AND THE SOLUTION TO A PROBLEM OF MOSTOWSKI, by H. Putnam. [1965] [9]p. (AFOSR-66-0418) (AF AFOSR-65-345) AD 632770 Unclassified

Also published in Jour. Symbolic Logic, v. 30. 49-57, Mar. 1965.

Sets for which there are decision procedures are considered under modification of the notion of a decision procedure by (1) allowing the procedure to "change its mind" any finite number of times, and (2) giving up the requirement that it be possible to tell (effectively) if the computation has terminated. Two theorems are proved concerning the necessary and sufficient conditions (in terms of the Kleene-Mostowski hierarchy of arithmetic predicates) that P be a trial and error predicate, and that there exist a k such that P is a k-trial predicate. A second group of results is concerned with the metatheory of quantification theory (without identity). It is shown that the formula wanted by Mostowski with no model in which (1) the universe of discourse is the natural numbers and (2) the predicate letters are all interpreted as recursively enumerable (r.e.) predicates or truth functions of r.e. predicates, does not exist. Every consistent formula of quantification theory does have a model in Σ_1^*, the smallest class containing the r.e. predicates and closed under truth functions.

3235

[Yeshiva U.] Belfer Graduate School of Science, New York.

ANALYTIC NATURAL DEDUCTION, by R. M. Smullyan. [1965] [17]p. incl. diagrs. (AF AFOSR-63-433) Unclassified

Presented at Internat'l. Cong. of Mathematicians, Stockholm (Sweden), Aug 15-22, 1962.

Published in Jour. Symbolic Logic, v. 30: 123-139, June 1965.

Some natural deduction systems for quantification theory whose only quantificational rules involve elimination of quantifiers are considered. By imposing certain restrictions on the rules, a system is obtained which is termed Analytic Natural Deduction; it has the property that the only formulas used in the proof of a given formula X are either subformulas of X, or negations of subformulas of X. By imposing further restrictions, a canonical procedure is obtained which is bound to terminate if the formula being tested is valid. The procedure can be thought of as a partial linearization of the method of semantical tableaux. The completeness theorem for semantical tableaux rests essentially on Konig's lemma on infinite graphs. The completeness theorem for natural deduction uses as a counterpart of Konig's lemma, a lemma on infinite "nest structures", as theory are defined in the article. These structures can be looked at as the underlying combinatorial basis of a wide variety of natural deduction systems.

3236

Yeshiva U. Belfer Graduate School of Science, New York.

SCALED PARTICLE THEORY OF FLUID MIXTURES, by J. L. Lebowitz, E. Helfand, and E. Praestgaard. [1965] [6]p. incl. diagrs. refs. (AFOSR-65-2782) (AF AFOSR-64-508) AD 629819 Unclassified

Also published in Jour. Chem. Phys., v. 43: 774-779, Aug. 1, 1965.

An extension of a previous one-component theory of hard-sphere systems (in 3, 2, and 1 dimensions) and the surface tension of real systems is made to mixtures. The theory is based on consideration of an approximate expression for the work of adding an additional hard sphere to a mixture. Comparison between theory and molecular-dynamics calculations of the various contributions to the virial pressure (related to contact distribution functions) of such hard-sphere mixtures is excellent. Comparison of the theory with experimental surface tensions of mixtures of simple liquids is satisfactory. (Contractor's abstract)

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Yeshiva U. Belfer Graduate School of Science, New York.

MICROSCOPIC THEORY OF BROWNIAN MOTION IN AN OSCILLATING FIELD; CONNECTION WITH MACROSCOPIC THEORY, by J. L. Lebowitz and P. Résibois. [1965] [11]p. incl. refs. (AFOSR-65-2865) (AF AFOSR-64-508) AD 628252 Unclassified

Also published in Phys. Rev., v. 139: A1101-A1111, Aug. 16, 1965.

Recently, Lebowitz and Rubin, and Resibois and Davis, showed that the Fokker-Planck equation for the distribution function of a Brownian particle (B particle) of mass M, in a fluid of particles of mass m, may be derived directly from the Liouville equation for the joint

distribution of fluid and B particle. It is the lowest order term in a $(m/M)^2$ expansion of the effect of the fluid on the distribution of the B particle. These authors studied in particular the steady-state distribution function of B particles acted on by a small constant external field E, which results from a balance between the effects of the driving force and those of the fluid. These studies are now extended to the case where the B particle is acted on by a time-dependent field. Complete agreement is had between the microscopic theory and that obtained from stochastic considerations. The relation between the different formalisms used by Lebowitz and Rubin and by Resibois and Davis are also clarified.

