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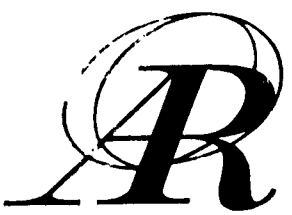
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BASIC RESEARCH RESUMES

1961-1962

A Survey of Basic Research Activities
of the
Office of Aerospace Research



OAR-9

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UNITED STATES AIR FORCE

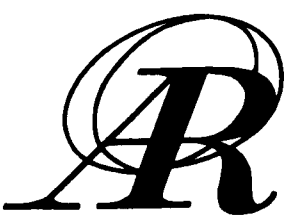
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BASIC RESEARCH RESUMÉS

1961 - 1962

A Survey of Basic Research Activities
of the
Office of Aerospace Research



OAR-9

FOREWORD

The Office of Aerospace Research was established on 1 April 1961. This Headquarters and its component organizations on three continents--Air Force Office of Scientific Research, Air Force Cambridge Research Laboratories, Aeronautical Research Laboratories, European Office of Aerospace Research, Colorado Astronautical Research Laboratory, Churchill Research Range, and Latin American Office of Aerospace Research--spend approximately $100 million per year in selecting, purchasing, supervising and conducting research in areas of present and future Air Force needs and interests.

This book reports, describes, classifies and indexes some 2500 intra- and extramural Air Force research efforts current during fiscal 1961-1962. Most of the efforts included come directly under Office of Aerospace Research support and supervision. Related efforts under the Air Force Systems Command have been included whenever possible.

The two previous editions of this book have apparently proved useful to those concerned with the administration, conduct and application of research. It is hoped that this volume will serve equally well in avoiding unnecessary duplication of research, in minimizing time spent in planning or soliciting support for research already well underway and in helping to match the names of Air Force scientists and organizations with their research interests.

There is an almost inevitable lag between the performance of research and the formal publication of the results. I hope that the progress of research, and the transition from research to technology, can be helped by this description of research efforts in being.

Don R. Ostrander

DON R. OSTRANDER
Major General, USAF
Commander
Office of Aerospace Research

INTRODUCTION

This book is a set of indexed abstracts of research efforts supported by the Office of Aerospace Research. These abstracts were written by many different scientists in many different Office of Aerospace Research organizations as part of an existing Department of Defense research management requirement, the DD-613, common to the three Services. Every in-house research effort, contract or grant of a Department of Defense agency is reported on this form yearly.

Current DD-613's for all relevant Office of Aerospace Research efforts were gathered together and turned over to the contractor. The contractor, in turn, edited the abstracts, organized them into 24 broad subject categories represented by the chapters of this book, and indexed them by contractor, principal investigator and contract number. The contractor then devised, and applied, a new method of subject indexing, described in more detail in the "Editors' Note". This index is designed to be used in both depth and breadth; highly specific indexing for the specialist, broader generic indexing for the administrator.

Indexes point to something--in this case short descriptions of current research efforts. Results, as they occur, are published through the normal channels of scientific communication--journal articles, reports, symposium proceedings and the like. Help in locating and obtaining these publications is available to Department of Defense contractors through the Armed Services Technical Information Agency (ASTIA). The services of the Office of Technical Services, Department of Commerce, which has access to all unclassified publications received by ASTIA, are commended to those outside the DOD community. Scientists working in Air Force Laboratories whose work is reported here will welcome direct contact to discuss their research efforts.

Current concentration on the complexities and problems of establishing large central registers of research and development projects tends to overlook the point that the late, legendary, and lamented John Henry died to prove--that in the hands of a skilled operator an instrument as simple but sophisticated as an eight pound sledge can match the performance of an early model steam drill. This is especially true if you don't have very many holes to drill, and don't want to wait till the man brings the steam drill round.

A book of this sort, properly organized and indexed, can answer many kinds of questions about the information within its covers, more quickly and inexpensively than any computer-based system now in existence. We expect that such books will always be an indispensable part of any future information systems. The time and effort saved by this book has, for this office, proven to be far greater than the work involved in producing it. We trust that others will find it equally useful and worth emulating.

Harold Wooster

HAROLD WOOSTER
Director
Information Sciences

EDITORS' NOTE

This third edition of Basic Research Resumés, as was the case in previous editions, is a by-product of an experiment in the preparation of non-manipulative correlative subject indexes based on the principles of permutation indexing. In its evolution, the experiment went through three distinct phases. The first was given to the basic design of the index and indexing procedure and to the development and normalization of the indexing vocabulary. The second was given to the development of semi-mechanical procedures by which the permutations could be done consistently and accurately by clerk-typists with a minimum of guidance. The specific procedure developed was for the indexer to indicate the terms to be permuted and for the clerk-typist to permute them by working clockwise through the subject terms in a phrase until all were provided for. Permutation was facilitated by keeping terms in uninverted order and accounting for inverted terms by means of "see" references.

The third phase in the evolution of the experiment was given to the development of procedures which would ultimately lead to permutation and printout by computer. The burden of this phase was the elimination of inconsistencies, redundancies, and entry compressions that might make index preparation by non-human means difficult. As it developed, and as has been the experience in other situations of this kind, making the indexing more compatible to machine processing also made it more compatible to human processing. We therefore decided to postpone machine processing and to concentrate instead on a more mechanized procedure for human operators.

The present subject index is the product of this semi-mechanized approach. It is in essence a cross between a conventional alphabetical index and a mechanically-produced permutation index. It has the appearance of a conventional book index. Aside from the method of production, a basic point of difference between most permutation indexes and the present one is in the source of terms. Terms are "assigned" from an authority list which is independent of the indexed documents and their texts. The authority list in the present case was the subject index to previous Basic Research Resumés, supplemented by a variety of dictionaries, encyclopedias and monographs.

There is an interesting analogy between the present approach and the "links" which were developed by E. I. du Pont de Nemours and Company and which are being utilized in the indexing of articles in publications of The American Institute of Chemical Engineers. In essence, the du Pont procedure consists of describing the contents of a document by means of phrases made up of terms drawn from a thesaurus, and "posting" on term cards in such a way as to identify not only the document but also the descriptive phrase in which a given term appears. The element of uniqueness in our application of the general concept of "links" is that we permute by all the significant terms in a descriptive phrase, so that each term becomes an access point in the index and has its context established by always being attached to the phrase of which it is a part.

One final aspect of the subject index to the present Basic Research Resumés has to do with its audience levels. While derived from and related to the subject index to the previous Basic Research Resumés, the index to the present edition is addressed to two distinct audiences whereas the earlier ones were only addressed to a single audience. The previous editions were frankly addressed exclusively to specialists in the fields covered. As a result, the subject indexes were made as specific and technical as possible, and reflective of the most current terminologies and usages. The present edition is addressed to administrators as well as scientific specialists. The administrator-audience is provided for by the incorporation of generic unidimensional entries in addition to specific multidimensional entries for each indexed item. The generic entries used are the scope notes preceding and describing each chapter in the volume.

Saul Herner and Walter Johanningsmeier
HERNER AND COMPANY
Washington, D. C.

November 1962

ADDRESSES AND DESIGNATIONS OF AIR FORCE R & D ORGANIZATIONS

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Washington 25, D C

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
Bldg T-D
Washington 25, D C

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- Biological Sciences Division (SRLA)
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Bedford, Massachusetts

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- Optical Physics Laboratory (CRZC)
- Research Instrumentation Laboratory (CRZE)
- Terrestrial Sciences Laboratory (CRZG)
- Meteorological Research Laboratory (CRZH)
- Ionospheric Physics Laboratory (CRZI)
- Sacramento Peak Observatory (CRZR)
- Meteorological Development Laboratory (CRZW)

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Brussels, Belgium

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(Rio de Janeiro, Brazil)
U S Regional Science Office/LAOAR
American Embassy
APO 676, New York, N Y

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U S Air Force Academy
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HQ RESEARCH AND TECHNOLOGY DIVISION
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Bedford, Massachusetts
- Operational Applications Laboratory (ESRH)

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Air Force Unit Post Office
Los Angeles 45, California

SPACE SYSTEMS DIVISION
Air Force Post Office
Los Angeles 45, California

FOREIGN TECHNOLOGY DIVISION
Wright-Patterson AFB, Ohio

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I. DESCRIPTIONS OF INDIVIDUAL EFFORTS

1. ORGANIC CHEMISTRY

Organic Reactions, Organic Syntheses, Organoboron Compounds, Organometallic Compounds, Organosilicon Compounds, Organic Polymers, Polymerization

1.1

Akron U., Ohio.
EFFECTS OF MOLECULAR CHAIN CONFIGURATION ON THE ULTIMATE PROPERTIES OF ELASTOMERIC HIGH POLYMERS, M. Morton. Project 7342(802A), Contract AF 33 (616)-6986; ASRC, ASD.

It is the purpose of this study to elucidate the effects which chain configuration, degree and type of cross-linking, crystallinity, and reinforcement fillers have on the ultimate physical properties of elastomers.

1.2

Akron U., Ohio.
MOLECULAR STRUCTURE AND PHYSICAL BEHAVIOR OF POLYMERS, M. Morton, F. Bneche. Project 7342(802A), Contract AF 33(616)-6965; ASRC, ASD.

The work under this contract falls into two general areas: (1) studies designed to elucidate polymer structure by such methods as light-scattering, temperature and/or shear rate dependence of dilute solution viscosity, tensile strength and tensile creep measurements as a function of temperature in addition to second order transition measurement. Selected polymers will be used in this study including novel organic and/or inorganic polymers; and (2) the investigation of the effect of branding, chain entanglement and other important variables on the mechanical behavior of amorphous polymer systems. The latter studies include such features as the refinement of existing theory, as well as the experimental verification of such refinements as they are offered. Included also is the preparation and characterization of systems containing known kind and amount of branching.

1.3

Barcelona U. (Spain).
SYNTHESIS AND PROPERTIES OF ALKAROMATIC CHLOROCARBONS, M. Ballester. Project 7023(802A), Contract AF 61 (052)-141; ARC, ARL.

The contractor will study the synthesis and properties of perchlorinated alkaromatic compounds of high molecular weight including polymers. Preliminary work has suggested high thermal and chemical stability for such substances and the present contract will delineate their potential. Progress has been good in the synthesis of perchloro-compounds by means of model compounds and data are being accumulated on the conditions for polymerizing them with ionic reagents.

1.4

Battelle Memorial Inst., Columbus, Ohio
PYROLYTIC MECHANISMS IN ORGANOSILICON CHEMISTRY, A. Levy. Project 7023(802A), Contract AF 33(616)-7236; ARC, ARL.