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Yeshiva U. Belfer Graduate School of Science, New York.

SEPARATION OF THE INTERACTION POTENTIAL INTO TWO PARTS IN TREATING MANY-BODY SYSTEMS. I. GENERAL THEORY AND APPLICATIONS TO SIMPLE FLUIDS WITH SHORT-RANGE AND LONG-RANGE FORCES, by J. L. Lebowitz, G. Stell, and S. Baer. [1965] [17]p. incl. illus. diagrs. refs. (AFOSR-66-0397) (Sponsored jointly by Air Force Office of Scientific Research under AF AFOSR-64-508, Atomic Energy Commission, and National Science Foundation)
AD 629816 Unclassified

Also published in Jour. Math. Phys., v. 6: 1282-1298, Aug. 1965.

Systematic methods are developed for investigating the correlation functions and thermodynamic properties of a classical system of particles interacting via a pair potential $v(r) = q(r) + w(r)$. The method is then applied to the case in which $w(r)$ is a "Kac potential" $w(r, \gamma) = \gamma^{\nu}\varphi(\gamma r)$ (ν the dimensionality of the space) whose range γ^{-1} is very long compared to the range of $q(r)$. The work is related closely to the work of Kac, Uhlenbeck, and Hemmer. The main new feature of the new method is the separation of the correlations, e.g., the two-particle Ursell function $\mathfrak{Y}(r)$, into a short-range part $\mathfrak{Z}^S(r, \gamma)$ and a long-range part $\mathfrak{Z}^L(y, \gamma)$, $y = \gamma^r$; r the distance between the particles. The 2 parts of $\mathfrak{Z}$ are defined in terms of representation by graphs with density (or fugacity) vertices and K- and Φ-bonds, $K(r) = e^{-\beta i} - 1$, $\Phi = -\beta w$. A resummation of these graphs then yields a simple graphical representation for the long-range part of the correlation functions in terms of graphs with Φ-bonds and "hypervertices" made up of the short-range part of the correlations. This representation is then used in this paper to make separate expansions of $\mathfrak{Z}^S(r, \gamma)$ and $\mathfrak{Z}^L(y, \gamma)$ and through them of the thermodynamic parameters in powers of γ. Explicit calculations of the Helmholtz free energy is carried out to a higher order in γ than done previously by Hemmer and it is shown how to carry out the calculation, in principle, to any order. The general method is further applied (in separate articles) to lattice gases, plasmas, and to the special problem of critical phenomena. (Contractor's abstract)

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Yeshiva U. [Belfer Graduate School of Science, New York.

INEQUALITIES FOR THE GROUND STATE OF LIQUID ^{4}He (Abstract), by O. Penrose. [1965] [1]p. (In cooperation with [London U. Imperial Coll. of Science and Tech. (Gt. Brit.)]) [AF AFOSR-64-508]
Unclassified

Published in Proc. Ninth Internat'l. Conf. on Low Temperature Physics, Columbus, Ohio (Aug. 31-Sept. 4, 1964), ed. by J. G. Daunt, D. O. Edwards and others. New York, Plenum Press, v. LT9(Pt. A): 91, 1965.

Simple upper bounds can be calculated both for the energy and for the fraction of condensed particles, for a system of interacting Bose particles with hard cores.

For example, if liquid He^4 is treated as a system of hard spheres at a density of 0.28 times the close-packing density, the inequality shows that at most 72% of the particles can have zero momentum. The upper bound on the energy is similar to that given by Dyson (Phys. Rev., v. 106: 20, 1957), but is not restricted to hard-sphere interactions.

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Yeshiva U. Belfer Graduate School of Science, New York.

BOOTSTRAP GRAVITATIONAL GEONS, by A. Komar. [1965] [5]p. (AFOSR-65-1068) (AF AFOSR-64-509)
AD 620494 Unclassified

Also published in Phys. Rev., v. 137: B462-B466, Jan. 25, 1965.

It is shown that there exist solutions of the vacuum Einstein field equations with the property that exterior to the Schwarzschild radius, R = 2m, the solution appears to be that of a static spherically symmetric particle of mass m, whereas interior to the Schwarzschild radius the topology remains Euclidean and the solutions have the property of a bundle of gravitational radiation so intense that the mutual gravitational attraction of the various parts of the bundle prevent the radiation from spreading beyond the Schwarzschild radius. It is not known whether there exist solutions of this type which remain nonsingular for all times; however, no singularity can ever by observed exterior to the Schwarzschild radius. The Cauchy data for one such solution are explicitly exhibited.

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Yeshiva U. Belfer Graduate School of Science, New York.