This effort is concerned with the study of the mechanism of thermal degradation of perarylated metalloidal and non-metallic elements of row 3 of the periodic system. Data have been obtained on the kinetics and mechanism of pyrolysis of tetraphenylsilane and other perarylated silanes, triphenylphosphine, diphenylsulfide, diphenylsulfoxide and their derivatives at temperatures up to 700°C. Product analyses and the kinetics of breakdown are determined to ascertain the pertinent mechanisms with a view to correlating stability and structure. To date it has been ascertained that pyrolysis of these compounds goes principally through a non-free-radical mechanism. In most cases benzene, some simple compound of the central atom, and an incompletely characterized polymeric residue constitute the chief products isolated. The decompositions appear to be kinetically first order with the relative order of decreasing thermal stability being the perphenylated silane, phosphine, sulfide, sulfone, and sulfoxide. This has demonstrated conclusively the value of continuing investigation of the chemistry of the perarylated silanes. The current research program is specifically being directed to the pyrolysis of hydrogenated perarylated silanes and their derivatives.

1.5

Boston U., Mass.
ATOM CHEMISTRY REACTIONS, N. N. Lichtin. Project 7635(770A), Contract AF 19(604)-5695; CRZA, AFCRL.

Study of chemiluminescent reactions of organic molecules and atomic oxygen and nitrogen. Study of reaction of propylene and atomic nitrogen to assist in understanding mechanisms.

1.6

Boston U., Mass.
REACTIONS OF "ACTIVE NITROGEN," N. N. Lichtin. Project 9760(802A), Contract AF 49(638)-2; SRC,

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

AFOSR.

This program consists of the investigation of the reactions with selected organic compounds such as conjugated dienes with "active nitrogen" produced from ordinary nitrogen in a glow discharge. Simple reactions, yielding a limited number of products have been studied. Emphasis is on the stoichiometry, and the kinetics of the reactions.

1.7

California U., Berkeley.
MOLECULAR ORBITAL THEORY IN ORGANIC CHEMISTRY, A. Streitwieser. Project 9763(802A), Grant AF-AFOSR-62-175; SRC, AFOSR.

The purpose of this research is to compare pertinent experimental data and theoretical calculations in suitable systems to determine the range of quantitative applications and the practical limitations of quantum mechanical calculations based upon simple linear combinations of atomic orbitals. The substances being studied are carbonium ions, carbanions and cyclic rearrangements. These experiments and calculations will test a theory which may allow the prediction of rates of chemical reactions.

1.8

Case Inst. of Tech., Cleveland, Ohio.
PHTHALOCYANINE POLYMERS, M. E. Kenney. Project 9762 (802A), Contract AF 49(638)-773; SRC, AFOSR.

This is a study of inorganic phthalocyanine polymers. Most polymeric phthalocyanines have been linked through (less stable) bonds formed between open positions on the organic ring and the bridge substituent. In this research attention is being directed to the chemistry of the inorganic core. Proper variation of this core should lead to phthalocyanines of widely varying properties and eventually to phthalocyanine polymers in which the individual phthalocyanine rings are linked through their metallic cores.

1.9

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
PERARYLATED SILANES, L. Spialter. Project 7023 (802A), Internal.

Perarylated silanes, representing a new class of molecules constructed basically from the simple building blocks, silicon atoms and aryl or chemical ring groups, are being studied with respect to their synthesis and chemical and physical properties. Subclasses already investigated, or to be examined, include the monosilanes, silarylenes and high molecular-weight polysilarylenes. Efforts are being made to learn more about their unusual properties, such as extraordinary thermal, chemical and radiation stability, promising electrical characteristics, and interesting chemical reaction mechanisms. Current studies also include the role of steric groups in influencing the course and extent of hydrogenations, pyrolysis and condensation reactions of perarylated silanes and their derivatives.

1.10

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
TERTIARY AMINES AND DERIVATIVES, L. Spialter. Project 7023(802A), Internal.

This research investigation is concerned with the study of the properties of tertiary amines and their derivatives. This includes examination of synthetic procedures, acid-base strength relationships and theoretical concepts associated therewith. In addition, one phase of this program has involved a detailed literature survey on these compounds. The most recent experimental work has dealt with the role of added neutral salts in affecting the apparent base strength of aliphatic tertiary amines. The study has been extended to diamines and polyamines with some interesting theoretical consequences being developed in connection with the solvation of such compounds.

1.11

Chicago U., Ill.
REACTIVE INTERMEDIATES IN CYCLOPROPANE CHEMISTRY, W. G. Brown. Project 9762(802A), Contract AF 49(638)-784; SRC, AFOSR.

This research seeks to understand the identity and behavior of the reactive intermediates responsible for the formation of cyclopropane or derivatives of cyclopropane in the radiolysis of various organic compounds. Objectives are: (1) a study of the cyclopropyl free radical, and the temperature dependence of its isomerization to the allyl radical, (2) a careful study of selected open-chain and cyclic radicals to detect, if possible, the occurrence of β-hydrogen abstraction leading to the formation of three-membered rings, (3) an examination of the reaction products of methylenecyclopropane, (4) to study the role of di-radicals in reactions leading to cyclopropane derivatives.

1.12

Chicago U., Ill.
OXIDATION OF AROMATIC COMPOUNDS BY ELECTRON TRANSFER, M. J. S. Dewar. Project 9763(802A), Grant AF-AFOSR-62-104; SRC, AFOSR.

This is a study of the oxidation of aromatic compounds by electron transfer. This is to be accomplished by metals in high valence states, by

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

radiation or by ultraviolet light. The object is the elucidation of reaction mechanisms, and the study of possible synthetic uses and their relation to radiation damage and oxidation stability. The study will include reaction kinetics and products of hydrocarbon oxidation, substituent effects on those rates and products, quantum mechanical interpretation of the results, the mechanism of side-chain oxidation to carbonyl, and the role of radiation in these oxidations.

1.13

Colorado U., Boulder.
STEREOCHEMISTRY AND ISOMERISM, S. J. Cristol. Project 9760(802A), Contract AF 49(638)-795; SRC, AFOSR.

Certain unusual rearrangements during additions of mercaptans and other compounds to mono-olefins and variously constrained dienes, and during opening of epoxides, will be studied along with, and by means of related solvolyses and deaminations. Besides improving understanding of the rearrangements, more widely useful concepts will be tested, such as the existence of the nonclassical carbonium ion intermediates.

1.14

Colorado U., Boulder.
VISCOELASTIC PROPERTIES OF POLYMER SOLUTIONS AND GELS, S. J. Gill. Project 9760(802A), Contract AF 49(638)-310; SRC, AFOSR.

This study will extend present knowledge of viscoelastic behavior of polymers to the practical state of large strains, and correlate the molecular structure of polymeric systems with mechanical and optical effects in the state of large strain. The approach is to show a difference in optical birefringence and other properties which can be followed either as a strain-time effect or compared to the extent of initial strain. Another attack is to study the elastic properties of a continuously sheared solution.

1.15

Colorado U., Boulder.
THERMO-AND PHOTO-CHEMISTRY OF ORGANIC HALOGEN COMPOUNDS, J. R. Lacher, J. D. Park, Project 9762 (802A), Contract AF 49(638)-241; SRC, AFOSR.

The thermochemistry of the addition of hydrogen, halogen, and hydrogen halide to unsaturated organic compounds is being studied. Synthesis of fluorinated compounds and investigation of the mechanism of the above reactions are underway. The effect of light on addition reactions of fluoro-olefines and the combustion and energetics of reactions of organic halogen compounds are being studied.

1.16

Cornell U., Ithaca, N.Y.
CRITICAL OPALESCENCE AND MOLECULAR FORCES, P. J. Debye. Project 9760(802A), Grant AF-AFOSR-62-12; SRC, AFOSR.

Investigation of the interactions of polymer molecules as a function of their mutual distances by means of observing the angular intensity distribution of visible light scattered by polymer solutions in the vicinity of the critical point. Efforts will also be made to understand abnormal viscosity behavior at the critical point as a result of correlation of concentration - fluctuations in neighboring points of the mixture. Such a critical investigation of intermolecular forces and viscosity of polymers should ultimately lead to a more thorough understanding of high-molecular-weight materials.

1.17

Cornell U., Ithaca, N. Y.
MECHANISM OF THE DIELS-ALDER REACTION, M. J. Goldstein. Project 9763(802A), Contract AF 49(638)-942; SRC, AFOSR.

The proposed research is an investigation of the mechanism of the Diels-Alder reaction. It is based on the belief that the decarboxylation of the Diels-Alder adducts of α-pyrone can offer unequivocal answers concerning a hypothetical short-lived intermediate in this reaction. Interesting preliminary experiments showed that acetylenedicarboxylate apparently underwent a self-condensation, in a manner heretofore unknown. Elucidation of this phenomenon is being attempted.

1.18

Cornell U., Ithaca, N. Y.
DERIVATIVES OF CYCLIC OLEFINS, F. J. Moriconi. Project 9763(802A), Contract AF 49(638)-688; SRC, AFOSR.

The purpose of this research was to synthesize the unknown and unique hydrocarbon dimethylenebenzocyclobutene and study its usefulness as a precursor for the realization of derivatives of cyclobutadiene *via* application of the Diels-Alder diene synthesis.

1.19

Denver Research Inst., Colo.
SYNTHESIS AND EVALUATION OF HIGH-ENERGY ORIENTED POLYMERS, D. N. Gray. Project 2858(801A), Contract AF 08(635)-1938; ASD.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESHR- Operational Applications Lab

This contract involves: (1) research on the synthesis and/or formulation of stereoregulated (atactic, isotactic, etc.) polymer combinations which contain one or more high-energy groups and which exhibit superior physical properties; and (2) the determination of the basic relationships between steric configuration (including the type, number, and position of high-energy groups) and such properties as elasticity, density, mechanical strength, melting or softening point, dimensional stability and resistance to external stimuli (electromagnetic radiation, heat, shock, etc.). Both atactic and isotactic polymers of 2-nitro-2-methyl propyl methracrylate have been prepared, their structure proved, and currently are being evaluated.

1.20

Denver Research Inst., Colo.
FLUOROCHEMICALS, J. J. Schmidt-Collerus. Project 2858(801A), Contract AF 08(635)-2109; ASD.

This program consists of: (1) the synthesis of new fluoro-explosives; (2) the correlation of their molecular and crystal lattice structure with properties; (3) the effect of the addition of light metals and/or metal hydrides on the properties of the new fluoro-compounds synthesized, together with theoretical explanations to account for any marked changes in properties; (4) the study of unique procedures suitable for the vacuum deposition of light metals on solid, high-energy particulates containing fluorine; and (5) theoretical calculations designed to indicate the potential of these high-energy materials as propellants per se, or as propellant additives. A number of new fluoro-derivatives have been prepared and correlation studies are continuing.