SPHERICALLY SYMMETRIC GRAVITATIONAL FIELDS, by P. G. Bergmann, M. Cahen, and A. B. Komar. [1965] [5]p. (AFOSR-65-2785) [AF AFOSR-64-509]
AD 629820 Unclassified

Also published in Jour. Math. Phys., v. 6: 1-5, Jan. 1965.

It is shown that the Schwarzschild solution is the only spherically symmetric solution of the Einstein vacuum field equations, even when the differentiability of the metric is weakened to the extent of permitting solutions which are C^0 piecewise C^1. Petrov's purported counter-example is analyzed and shown to be essentially equivalent to Schwarzschild's example. (Contractor's abstract)

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[Yeshiva U. Belfer Graduate School of Science, New York]

PHYSICS AND GEOMETRY, by P. G. Bergmann. [1965] [4]p. (AFOSR-66-1334) (AF AFOSR-64-509) AD 641630 Unclassified

Also published in Logic, Methodology and Philosophy of Science. Proc. 1964 Internat'l. Cong., Hebrew U., Jerusalem (Israel) (Aug. 26-Sept. 2, 1964), ed. by Y. Bar-Hillel. Amsterdam, North-Holland Publishing Co., 1965, p. 343-346.

The lecture is primarily concerned with general relativity, and with the relationship between physics and geometry suggested by that theory. The general theory of relativity is Einstein's theory of gravitation, right now the only theory of gravitation that, after Newton's, has achieved a measure of universal recognition. Initially, general relativity physics was claimed to have been geometrized; if space-time is represented as a differentiable manifold which the attributes of a (pseudo) Riemannian geometry, then it has been suggested that general relativity represents the "physicalization of geometry". Granting the transition from linear manifolds to more general structures as implied by general relativity, then one principal result is that the identification of world points (the localization of events in space-time) by their coordinate values loses a great deal of its former substance. In general relativity there are no inertial frames, and there are no other simple means by which a world point can be identified. The only clear-cut identifications that are still possible in general relativity are those of whole fields, in extended 4-dimensional domains, not of world points. It is suggested that the interpretation of geometric and of physical statements in general relativity differs fundamentally from that of statements in earlier theories based on rigid rectilinear frames of reference, and there is a need for the construction of a new vocabulary, a subset of the conventional vocabulary.

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Yeshiva U. Belfer Graduate School of Science, New York.

FOUNDATIONS OF SPECIAL RELATIVITY AND THE SHAPE OF THE BIG DIPPER, by A. Komar. [1965] [4]p. [AF AFOSR-64-509] Unclassified

Published in Amer. Jour. Phys., v. 33: 1024-1027, Dec. 1965.

The foundations of the special theory of relativity are examined in a new form which is more in keeping with the space-time symmetry of the resulting theory, and which employs those concepts which are most directly related to actual observation. The transformation group to which one is immediately led is the conformal mappings of the 2-sphere, which, as is well known, is isomorphic to the homogeneous improper orthochronous Lorentz group. In order to obtain extensions to the Poincare group and/or the Einstein group of general relativity, additional assumptions are required. (Contractor's

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Yeshiva U. [Belfer Graduate School of Science] New York.

ON A SPECIAL CLASS OF TYPE-I GRAVITATIONAL FIELDS, by M. Trümper. [1965] [6]p. (AF AFOSR-64-509) Unclassified

Published in Jour. Math. Phys., v. 6: 584-589, Apr. 1965.

This paper contains an investigation of the algebraic structure and the analytic properties of a class of normal hyperbolic Riemannian 4-spaces restricted by the following condition: There exists a timelike unit vector u^a such that the Riemann tensor satisfies ${}^*R_{abcd}u^b u^d = 0$. This condition is shown to be equivalent to the statement that the conform tensor is Petrov type I with real eigenvalues, u^a being a principal vector and an eigenvector of the Ricci tensor. The eigen null directions (Debever vectors) of the conform tensor lie in a timelike hyperplane. The complete set of Bianchi identities is examined. It yields an expression for the covariant eigentime derivative of ϵ_{ab} and an algebraic relation linking the rotation and shear of u^a to the curvature tensor of the Riemannian space. The general results are applied to special Einstein spaces ($R_{ab} = 0$). A simplified proof of the theorem that in the case of non-degeneracy such spaces are static, the curves of the congruence being paths of an isometric motion was given. (Contractor's abstract)

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Yeshiva U. Belfer Graduate School of Science, New York.

EXACT SOLUTION OF A MANY-FERMION SYSTEM AND ITS ASSOCIATED BOSON-FIELD, by D. C. Mattis and E. H. Lieb. [1965] [9]p. (AFOSR-66-0395) [AF AFOSR-64-713] AD 630221 Unclassified

Also published in Jour. Math. Phys., v. 6: 304-312, Feb. 1965.

Luttinger's exactly soluble model of a 1-dimensional many-fermion system is discussed. It is shown that he did not solve his model properly because of the paradoxical fact that the density operator commutators $[\rho(p), \rho(-p')]$, which always vanish for any finite number of particles, no longer vanish in the field-theoretic limit of a filled Dirac sea. In fact the operators $\rho(p)$ define a boson field which is ipso facto associated with the Fermi-Dirac field. This observation is then used to solve the model, and obtain the exact (and now non-trivial) spectrum, free energy, and dielectric constant. This is also extended to more realistic interactions in

an Appendix. We calculate the Fermi surface parameter n_k, and find: $\partial n_k / \partial k|_{kF} = \infty$ (i.e., there exists a sharp Fermi surface) only in the case of a sufficiently weak interaction. (Contractor's abstract)

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Yeshiva U. Belfer Graduate School of Science, New York.

SUPPRESSION AT HIGH TEMPERATURE OF EFFECTS DUE TO STATISTICS IN THE SECOND VIRIAL COEFFICIENT OF A REAL GAS, by S. Y. Larsen, J. E. Kilpatrick and others. [1965] [2]p. (AFOSR-66-0396) (AF AFOSR-64-713) AD 629871 Unclassified

Also published in Phys. Rev., v. 140: A129-A130, Oct. 4, 1965.

It is shown that the repulsive core present in realistic 2-body potentials and in hard spheres leads to the rapid suppression of the effects of statistics in the second virial coefficient, except at very low temperatures. For hard spheres, an upper bound is obtained which goes down exponentially with temperature when the latter becomes large.

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Yeshiva U. Belfer Graduate School of Science, New York.

ON TRANSFINITE RECURSION, by R. M. Smullyan. [1965] [11]p. (AFOSR-67-1524) (AF AFOSR-65-433) Unclassified

Presented at Internat'l. Cong. of Science and Methodology, Jerusalem (Israel), 1964.

Also published in Trans. New York Acad. Sci., v. 28: 175-185, Dec. 1965.

The purpose of the article is to prove a certain principle common to several important constructions in set theory. The unifying principle, the double superinduction principle introduced, reduces to a common denominator proofs of Zorn's lemma and Zermelo's well ordering theorem, some results on ordinal numbers, and the proof of the tranfinite recursion theorem. One well known proof of Zorn's lemma uses a lemma known as Bourbaki's fixed point theorem. The Double Superinduction Principle, so to speak, abstracts the heart of the proof of Bourbaki's lemma, and once this principle is established in its own right, the proof of Bourbaki's lemma becomes particularly lucid. Some have felt that Bourbaki's lemma comes about as close as possible to Zorn's lemma without actually using the axiom of choice. One theorem is given which, likewise, comes just about as close as possible to the well ordering theorem without using the axiom of choice. This also yields another equivalent of the axiom of choice.

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Yeshiva U. Belfer Graduate School of Science, New York.

QUANTIZED GRAVITATIONAL THEORY AND INTERNAL SYMMETRIES, by A. Komar. [1965] [3]p. (AFOSR-65-1874) (AF AFOSR-65-816) AD 626100 Unclassified

Also published in Phys. Rev. Ltrs., v. 15: 76-78, July 12, 1965.

The construction of a general relativistic quantum theory of gravitation is discussed. Considering that the Einstein group is a function group and simple, it is suggested that there exists no unique procedure for constructing such a theory. A truncated classical theory is considered which is obtained by considering only those families of solutions of the Einstein field equations which satisfy boundary conditions at infinity suitable for a discussion of gravitational radiation. From this theory one can recover a preferred group of spacetime transformations, the generalized Bondi-Metzner (GBM) group, similar to the Poincaré group though infinite. The GBM group has 2 Abelian normal subgroups, called T and ST, where T is a 4-dimensional group associated with the translations. It is proposed that the infinite group I = GBM/T is a possible candidate for the internal symmetry group.

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Yeshiva U. Belfer Graduate School of Science, New York.

SOME COMMENTS ON THE ONE-DIMENSIONAL MANY-BODY PROBLEM, by E. H. Lieb. [1965] [24]p. (AFOSR-66-1574) (AF AFOSR-66-508) AD 637834 Unclassified

Presented at Fourth Eastern Theoretical Physics Conf., Stony Brook, N. Y., Nov. 26-27, 1965.

In the first half, the implication and significance of one dimensional models for many-body physics is discussed. In the second part, a brief historical survey is given of existing models and results obtained to date.

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