1.21

De Paul U., Chicago, Ill.
NITROGEN AND SULFUR GROUPS ATTACHED TO THE SAME CARBON ATOM, E. Lieber. Project 9760(802A), Contract AF 49(638)-474; SRC, AFOSR.

This research is a study of systems containing, or which can give rise to, azido - and thio-groups attached to the same carbon atom. The principle that this grouping is incapable of independent existence unless stabilized by ring formation is new. The main objective of this research is an understanding of heterogeneous ring systems. The high energy compounds under investigation detonate and are more or less inherently unstable.

1.22

Directorate of Materials and Processes; ASRC, ASD, Dayton, Ohio.
POLYMER DEGRADATION MECHANISMS, I. J. Goldfarb. Project 7342(802A), Internal.

Investigations will be carried out on the mechanism of the degradation of polymers by thermal, oxidative, radiative and hydrolytic means. Emphasis will be on model systems in order to obtain the basic mechanisms. Both theoretical and experimental methods will be utilized. Experimental kinetics of degradation combined with the theoretical treatment of the rates will lead to the mechanism of these degradations. Quantum mechanical calculations of the structure and reactivity of compounds of interest will be undertaken. Such properties as electronegativities, bond energies, etc. will be calculated.

1.23

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
FUNDAMENTAL PHYSICAL BEHAVIOR OF ELASTOMERS, F. S. Owens. Project 7342(802A), Internal.

The more common performance properties (e.g. volume swell, tear strength, etc.) of elastomeric polymers and vulcanizates have been extensively measured and documented. However, the basic behavior of elastomeric high polymers which give rise to such desirable properties as extensibility, compliance, elasticity or lack of such properties at elevated temperatures has not been studied to the extent necessary to predict the behavior of new elastomers. Principal efforts will be concentrated on the new high temperature resistant elastomers and directed toward the study of the fundamental physical aspects such as the mechanism of stress relaxation under extension and compression and temporary loss of mechanical properties of elastomers at elevated temperatures up to 1000°F.

1.24

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
EXPLORATORY ORGANOMETALLIC RESEARCH, H. Rosenberg. Project 7342(802A), Internal.

It is planned to explore the chemistry of the ferrocene molecule, the silazenes, various phosphorus-carbon and phosphorus-nitrogen containing compounds, as well as related organometallic and organometalloidal systems, in order to uncover convenient synthetic routes to desirable thermally and radiation-stable monomeric and polymeric materials. Polymerization reactions under a variety of conditions will be explored to determine whether, for example, polymers containing ferrocenyl moieties, in the backbone can be prepared. Where conventional polymerization techniques are not successful, novel conditions and synthetic methods will be investigated to prepare the desired macromolecular structures.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

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CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

1.25

Fordham U., N. Y.
CHEMISTRY OF SYDNONES, I. M. Hunsberger. Project 9762(802A), Contract AF 18(603)-127; SRC, AFOSR.

This project is concerned with the synthesis of sydnones, the investigation of the chemical structure required for phototropy, and the study of the mechanism of the interconversion of the colored and colorless forms.

1.26

Fordham U., N. Y.
SMALL RING COMPOUNDS, E. J. Moriconi. Project 9762 (802A), Grant AF-AFOSR-62-18; SRC, AFOSR.

The chemistry of high-energy, strained cyclic systems has, in the past few years, received considerable attention from both theoretical and experimental chemists. It is proposed to conduct the following research: (1) prepare the unknown tetraphenylcyclobutadiene and several pyridocyclobutadienes and/or their metal salts. The reactions, spectroscopic properties, base strength and bond structure of these compounds will also be examined; (2) preparation and synthesis of several fused aromatic ring azetes and their corresponding dihydro derivatives, the fused ring azetines using a variety of unusual starting materials. A detailed study of the physical and chemical properties of these systems would also be accomplished; and (3) combination of N-heterocyclic fused rings and the azetes in the preparation of some pyride and quino azetes. The desired compounds would then be screened for possible physiological activity.

1.27

Gabriel Co., Pasadena, Calif.
CHEMICAL SYNTHESIS WITH MONOENERGETIC IONS, M. Farber. Project 9750(801A), Contract AF 49(638)-913; SREP, AFOSR.

The direct reaction of selected free-radicals, as low pressure gases, with a precisely controlled beam of ions, is being investigated. The ions are produced by electrical or electrodeless discharges; all but one desired ionic species are discarded while the desired kind of ion is decelerated to essentially a uniform velocity before entering the reaction chamber containing the free-radical (or other) target gas. This kind of experiment has never been attempted before. Essentially new kinds of apparatus had to be designed. During the first fifteen months of this work, a cold-cathode oscillating-electron ion source was designed, constructed and shown to produce ion beams of 0.5 milliampere; and a radiofrequency mass spectrometer was designed, constructed and tested as the "filter" for producing ions of nearly equal energy. Some problems remain in uniformly decelerating these ions to thermal energy (about 1 electron volt) just before they reach the target, but chemical experiments will begin in the near future. As first choices, NO_2^+ or NF_2^+ beams will be used with targets of methyl radicals or benzene.

1.28

George Washington Carver Foundation, Tuskegee Inst., Tuskegee, Ala.
ALPHA-FLUOROALKYL THIOETHERS, C. T. Mason. Project 9762(802A), Contract AF 49(638)-283; SRC, AFOSR.

The synthesis and the chemical and physical properties of thioethers having a fluorine atom in a position alpha to the sulfur atom are being studied.

1.29

Georgia Inst. of Tech., Atlanta.
NUCLEIC ACID CHEMISTRY, J. R. Cox. Project 9760 (802A), Grant AF-AFOSR-62-163; SRC, AFOSR.

Investigation of nucleic acid chemistry.

1.30

Harvard U., Cambridge, Mass.
ORGANOMETALLIC COMPOUNDS OF THE GROUP III ELEMENTS, F.G.A. Stone. Project 9762(802A), Contract AF 49 (638)-518; SRC, AFOSR.

This research is a systematic study of metal-carbon bonding of trialkyl and triaryl compounds of the group III elements. Interaction of groups such as the perfluoroalkyl (e.g. CF_3), the vinyl, or the halogen-substituted alkyl (e.g. C_2H_4F) with electron acceptor atoms is being investigated. Infrared and nuclear magnetic resonance techniques are being used to study the type of organometallic compound exemplified by aluminum derivatives such as $(Me_2AlOMe)_2$ and $(Me_2AlOSiH_3)2$.

1.31

Illinois U., Urbana.
ELECTRON-DEFICIENT METAL ALKYLS, T. L. Brown. Project 9760(802A), Contract AF 49(638)-466; SRC, AFOSR.

A detailed study of the physical and chemical properties of metal alkyls is being undertaken. The study is being restricted to the so-called electron-deficient metal alkyls, that is, those of the group Ia, IIa, and IIIa metals, with possibly a few of those from the b groups. Emphasis is placed on those compounds about which least is known. Methods of preparation and handling have been worked out. Physical properties, such as infrared and NMR spectra and x-ray diffraction behavior are being

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ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
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investigated, as well as other physical properties. An attempt will be made to evaluate important thermodynamic properties such as heats of combustion and other heats of reaction as well as heats of fusion, evaporation, or sublimation. The objectives of the proposed research are first, a clearer understanding of the nature and magnitude of the bending forces in metal alkyls. This question is of fundamental importance in modern valency theory.

1.32

Illinois Inst. of Tech., Chicago, Ill.
SYNTHESIS WITH CARBIDES, S. I. Miller. Project 9762 (802A), Contract AF 49(638)-39; SRC, AFOSR.

This research is a study of reactions of organometallic compounds, particularly carbides. The lability of hydrogen in organic compounds is also being investigated as a source of carbanions. This is a novel approach to the syntheses of organic materials useful as fuels and polymers. It may lead to information on the role of carbide reactions in geochemical processes.

1.33

Kentucky U., Lexington.
CHEMISTRY OF N-SULFINYL AMINES, W. T. Smith. Project 9760(802A), Contract AF 49(638)-49; SRC, AFOSR.

A study is being made of the chemistry of N-sulfinyl amines. This includes the preparation, absorption spectra, a study of the hydrolysis rates, reactions with alcohols, and an attempt to obtain optical activity in carbonyl adducts.

1.34

Leicester U. (Gt. Brit.).
CHEMICAL REACTIVITY OF THE ARYL-SILICON BOND, C. Eaborn. Project 7023(802A), Contract AF 61 (052)-64; ARC, ARL.

The contractor will investigate the cleavage of silicon-aromatic bonds in arylsilanes by kinetic methods and product analysis. The aryl groups will be chosen from structures likely to reveal polar and steric influences on bond reactivity with a view to ascertaining the dependence of bond stability on molecular constitution. The contractor has recently been studying the rates of cleavage of the bond between silicon atoms and p-methoxyphenyl groups in a variety of suitably substituted tetra-aryl silanes. Electronic as well as steric factors have been found to affect profoundly the course of this reaction.

1.35

Leicester U. (Gt. Brit.).
REACTIONS OF ORGANO-METALLIC COMPOUNDS, C. Eaborn. Project 7023(802A), Grant AF-EOAR-61-1, ARZ, ARL.

This program involves a study of rearrangements and cleavages occurring in organometallic compounds with emphasis on kinetics and mechanisms of the reactions. The purpose of the program is to obtain a fuller understanding of the nature of carbon-to-metal bonds and the correlation between molecular structure and bond reactivity.

1.36

Los Angeles State Coll., Calif.
CHEMICAL EFFECTS OF ULTRASONIC WAVES, D. L. Currell. Project 9763(802A), Contract AF 49(638)-471; SRC, AFOSR.

The degradation of organic substances like halobenzenes, pyridine, and phenols by ultrasonic treatment is yielding to this research attack, so that its mechanism is becoming clearer. The effects of different dissolved gases and of pH point toward vaporization into ultrasonically formed cavities and immediate adiabatic compression appear to be essential to the reaction.

1.37

Maryland U., College Park.
CHEMICAL RESEARCH ON POLYPHENYLS, E. F. Woods. Project 7023(802A), Contract AF 33(657)-7833; ARC, ARL.

The contractor shall investigate the synthesis of large ring molecules wherein the basic repeating unit is the meta-phenylene moiety. Efforts shall be centered about such macro-rings containing five or six phenylenes. He shall investigate the synthesis of long branched poly-phenylene molecules; and shall unequivocally establish the structure and properties of all major reaction products by the necessary physical and chemical characterization.

1.38

Massachusetts U., Amherst.
DYNAMIC BIREFRINGENCE OF POLYMERIC SOLIDS, R. S. Stein. Project 9760(802A), Grant AF-AFOSR-61-28; SRC, AFOSR.

This research seeks knowledge of the motions of structural units of polymers which are so small that static stress experiments do not measure them. The approach, through birefringence under dynamic stress has these aspects: (1) frequency dependencies of stress-optical coefficients,

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different for different linear polymers, are expected and will be sought; (2) small dynamic strain components will be added to constant strain, with same or different relative directions, for study of directional constraints to motion in oriented polymers; and (3) amorphous region-crystal intereffects. The theoretical analysis will be supported by simultaneous studies of dynamic molecules and NMR studies under parallel conditions.

1.39

Mellon Inst. of Industrial Research, Pittsburgh, Pa.
PHYSICAL CHEMISTRY OF THERMALLY STABLE POLYMER SYSTEMS, T. G. Fox. Project 7342(802A), Contract AF 33(616)-6968; ASRC, ASD.

The work under this contract is divided into three prime areas: (1) the investigation of the dilute solution properties of novel organic, semi-organic or inorganic polymer systems to more fully characterize them as to structure, molecular weight, configuration and related properties; (2) the investigation of the mechanical properties of selected polymer systems to more completely detail and correlate those features which are important in determining the physical property-temperature characteristics of these materials; and (3) the study of the thermal degradation of selected polymers in an effort to quantitatively determine the kinetics and mechanism of the degradation process.

1.40

Metallurgy and Ceramics Lab., ARC, ARL, Dayton, Ohio.
HIGH ENERGY MOLECULES STUDY, J. W. Connolly. Project 7013(801A), Internal.

An experimental program for the synthesis and stabilization of energetic molecules is being conducted. Compounds being synthesized and investigated fall in the areas of the covalent perchlorates and compounds containing the acetylenic function. Efforts to inhibit the reactivity of the acetylenic function via the urea inclusion complex phenomenon disclosed a new method of esterification. Several solvent systems are being investigated in an effort to increase the yields and rates of esterification.

1.41

Minnesota U., Minneapolis.
ORGANIC MERCURY COMPOUNDS, M. M. Kreevoy. Project 9763(802A), Contract AF 49(638)-711; SRC, AFOSR.

The rate of the elimination reactions of organic compounds of mercury will be studied as a function of the nature and structure of the groups attached to the carbon chain in order to determine the mechanism and the transition state structure in the maximum possible detail.

1.42

National Bureau of Standards, Washington, D. C.
THERMAL DEGRADATION OF POLYMERS, M. Wacks. Project 7342(802A), Contract DO (33-616)58-8; ASRC, ASD.

This work involves research to determine the mechanisms of thermal degradation of polymers by performing various experiments in which polymers are degraded under controlled conditions. Experiments will be conducted within a mass spectrometer in order to determine the unstable, intermediate degradation products. This information will be used to postulate the basic mechanisms of the thermal degradation of polymers.

1.43

New Hampshire U., Durham.
ORGANOBORON CHEMISTRY, H. G. Kuivila. Project 9760(802A), Contract AF 49(638)-312; SRC, AFOSR.

The research is designed to extend our understanding of the mechanisms of reactions of organoboron compounds. Specifically, the hydrolysis of organic boron acids, the oxidative cleavage of the carbon-boron bond, and the role of chelating agents in catalyzing replacement reactions will be studied.

1.44

New York State U., Albany.
STABLE AND UNSTABLE SILYL AND GERMYL COMPOUNDS, T. D. Goldfarb. Project 9762(802A), Grant AF-AFOSR-61-11; SRC, AFOSR.

This investigation is to elucidate the facts which govern the chemical properties on methyl, silyl and germyl compounds. To this end, new reactions of silyl and germyl compounds will be studied. Primary attention will be directed to those reactions which may lead to new species, both stable and unstable. The possible synthesis of stable species will be investigated by vacuum line techniques. The possible formation of unstable species, such as silyl and germyl free radicals and molecules which polymerize rapidly, will be investigated by the matrix isolation spectroscopic techniques. The studies will be made by infrared and ultraviolet spectroscope. Isotopically labeled compounds will be prepared for these investigations.

1.45

New York U., N. Y.
PREPARATION, PROPERTIES AND REACTIONS OF ORGANO-ALUMINUM COMPOUNDS, C. J. Marsel. Project 7013 (801A), Contract AF 33(616)-5610; ARC, ARL.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
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ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRME- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
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The general course of the reaction of aluminum alkyls and dialkylaluminum hydrides with amines has been established along with the metathetical reactions of alkylaluminum halides with metallic salts. The previously described synthesis of aluminum triaryls has been improved and applied to the preparation of tri-p-chlorophenylaluminum. A good portion of the research has been concerned with investigations of the complex reactions occurring during the hydrolysis of organoaluminum compounds. A reaction has been discovered which promises to establish aluminum alkyls as an important new source of free radicals. This reaction involves the oxidation of aluminum alkyls with transition metal halides resulting in typical radical products such as alkanes and alkenes.

1.46

Nottingham U. (Gt. Brit.).
CHEMISTRY OF BORON, W. N. Greenwood. Project 7013 (801A), Contract AF 61(052)-111; ARL, CRB.

Studies are being made of the synthesis and properties of new types of boron compounds. An investigation is underway of the reactions of borane with triallylamine, triallylboron, and substituted cyclododecatriene. In addition, the reaction of compounds of the type (RBH_2) with 1-substituted and 2-substituted butadienes will also be studied. Work on the determination of ionic mobilities in fused coordination compounds using isotopic tracers, principally B^{10} and deuterium is to be completed. Investigations of the autoxidation, protonation and oxidative hydrolysis of cyclic organoboranes are being continued.

1.47

Ohio State U. Research Foundation, Columbus.
BULKY SUBSTITUENTS AND CHEMICAL STABILITY, M. S. Newman. Project 9762(802A), Contract AF 33(616)-3412; SRC, AFOSR.

This is an investigation of the effects of bulky groups in stabilizing molecules against breakdown by heat and moisture. The ionization of acids like di-(t-butyl)-acetic, the hydrolysis rates of nitriles like di-(t-butyl)-acetonitrile, the decomposition of o -diazoketones and the reduction of hindered nitriles are under study.

1.48

Ohio State U., Columbus.
COMPOUNDS CONTAINING TRIHALOMETHYL GROUPS, M. S. Newman. Project 9762(802A), Contract AF 49(638)-277; SRC, AFOSR.

This is a study of the rearrangement reactions of the trihalomethyl group, $-CCl_3$, on ring compounds. In this process sometimes a methyl group rearranges and sometimes a trichloromethyl group rearranges. The factors which determine which one occurs will be sought.

1.49

Ohio State U., Columbus.
REACTIONS OF CHLOROCARBONIUM IONS, M. S. Newman. Project 9762(802A), Grant AF-AFOSR-62-28; SRC, AFOSR.

It is proposed to test a postulated chlorocarbonium ion mechanism for the reaction of phosphorus pentachloride with ketones, and to throw more light on the behavior of chlorocarbonium ions having structural features of interest. The object is to generate a chlorocarbonium ion on a carbon adjacent to sites similar to those from which rearrangements are known to occur in other carbonium ion systems, i.e., neopentyl, phenonium allylic and bicyclic types.

1.50

Organic Chemistry Inst. T.N.O. (Netherlands).
SYNTHESIS OF TIN-HETEROATOMIC POLYMER SYSTEMS, G.J.M. Van der Kirk. Project 7342(802A), Contract AF 61(052)-218; ASRC, ASD.

The contractor will carry out an investigation of the synthesis of organotin polymers containing other hetero elements in the polymer chain by reactions of organotin hydrides with bis-unsaturated compounds of several other metals and metalloids (i.e. divinyl- or diallyl-compounds of Si, B, Ge, P etc.). Other promising techniques which are predicted from accomplished research will also be studied.

1.51

Pennsylvania State U., University Park.
REVERSIBILITY OF RADICAL-OLEFIN REACTIONS, P. S. Skell. Project 9760(802A), Contract AF 49(638)-457; SRC, AFOSR.

This is an attempt to establish the conditions for reversibility of a variety of radical-olefin reactions. Among the objectives are: (a) the elaboration of direct evidence for reversibility of radical-olefin reactions, (b) the detection of stereospecificity in various radical polymerization and non-polymerization processes, and (c) the evaluation of kinetic isotope effects in radical reactions. These studies will also yield information about entropies of polymerization and possibly values for rotation barrier about single bonds in radicals. Synthetic methods will be developed for the cis- and trans-monodeutero-olefins, making them available for other investigations.

1.52

Pennsylvania U., Philadelphia.
CONJUGATED SILICON AND SULFUR COMPOUNDS, L. Goodman. Project 9760(802A), Grant AF-AFOSR-62-39; SRC, AFOSR.

This proposal involves a combined theoretical and experimental study of the electronic energy levels of small molecules containing silicon and sulfur in valence states favorable for conjugation. The purpose of the proposal is twofold: (1) to investigate and classify the electronic spectra of these molecules, $RSiH_3$, $RSCH_3$, and RSH where R is vinyl, phenyl or substituted phenyl; and (2) from the spectra to infer the detailed nature of the chemical binding between the 3rd-row element and the organic moiety.

1.53

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
SYNTHESIS OF POTENTIAL ORGANIC SEMICONDUCTORS AND PHOTOCONDUCTORS, J. D. Bass. Project 6694(750F), Internal.

The goal of this program is the synthesis of several series of new organic and organometallic compounds designed for electrical testing to determine semiconductive and photoconductive activity. From these studies the elements of structures responsible for electrical and photo effects should be determined leading to a better understanding of the conduction mechanisms involved. A knowledge of these mechanisms will permit design of organic structures with optimum solar energy conversion characteristics.

1.54

Pittsburgh U., Pa.
DEOXYGENATION REACTIONS OF AMINE OXIDES AND SULFOXIDES, T. Cohen. Project 9760(802A), Contract AF 49(638)-788; SRC, AFOSR.

The research involves a study of deoxygenation reactions of amine oxides that have recently been discovered. The goal of the proposed investigation is the elucidation of the nature, scope and mechanism of each of these reactions and the application of this information to the discovery of new reactions might be of considerable synthetic and theoretical interest. The reactions of amine oxides and sulfoxides to be investigated are those with anhydrides, esters, ketones, aldehydes, unsaturated carbonyl compounds, epoxides and ethylene imines.

1.55

Polytechnic Inst. of Brooklyn, N. Y.
SYNTHESIS OF ORIENTED POLYMERS BY HETEROGENEOUS CATALYSIS, C. G. Overberger. Project 7342(802A), Contract AF 33(616)-6066; ASRC, ASD.

This contract will involve research to elucidate an understanding of the basic relationships between structural and physical properties of polymers prepared from heterogeneous catalyst systems. In addition, research on the basic mechanism of heterogeneous catalysis will be conducted. Included in this investigation will be studies of transition metal initiation, copolymerization techniques and the effect of the other variables, such as optically active centers. Research on the preparation of ladder-type polymers using such techniques as the polymerization of alpha, beta-unsaturated aldehydes, dialdehydes, and the investigation of Diels-Alder reaction will also be undertaken.

1.56

Princeton U., N. J.
KINETICS OF OZONE OXIDATIONS, D. Garvin. Project 9763(802A), Contract AF 18(603)-134; SRC, AFOSR.

The mechanism of the oxidative attack of ozone on organic molecules and on hydrogen was studied. The reactions may be those of O atoms or O_3 molecules. Chemical kinetic studies of the systems, ozone-ethanol, ozone-diethyl ether, ozone-isopropanol, and ozone-propylene oxide were investigated as well as the rate and mechanism of the hydrogen-ozone reaction.

1.57

Princeton U., N. J.
EQUILIBRIA AND MECHANISMS IN IONIC POLYMERIZATION, A. V. Tobolsky. Project 9762(802A), Contract AF 49 (638)-974; SRC, AFOSR.

The research is a study of the reaction between the initiator and monomer, in the formation of polymers using ionic catalysts. The investigation begins with a study of the equilibrium constants using -methyl styrene as the monomer tetrahydrofuran as the solvent and using such initiators as sodium anthracene, sodium stilbene, sodium styrene, sodium methyl methacrylate, lithium naphthalene, lithium anthracene. Equilibrium polymerization studies will also concern $(PNCl_2)_3$ and its polymers in the presence of various initiators. Various copolymers will also be studied.

1.58

Purdue Research Foundation, Lafayette, Ind.
FERROCENE AND RELATED COMPOUNDS, R. A. Benkeser. Project 9760(802A), Contract AF 49(638)-297; SRC, AFOSR.

The objectives of the research are: to determine the manner in which the properties of the ferrocene moiety is affected by substituent groups, to

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determine whether ferrocene and vinyl ferrocene will undergo free radical reactions; and to investigate possible methods of decomposing ferrocene and its derivatives into the parent cyclopentadienes. The project will provide new ferrocene type compounds. It will also provide quantitative information about the electron donating character of various ferrocenes. Ferrocene itself is an effective oil additive, has good thermal stability and is resistant to gamma radiation.

1.59

Purdue Research Foundation, Lafayette, Inc.
REACTIONS OF AMBIDENT ANIONS, M. Kornblum. Project 9762(802A), Contract AF 49(638)-324; SRC, AFOSR.

Nucleophilic substitution and addition reactions of anions, such as the nitrate anion are being investigated in order to obtain a clear understanding of the factors (such as electronic and steric) which govern the reactions of the anions. The reactions of ambident anions are significant in the synthesis of materials. New knowledge may enable the prediction of addition reactions of such ions as $(CN)^-$, $(SCN)^-$, $(NO_2)^-$.

1.60

Purdue U., Lafayette, Inc.
NUCLEOPHILIC ADDITION, W. E. Truce. Project 9762 (802A), Contract AF 49(638)-531; SRC, AFOSR.

The investigation is a study of electronic and steric effects as controlling forces in determining the geometry of nucleophilic additions to acetylene and olefins.

1.61

Queens Coll., N. Y.
SYNTHESIS WITH METHYLENE COMPOUNDS, A. H. Blatt. Project 9762(802A), Contract AF 49(638)-796; SRC, AFOSR.

The research is a study of the addition of reactive methylene compounds to azomethines to form Mannich bases, also the conversion of the Mannich bases to unsaturated compounds and vice versa. Three aspects of the reactions are being studied: (1) the experimental conditions (catalysts, solvents, etc.) for carrying out the reactions efficiently; (2) the generality and usefulness of the reactions as methods of preparing different classes of unsaturated compounds; and (3) the mechanisms of the reactions.

1.62

Royal Coll. of Science and Tech., Glasgow (Gt. Brit.).
PROPERTIES IN FERROCENE DERIVATIVES, P. L. Pauson. Project 9762(802A), Contract AF 61(052)-321; SRC, AFOSR.

This research is a study of the preparation and properties of ferrocene derivatives, especially those having such hetero-atoms directly attached to the nucleus, those in which the two rings are bridged, and those in which two or more ferrocene nuclei are linked together or in which the ferrocenyl groups are linked to other organometallics.

1.63

Sheffield U. (Gt. Brit.).
HALOGENATION OF ALIPHATIC HYDROCARBONS AND DERIVATIVES THEREOF, J. M. Tedder. Project 7023(802A), Contract AF 61(052)-63; ARC, ARL.

The contractor is investigating the monofluorination of a variety of aliphatic hydrocarbon derivatives by means of a direct reaction between elementary fluorine and the respective hydrocarbon both in the liquid and gas phase. The contractor will then investigate the chlorination of the same diphasic compounds under the same conditions and compare the results obtained with the fluorination reactions. By means of these results, the contractor should be able to develop a general picture of the effect of different groups upon the course of halogenations. If time allows, the contractor will investigate the more extensive fluorination of aliphatic hydrocarbons to polyfluorinated compounds and ultimately to completely fluorinated structures (perfluorocarbons).

1.64

Southampton U. (Gt. Brit.).
KINETIC STUDY OF ION-SENSITIZED POLYMERIZATION, E.A.S. Cavell. Project 7342(802A), Contract AF 61(052)-376; ASRC, ASD.

The purpose of this investigation is the undertaking of a kinetic study of ion-sensitized terminations of radical polymerization reactions by salts of transition metals. Special emphasis will be placed by the contractor in this study on the oxidation potential of the cation and the chemical nature of ion with regard to affecting polymerization rates. In addition, the contractor will investigate the effect of temperature on ion-sensitized terminations of polymerization reactions.

1.65

Stanford Research Inst., Menlo Park, Calif.
MECHANISMS OF REVERSIBLE AND IRREVERSIBLE LOSS OF MECHANICAL PROPERTIES OF ELASTOMERIC VULCANIZATES WHICH OCCUR AT ELEVATED TEMPERATURES, T. Smith. Project 7342(802A), Contract AF 33

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
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SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
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CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRP- Geophysics Research Directorate
CRRA- Photochemistry Lab
CRRC- Thermal Radiation Lab
CRRE- Research Instrumentation Lab
CRRG- Terrestrial Sciences Lab
CRRH- Meteorological Research Lab
CRRI- Ionospheric Physics Lab
CRRM- Sacramento Peak Observatory

(616)-8298; ASRC, ASD.

The objective of this work is the elucidation of the mechanism of reversible and irreversible loss of strength of elastomers at elevated temperatures. The investigation will be conducted primarily on new high temperature elastomers including fluoroelastomers. The work will include studies of relaxation of stress as a function of chemical composition, molecular weight distribution, and related fundamental parameters, as well as studies of ultimate properties, in the presence and absence of severe environments. The information derived from these studies will significantly increase thermal limits of such elastomers.

Stanford Research Inst. see 1.85

1.66

Stanford U., Calif.
FACTORS INVOLVED IN THE STABILITY OF CYCLOPROPANES, R. H. Eastman. Project 9760(802A), Grant AF-AFOSR-62-116; SRC, AFOSR.

A series of substituted cyclopropanes of such nature that a fixed geometrical relationship exists between the plane of the cyclopropane ring and that of an attached chromophoric system will be prepared. The influence of changing electron density upon the stability of the cyclopropane ring in bicyclics wherein the cyclopropane portion is under the influence of another unsaturated group will be studied.

1.67

Stauffer Chemical Co., Weston, Mich.
SYNTHESIS AND CHARACTERIZATION OF HIGHLY ARYLATED ORGANIC SILICON COMPOUNDS, A. R. Anderson. Project 7023(802A), Contract AF 33(616)-8355; ARC, AML.

This program is concerned with the synthesis of pararylated silanes, and their precursors, in basically larger than laboratory-sized quantities. Various selected compounds of the pararylated silane class are prepared to provide reaction intermediates, compounds for evaluation, or to fill gaps in an area already partially explored.

1.68

Texas Technical Coll., Lubbock.
REACTIONS OF THIOAROMATIC COMPOUNDS, H. J. Shine. Project 9762(802A), Grant AF-AFOSR-61-48; SRC, AFOSR.

This research is an investigation of the reactions of thianthrene, thianthrene monoxide, thianthrene dioxide and certain aromatic disulfides with strong acids. It will correlate the electron spin spectra with the transformations in the visible spectra. Further, it will provide needed information on the radical forming ability of thio compounds. This is closely related to the involvement of mercapto (-SH)and disulfide (-S-S-) linkages in radiation damage to proteins and peptides, that is, the biological effects of radiation.

1.69

Tufts U., Medford, Mass.
INTERMEDIATES IN THE OZONATION OF ALKENES, F. L. Greenwood. Project 9760(802A), Contract AF 49(638)-292; SRC, AFOSR.

The object of this research is to gain a better insight into the mechanism of the ozonation of alkenes. Dimeric acetone peroxide has been prepared and the infrared spectra of this compound and that of acetone, propionaldehyde and 3-hexene ozonide are being determined at -75°C. The reaction of dimeric acetone peroxide, acetone, propionaldehyde and 3-hexene ozonide with the methyl Grignard reagent and with n-butyllithium or phenyllithium at -75° will be studied and the reaction products identified. This knowledge of the mechanism of ozonation will contribute to the search for antiozonants to protect rubbers and other organic polymers from atmospheric ozone deterioration.

1.70

Turin U. (Italy).
DIAZOALKANE POLYMERIZATION, A. Nasini. Project 7342(802A), Contract AF 61(052)-535; ASRC, ASD.

The contractor will conduct research to achieve a better understanding of the polymerization of polyalkylidenes by the decomposition of diazoalkanes. Emphasis will be placed on: (a) study of the kinetics of polymer formation as a consequence of decomposition of diazomethane and other alkylidenes upon metal catalysts; (b) research on influence of solvents on polymer formation; (c) research on chain mechanism in polymerization; and (d) quantitative research on structure of the polyalkylidene chain and on its crystallinity.

1.71

University Coll., London (Gt. Brit.).
REARRANGEMENTS OF HYDRAZOBENZENES, E. D. Hughes. Project 9760(802A), Contract AF 61(052)-66; SRC, AFOSR.

This is a study of the mechanism of the benzidine-and-semidine rearrangements of hydrazobenzenes, by correlating the values of product ratios and reaction rates and the effect on them of substituting deuterium for hydrogen.

AML- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARH- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAGR- Advanced Studies Office
RAG- Directorate of Engineering
RAHA- Advanced Development Lab
RAH- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEGR- Research Division
AFWC- Air Force Special Weapons Center
SRR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESRR- Operational Applications Lab

1.72

University Coll. of North Staffordshire (Gt. Brit.). HEATS OF FORMATION OF LITHIUM, BERYLLIUM AND ALUMINUM ALKYLS, C. S. Mortimer. Project 9750(801A), Contract AF 61(052)-307; SRE, AFOSR.

The particular focus of this contract will be on carbon-lithium, carbon-beryllium and carbon-aluminum bond energies, through the heats of formation of the metal alkyls. These will be determined, whenever possible, both by hydrolytic reactions and by rotating-bomb combustion calorimetry. During the first year of work, the heat of formation of lithium trityl has been obtained by reaction with benzyl bromide.

1.73

University of Southern California, Los Angeles. STERIC EFFECTS IN CONJUGATED SYSTEMS, J. A. Berson. Project 9760(802A), Contract AF 49(638)-828; SRC, AFOSR.

This is an inquiry into the relationships among several chemical and physical effects of parts of molecules which crowd other parts in analogues of a new non-benzenoid type of aromatic compound. Specifically, compounds like N-substituted 2 pyridylidenylcyclopentadiene will be studied. The interaction of the crowding with other molecularly internal chemical influences will be examined in these same new types. Previously unknown compounds will be synthesized and their chemical and physical properties measured.

1.74

University of Southern California, Los Angeles. FLUORINATION OF ORGANIC SULFUR COMPOUNDS, N. Kharasch. Project 9762(802A), Contract AF 49(638)-718; SRC, AFOSR.

This research is a study of the direct fluorination of sulfenyl derivatives and disulfides using other fluorinating agents besides elementary fluorine. The chemical properties of arylsulfur trifluorides will be studied. The synthesis of chloroalkanesulfenyl fluorides will be attempted. A systematic comparison of the sulfenyl fluorides with corresponding sulfenyl chlorides and bromides will be included.

1.75

University of Western Ontario (Canada). ORGANOMETALLIC COMPOUNDS AND POLYMERS BASED ON METAL-NITROGEN BOND SYSTEMS, D. C. Bradley. Project 7342 (802A), Contract AF 33(616)-6934; AERC, ASD.

The contractor shall investigate preparative methods leading to the formation of metal-nitrogen bonds and metal-oxygen-silicon bonds. The synthesis of metal-nitrogen compounds shall be directed towards materials such as $M(NR_2)_n$ and $(R_2N)_nM(NR)_x\text{-}M\text{-}(NR_2)_n$ where M is a metal such as Ti, Zr, Hf, Ta and R is alkyl, aryl or hydrogen. The siloxy metal work will be directed towards preparation of compounds of the type $RM_{n+1}\text{-}O\text{-}(M_nO\ SiR_2\text{-}O)_xOM_{n+1}$. This work is expected to lead to new preparative methods for metallo-nitrogen compounds and to new prototype metallo-nitrogen polymers.

1.76

University of Western Ontario (Canada). PHOTOCHEMICAL PRODUCTION OF STRAINED SYSTEMS, P. De Mayo. Project 9760(802A), Grant AF-AFOSR-61-6; SRC, AFOSR.

The objective of this research is to investigate the strained carbocyclic ring systems that are produced by irradiation with ultraviolet light, of molecules containing suitable chromophores. These occur by the addition of a conjugated system onto an isolated ethylenic linkage, or by the interaction with an extended system. The investigation and techniques are intended to elucidate this type reaction, providing a tool for the organic chemist for the general synthesis of highly strained molecules.

1.77

Uppsala U. (Sweden). EFFECT OF SHEAR RATES ON VISCOSITY OF POLYMER SOLUTIONS, S. Claesson. Project 7342(802A), Contract AF 61(052)-392; AERC, ASD.

The objective of this research program is the measurement of the relative viscosities of various polymer solutions as a function of the rate of shear and concentration. From the data obtained the contractor will attempt to calculate the reduced and intrinsic viscosities of these polymer solutions as a function of the rate of shear. Furthermore, efforts will be made by the contractor to elucidate the frictional behavior and weak intermolecular forces which may be present with regard to the polymer solutions under investigation.

1.78

Utah State U., Logan. PYROLYSIS OF ESTERS, G. G. Smith. Project 9760 (802A), Grant AF-AFOSR-62-268; SRC, AFOSR.

The objectives of this research are to determine the effects of structural changes on the thermal stability of organic and inorganic esters and to study the mechanisms of their decompositions. This study will add to our understanding of the

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CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

thermal stabilities of organic compounds and will extend our understanding of the effects of polar changes to reaction rates and equilibria in unimolecular reactions.

1.79

Vienna U. (Austria).
ORGANIC CHEMISTRY AND FERROCENE, K. Schlogl. Project 7342(802A), Contract AF 61(052)-383; ASRC, ASD.

This program is concerned with an investigation of the organic chemistry of the novel organometallic ferrocene. The contractor will, in particular, study the synthesis of ferrocenyl acyloins and mono- and polybridged ferrocenes, as well as steric effects on these molecules. In addition, the preparation of ferrocenyl acetylenic and polyacetylenic derivatives will be attempted by the contractor through the reaction of ferrocenyl aldehyde with sodium acetylide and other suitable methods. The spectra and other physical and chemical properties of these compounds will be studied during the course of this investigation.

1.80

Wisconsin U., Madison.
RADICAL ADDITION AND DISPLACEMENT REACTIONS, H. L. Goering. Project 9760(802A), Contract AF 49(638)-721; SRC, AFOSR.

The research is a study of the mechanistic details of the addition of atoms and radicals to double bonds, and radical displacement reactions. It includes the investigation of the radical chain addition reactions of several systems including olefins and various dienes. Replacement reactions of allylic hydrogen atoms in a system which will make it possible to determine if allylic radicals are involved are also being studied.

1.81

Wisconsin U., Madison.
PI-BONDED ORGANOSILICON COMPOUNDS, R. West. Project 9760(802A), Grant AF-AFOSR-62-244; SRC, AFOSR.

Synthesis of new types of organosilicon compounds such as silicon substituted nitrenes and silylaso compounds, divalent silicone species, polysilylmethyl compounds and cyclic aromatic silicon containing rings will be attempted.

1.82

Wisconsin U., Madison.
STEREOCHEMISTRY OF ORGANOSILICON COMPOUNDS, R. West. Project 9760(802A), Contract AF 49(638)-285; SRC, AFOSR.

The objectives of this research program are the preparation of optical isomers and stereoisomers of cyclic organosilicon compounds, the resolution and separation of these isomers and finally the study of rates of reaction. Other investigations under way are on stereoisomerism of siloxanes, and the stereochemistry of the silane addition reaction. This research will lay the groundwork toward the formation of orientated silicon polymers.

1.83

Wyandotte Chemicals Corp., Mich.
CROSS-LINKING MECHANISM RESEARCH, K. L. Paciorek. Project 7342(802A), Contract AF 33(616)-7798; ASRC, ASD.

This work concerns the basic mechanism of cross-linking new high-temperature resistant elastomers in order to derive more stable and mechanically suitable elastomers and to enlarge our knowledge of the reaction of these types of reagents. The work involves the study of crosslinking produced by peroxides, amines and other reagents. The work to date has been devoted primarily to studies with the fluoroelastomers, such as Vitron and related polymers with amine vulcanization. Projected work will include other high-temperature systems.

1.84

Yale U., New Haven, Conn.
CLEAVAGE REACTIONS OF DISUBSTITUTED CARBON COMPOUNDS, J. English. Project 9760(802A), Contract AF 49(638)-37; SRC, AFOSR.

This research is a study of the structural and spatial requirements for the cleavage reaction of carbon-to-carbon bonds under relatively mild conditions. In addition, synthetic approaches to polyhydroxy compounds are being studied.

1.85

Stanford Research Inst., Menlo Park, Calif.
OXIDATION OF UNSATURATED COMPOUNDS, F. R. Mayo. Project 9762(802A), Contract AF 49(638)-1102; SRC, AFOSR.

This investigation is to obtain quantitative data on the products of reaction of representative unsaturated hydrocarbons in homogenous, liquid-phase reactions at low temperatures (50° - 100°c) so the primary products will be stable. A free radical initiator will be used to give reproducible rates of initiation at approximately 50°c. Ethylene, propylene, and the butylenes will be used as they are the simplest alkenes and reliable data under mild conditions are required.

See also: 2.31, 3.124, 3.2, 3.27, 4.10, 6.03, 6.05, 7.17-18, 7.60, 7.66-67, 8.13, 8.36, 14.69, 14.80.

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AFCRL- Air Force Cambridge Research Laboratories

CRE- Electronic Research Directorate
- CRER- Computer & Mathematical Sciences Lab
- CREC- Electronic Material Sciences Lab
- CRED- Electromagnetic Radiation Lab
- CREI- Astrosurveillance Sciences Lab
- CREK- Propagation Sciences Lab
- CRES- Communications Sciences Lab
- CREZ- Control Sciences Lab

CRI- Geophysics Research Directorate
- CRIA- Photochemistry Lab
- CRIC- Thermal Radiation Lab
- CRIE- Research Instrumentation Lab
- CRIG- Terrestrial Sciences Lab
- CRIM- Meteorological Research Lab
- CRIX- Ionospheric Physics Lab
- CRIR- Sacramento Peak Observatory

2. INORGANIC CHEMISTRY

Alkali Metals; Boron Chemistry; Ceramics; Coordination Compounds; Halides; Inorganic Polymers; Intermetallics; Metal Complexes; Metal Oxides; Rare Earths; Refractory Materials; Silicon Chemistry.

2.1

Aberdeen U. (Gt. Brit.).
STRUCTURAL CHEMISTRY OF SILICATES AND RELATED SUBSTANCES, H. F. W. Taylor. Project 9760(802A), Contract AF 61(052)-276; SRPS, AFOSR.

The object of this research is to establish the connection between the crystal structures of silicates and related substances and their chemical behavior. The most promising approaches seem to be the study of crystallographically ordered transformations occurring wholly or partly in the solid state, and the correlation of crystal structure with phase equilibrium data. The following investigations are being undertaken, principally by means of x-ray studies: (1) Dehydration of hydroxyl-containing silicates and related compounds, (2) study of the series of calcium borate hydrates, (3) study of transitions in calcium metasilicate and other simple metasilicates, and (4) study of oriented transformations effected either by heating in air or hydrothermally involving hydrated calcium silicates.

2.2

Alfred U., N. Y.
PROPERTIES OF OXIDES AS A FUNCTION OF COMPOSITION, T. J. Gray. Project 7022(802A), Contract AF 33(616)-7615; ASRC, ASD.

The properties of metallic oxide and surface films are being investigated in order to formulate general theories relating their electronic structure to their optical properties. These studies will be conducted by a specially equipped mass spectrometer which permits the oxidation of metal films to the oxide in a controlled environment as well as the measurements of photo-electrical and optical properties. The oxide of primary interest is that of magnesium. The properties to be characterized are the physical and mechanical nature, electronic structure, and light absorption by measurements of x-ray diffraction conductivity, photo conductivity, crystal perfection, and chemical analysis and the oxide's ability to adsorb and desorb various gases.

2.3

Alfred U., N. Y.
GRAIN SIZE EFFECTS ON THERMAL CONDUCTIVITY OF CERAMIC OXIDES, J. R. Tinklepaugh. Project 7022(802A), Contract AF 33(616)-7695; ARZ, AEL.

The effects of grain boundaries on the thermal conductivity of polycrystalline ceramic materials is under study. Zirconia and hafnia (monoclinic crystal structure) are to be compared with alumina (hexagonal) and magnesia (cubic). The influence of crystalline isotropy and grain boundaries is greatly increased if the grain size is very small. The kinetics of forming very fine grained ceramics under high temperatures and pressures are being studied. Flexural strength and dynamic modulus of elasticity are being studied in addition to the thermal conductivity.

2.4

Arizona State Coll., Tempe.
MAGNETIC SUSCEPTIBILITY OF RARE EARTH OXIDES AT LOW TEMPERATURES, C. M. Schroeder. Project 9760(802A), Grant AF-AFOSR-62-305; SRPS, AFOSR.

Measurements of the magnetic susceptibility of rare earth oxides over the temperature range 1.5 to 300 K are proposed on single crystal and powder specimens. Doped or reduced forms of the oxides are also believed to be of interest. The proposed measurements are expected to yield information about magnetic isotropy or anisotropy, possible antiferromagnetic transformations, and susceptibility contributions of impurities as well as their effective masses.

2.5

Arizona State Coll., Tempe.
ELECTRICAL PROPERTIES OF SOME OXIDES OF LANTHANIDE RARE EARTH ELEMENTS, C. J. Kevane. Project 9760(802A), Grant AF-AFOSR-62-130; SRPS, AFOSR.

The program of research on this contract includes the following: (1) prepare samples of selected lanthanide rare earth oxides suitable for obtaining meaningful measurements; (2) carry out a program of measuring such electrical properties as conductivity, Hall coefficient, Seebeck effects and magnetic susceptibility as may be necessary to obtain an understanding of the electronic structure of these oxides; (3) determine other properties such as structure and density when necessary for item 4 below; and (4) on the basis of experimental data attempt to develop a picture of the electronic structures of the lanthanide oxides.

2.6

Arizona U., Tucson.

AEL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMM- Electronics Technology Lab
RADC- Rome Air Development Center
RAEM- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RADA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SRR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
AFOC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESRR- Operational Applications Lab

COMPLEXING AGENTS (CHELATING AGENTS) FOR THE METALS NIOBIUM AND TANTALUM, H. Freiser. Project 7023(802A), Contract AF 33(616)-6415; ARC, ARL.

This work encompasses the study of the properties of compounds of niobium (III). The compounds will be prepared which point toward those which possess the greatest stability, with the ultimate goal of finding one or more of them sufficiently stable for ease of use under laboratory conditions. These stable compounds will be used in the development of separation techniques for the mixture, niobium-tantalum. The quantitative analytical determination of these mixtures will be developed by use of these compounds. Since very little is known of the chemistry of niobium (III) this is a pioneer study involving the preparation of niobium (III) compounds of several different classes, the determination of the properties of each compound so prepared, and determining an avenue of derivatives of the selected class of niobium (III) compounds offering promising properties.

2.7

Armour Research Foundation, Chicago, Ill.
ALKALI METAL OZONATES, F. Schossberger. Project 9760(802A), Contract AF 49(638)-618; SRC, AFOSR.

This research program is an investigation of the bond energies, structures and some thermodynamic properties of a series of alkali metal and ammonium ozonates. Information is obtained by determining the heats of reaction and x-ray data for these ozonates and comparing them with data for the corresponding azides and nitrites. It is expected that uncertainties concerning the energy and structure of the ozonate ion will be resolved.

2.8

Armour Research Foundation, Chicago, Ill.
DETERMINATION OF THE STRUCTURE OF O_3F_2, M. J. Klein. Project 9750(801A), Contract AF 49(638)-1091; SREP, AFOSR.

The object of this program is to delineate positively the molecular structure and other characteristics of the substance with the empirical formula O_3F_2. To this end, all available experimental techniques will be employed. High resolution electron paramagnetic resonance spectra of the solid and liquid, nuclear magnetic resonance spectra of solutions, microwave, infrared and visible spectra, dielectric constant, surface tension, and chemical reactions will all contribute data. It will be necessary to make most of these measurements below 100°K because of the substance's lack of stability at higher temperatures.

2.9

Armour Research Foundation, Chicago, Ill.
$Ti\text{-}ZrO_2$ System, R. F. Domagala. Project 7022(802A), Contract 33(616)-7074; ARZ, ARL.

The need for equilibria data between $Ti\text{-}ZrO_2$ has resulted from internal research on the metal modified oxides. The pseudo phase diagram for $Ti\text{-}ZrO_2$ between 700 - 2000°C is being determined by employing standard metallographic techniques. Over 40 different compositions will be employed to establish the phase boundaries in this system. Using materials of the highest purity, the compositions are arc-melted in a non-consumable electrode arc furnace with special care to insure no contamination of the melts. The homogeneity of the melted samples will be verified by examination of the microstructure. Samples shall be heat treated and quenched in a vacuum or inert atmosphere.

2.10

Assumption U., Windsor (Canada).
OPTICAL PUMPING OF ALKALI METAL VAPORS, L. Krause. Project 9774(804A), Grant AF-AFOSR-62-288; SRFP, AFOSR.

Research will be conducted on the Zeeman splittings of the magnetic sub-levels of alkali halides starting with sodium, potassium, rubidium and cesium. Also included are studies of optical orientation, resonance radiation excitation and decay, and polarisability factor variation between alkali-alkali atoms and alkali-rare gas atoms.

2.11

Atlantic Research Corp., Alexandria, Va.
HYDROGEN-FLUORINE REACTION, J. B. Levy. Project 9750(801A), Contract AF 49(638)-1131; SREP, AFOSR.

With the assumption that the reaction of $H_2\text{-}O_2$ is a chain reaction highly susceptable to inhibition, it is proposed to study the kinetics of this reaction under non-explosive conditions in a flow system at low pressures. It should be possible to establish the kinetics of the reaction and to see if the reaction is inhibited by type of surface (magnesium, copper, nickel, monel) or by appropriate additives (Teflon, calcium flouride, alumina). A subsequent goal of the program is the photo chemistry of the reaction.

2.12

Battelle Memorial Inst., Columbus, Ohio.
ZINC BLENDE TYPE SEMICONDUCTORS, A. C. Beer. Project 9762(802A), Contract AF 49(638)-939; SRPS, AFOSR.

It is proposed to investigate broadly four semiconducting intermetallic compounds of the zinc blende structure. The compounds are InSb, HgTe,

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InAs, and GaSb, each of which has unique properties which are representative of series of semiconductors more difficult to prepare, and with definite potential for a variety of useful devices. The materials are to be studied and characterized with thoroughness, the objectives being to determine the interrelation of various properties.

2.13

Boston U., Mass.
STRUCTURE OF BORON COMPOUNDS, K. Eriks. Project 9760 (802A), Contract AF 49(638)-65; SRC, AFOSR.

The purpose of this structural research in the field of boron hydrides and their derivatives is to achieve a better understanding of the chemical bonding in electron deficient compounds, of which boron compounds are prominent examples. This research applies x-ray diffraction techniques to the study of the structures of boron compounds, metal borides, boron hydrides and related compounds. Differing modifications of aluminum borides are being examined in order to obtain a better understanding of the boron-boron linkage. For knowledge of the bonding forces of boron with other elements, mixed hydrides of boron and phosphorus and nitrogen will be prepared and studied.

2.14

California U., Berkeley.
INTERNAL STRESSES IN CERAMIC BODIES, J. A. Pask. Project 9762(802), Contract AF 49(638)-4; AFOSR, SRPS, AFOSR.

The objective of this research is the development of methods for the measurement of internal stress in ceramic bodies in which two phases exist. This research has been extended to include (1) a determination of the limitations of the x-ray diffraction for the measurement of internal stress in model ceramic systems, (2) an analysis of the microstructures of two-phase model ceramic systems, and (3) a study of the correlation of the first two factors with the physical properties of a model ceramic system.

2.15

California U., Riverside.
PHYSICAL AND PREPARATIVE STUDIES OF TRANSITION METAL CHELATES, R. D. Archer. Project 7023(802A), Contract AF 33(657)-9035; ARC, AEL.

A fundamental study of the complexes of transition metal elements will be made, with initial effort on the inner complexes of molybdenum and tungsten. Gas chromatography will be used for analytical and preparative purposes when appropriate. Emphasis will be placed on preparing new completely and partially chelated complexes as well as gaining more information about complexes already known. Other physical methods will be used in addition to gas chromatography in order to elucidate the properties and chemistry of these complexes.

2.16

Chicago U., Ill.
RAMAN SPECTRAL INVESTIGATIONS OF FUSED BORIC OXIDE AND BORIC OXIDE MIXTURES, T. S. Young. Project 7013(801), Contract AF 33(616)-5697; ARC, AEL.

An examination was made of the Raman Spectra of fused boric oxide at elevated temperature in order to elucidate the structure of the material. Changes in structure with temperature and with added metallic oxides and water were also to be examined. Many technical difficulties were encountered in devising satisfactory apparatus for Raman spectroscopy at high temperatures. Primary efforts under the contract were devoted to this purpose and resulted in the successful development of equipment and methods in this new field.

2.17

Cincinnati U., Research Foundation, Ohio.
THERMODYNAMIC INVESTIGATION OF CERAMIC MATERIALS AT ELEVATED TEMPERATURES, M. Hoch. Project 7021 (802A), Contract AF 33(616)-6299; ARZ, AEL.

The degree of stabilization of zirconia in the cubic structure is being studied through the addition of various quadrivalent and bivalent metal oxide combinations. In future work TiO_2 plus TiO and VO will be studied. Research has continued on the Cr-Zr-O ternary system. The vapor pressure of chromium is relatively high at these temperatures and controlled atmospheres are necessary to prevent composition changes.

2.18

Denver Research Inst., Colo.
THERMODYNAMIC PROPERTIES OF III-V AND II-IV COMPOUNDS, C. E. Lunden. Project 5620(8/12A), Contract AF 19(604)-7222; CRRC, AFCRL.

The first phase of the program will consist of a literature survey concerning thermodynamic data of semiconductor elements and compounds. The experimental program to be conducted is to be divided into two separate efforts. The first phase of the program is to determine the heat capacity, heat of fusion, and heat of formation of AlP, GaAs, InSb, AlSb, and InP. The heat capacity and heat of fusion will be determined by drop calorimetry, high temperature drops to be conducted in an ice calorimeter and the low temperature drops in a diphenyl-ether calorimeter. The heat of formation will be determined in a tin-bath calorimeter currently under construction. The second phase, to be con-

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ARZ- Metallurgy & Ceramics Research Lab
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RAE- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
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ducted concurrently with the first phase is to determine the thermodynamic activities of liquid and solid solutions of binary systems of germanium and silicon-base alloys. The Knudsen effusion method will be employed with radioactive tracers to determine the activities.

2.19

Colorado U., Boulder.
COORDINATION CHEMISTRY OF THE GROUPS IV AND V METALS, R. N. Keller. Project 7023(802A), Contract AF 33 (657)-8321; ARC, AEL.

The contractor shall investigate the chemistry of the coordination compounds of the transition elements of Groups IV and V (titanium, zirconium, hafnium, vanadium, niobium, and tantalum). The overall objective shall be to establish the fundamental principles governing the formation, stability, and properties of the coordinated complexes characteristic of these elements. The program of research shall consist of: preparation of complexes in nonaqueous media, such as carbon tetrachloride, diethyl sulfoxide, formamide, dimethyl formamide, acetonitrile, and tetrahydrofuran; characterization and determination of properties; and stabilization of lower oxidation states by complex formation.

2.20

Cornell U., Ithaca, N.Y.
NEW SOLID STATE DEFECT STRUCTURES, M. J. Sienko. Project 9762(802A), Grant AF-AFOSR-62-218; SRPS, AFOSR.

This is a study of non-stoichiometric compounds. It includes the synthesis of new binary and ternary materials of the type X_2O_5, where x = radical Nb, Ta with added metal and oxygen deficiency and the study of their properties. The band structure in Sc_2O_3 is being investigated. Trapping centers in doped and in oxygen deficient transition metal oxides will be studied.

2.21

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio
FERROMAGNETISM OF ALLOYS AND INTERMETALLIC COMPOUNDS, K. Strnat. Project 7367(802A), Internal.

The objective of this work is to investigate the magnetic and related basic properties of new alloys and intermetallic compounds in bulk, fine particle and thin film forms. In recent years, much has been learned about the theory of fine particle permanent magnets and on this basis, experimental work on compounds combining reasonably high saturation magnetization and Curie points with large crystalline anisotropy is being undertaken. Of particular interest are alloys and compounds of manganese and highly paramagnetic rare earth metals like Gd, Tb, Dy, Ho, and Er. The work on alloys and compounds of these materials will include (1) their preparation, (2) full characterization of their crystal structure, (3) determination of polymorphic transitions at elevated temperatures, (4) determination of melting points, and crystal transformation temperatures, and (5) determination of their basic magnetic properties to determine their possible magnetic application. Ferromagnetic thin films will also be studied in order to determine the dependence of saturation magnetization and Curie temperature on the film thickness. Information on the domain structure of these films will also be obtained from this investigation. These studies are required for better understanding of the magnetic behavior of thin films which have many applications in memory devices. The basic tools to be used in this study include the Faraday effect, Kerr effect, and Bitter method for observing magnetic domains.

2.22

Durham U. (Gt. Brit.).
COORDINATION CHEMISTRY, N. N. Greenwood. Project 9762(802A), Grant AF-EOAR-62-27; SRC, AFOSR.

A systematic study of the coordination chemistry of group III elements will be undertaken. In addition to the recent work in boron halide complexes which is far from complete, much fundamental information remains to be obtained on aluminum, gallium, indium and thallium chemistry. This study proposed to investigate the thermochemistry and bonding of group III coordination compounds and also explore the chemistry of the hydrides and other compounds of gallium, indium and thallium.

2.23

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
VAPOR-PHASE CHROMATOGRAPHY AS AN ULTRA-PURIFICATION TOOL, J. K. Kennedy. Project 5620(802A) Internal.

The objective of this research is to investigate new physical and chemical methods for the purification of elements and compounds for direct or indirect application to semiconductor materials. Investigation of the extension of vapor-phase chromatography to the separation of volatile inorganics has been started. The mixture selected was the BCl_3, $AsCl_3$, $SiCl_4$ system. Initial experiments using silicone oils as the liquid substrate showed that although the elution peaks were well separated, each peak had a long tail. An effort to determine the cause of the tailing is being made. An evaluation of the separating poten-

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tial of this type of system for the preparation of pure materials will be made.

2.24

Fulmer Research Inst., Ltd., (Gt. Brit.).
STABILITY OF LOWER BORON HALIDES, P. Gross. Project 9750(801A), Contract AF 61(052)-405; SRE, AFOSR.

It is particularly important to determine the heats and free energies of formation in order that realistic calculations of performance of boron fuels with halogen (F or Cl) containing oxidisers may be made. Such measurements cannot be made in the usual direct manner, since these substances are non-existent at ordinary temperatures. In this work, high-temperature vaporization equilibria are being studied between (1) magnesium fluoride and boron, (2) boron trifluoride and boron, and (3) boron trichloride and boron. Measurements over a number of temperatures will give both the free energy and the heat of the equilibria under study, and from these the corresponding values for formation are readily obtained.

2.25

General Electric Co., Schenectady, N.Y.
DEFORMATION MECHANISMS IN REFRACTORY MATERIALS, M. L. Kronberg. Project 7022(802A), Contract AF 33(616)-7942; ARZ, ARL.

The effect of crystal structure on the deformation of selected refractory materials is continuing. This includes an investigation of the relationships between dislocations, structure, and flow properties. The experimental techniques include precision tensile testing under controlled low strain rates, high temperature hardness testing, and chemical methods to reveal dislocations. The additional work necessary to the understanding of the deformation characteristics of spinel (Al_2O_3 - MgO) is being done. Studies of fosterite (Mg_2SiO_4) and of chrysoberyl are being started. These materials were selected since they have a crystal structure in the hexagonal system that is analogous to the cubic structure of spinel. Work on quartz (SiO_2) will be initiated shortly to determine the particular characteristics that prevent its deformation.

2.26

General Electric Co., Schenectady, N. Y.
THE STRUCTURE OF VITREOUS AND LIQUID BORON TRIOXIDE AND SOME SIMPLE BORATES, J. D. Mackenzie. Project 7013(801A), Contract AF 33(616)-5699; ARZ, ARL.

This contract deals with the elucidation of the structure of crystalline and glassy boric oxide by physical measurements. A phase diagram of the relationship between the low and high pressure forms of B_2O_3 has been constructed. The effect of traces of water on the physical properties of B_2O_3 has been studied up to 1350°C. Infra-red measurements have been obtained for the first time on thin films of B_2O_3 heated to 800°C and shown to be water-free. Nuclear magnetic resonance studies of the glass subject to high pressure are being carried out. Data for the x-ray crystal structure studies of the two forms of boric oxide are being reduced and interpreted.

2.27

General Electric Co., Schenectady, N. Y.
CADMIUM TELLURIDE, W. W. Tyler. Project 7885(802A), Contract AF 33(616)-8264; ARX, ARL.

The ability to prepare low resistivity p and n type CdTe has been established. The techniques for accomplishing this will be refined and the effects of variations in stoichiometry, and of foreign impurities, will be studied by measurements of electrical and optical properties. In particular, the emission spectra at low temperatures and the free carrier absorption will be investigated.

2.28

George Washington U., Washington, D. C.
REACTIONS BETWEEN ALKALI METALS AND CARBON MONOXIDE, W. F. Sager, T. P. Perros. Project 9760(802A), Contract AF 49(638)-325; SRC, AFOSR.

Investigation of the nature of the binding between potassium and carbon monoxide at the various stages of the reaction prior to the formation of potassium carbonyl, $K_6C_6O_6$. This includes the identification of the chemicals and physical characteristics.

2.29

Harvard U., Cambridge, Mass.
INORGANIC SYSTEMS UNDER EXTREME HIGH PRESSURE AND TEMPERATURE, C. S. Hurlbut. Project 5621(802A), Contract AF 19(604)-7319; CRRC, AFCRL.

The work called for in this contract is to conduct research on the chemistry and physics of inorganic systems under conditions of extreme high pressure and high temperature. One such system which shows great promise is the silicate system. The basic properties of this system will be studied as well as the possible modification of one material into another. Modifications will be attempted both by direct application of ultra high pressure and high temperature and by means of prior change produced by chemical action.

2.30

Hebrew U. (Israel).
INTERNAL FIELDS ACTING ON NUCLEI IN SOLIDS, S. Cohen. Project 9763(802A), Contract AF 61(052)-347; SRPS, AFOSR.

Internal fields acting on nuclei in solids will be

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determined using the techniques of recoil-free resonance absorption and the perturbation of the angular correlation of gamma-ray cascades. Such measurements will provide information concerning the internal magnetic fields acting on rare earth nuclei in garnets and other ferrimagnetic materials; the effective electric field gradients acting on rare earth nuclei and their temperature dependence and correlation with bulk magnetic properties; the chemical and isomeric shift in Mössbauer absorption spectra of rare earth nuclei in different solids, leading to knowledge of the atomic s-like wave functions; and the internal magnetic fields acting on iron nuclei in magnetite through the transition temperature region.

2.31

Heidelberg U. (Germany).
INORGANIC POLYMER SULFUR CARBON COMPOUNDS, R. Appel. Project 7342(802A), Contract AF 61(052)-361; ASRC, ASD.

The objective of this program is the investigation of the synthesis and characterization of inorganic polymers based on the sulfur-nitrogen-carbon bond. Specifically, the contractor has just initiated the study of the reaction between sulfuryl dicarbonimide and diamines to obtain polysulfoureas. In a related effort attempts will be made to study the partial hydrolysis of sulfuryl dicarbimide in order to obtain the sulfamic carbimide and investigate its homopolymerization to mixed polysulfimide-carbimide derivatives.

2.32

Heidelberg U. (Germany).
SULFUR-PHOSPHORUS-NITROGEN POLYMERS, M. Becke-Goehring. Project 7342(802A), Contract AF 61(052)-35; ASRC, ASD.

The objective of this contract is to study the chemistry of compounds involving sulfur-nitrogen and phosphorus-nitrogen bonds.

2.33

Indiana U., Bloomington.
CHEMISTRY AND INTERCONVERSION OF BORON HYDRIDES, R. Schaeffer. Project 7013(801A), Contract AF 33(616)-5827; ARC, AEL.

This contract deals with the chemistry and more particularly the interconversion of boron hydrides. Work on the conversion of tetraborane to a new high density borane has been continued and the free radical catalyzed preparation of diborane from boron trichloride further studied. The major effort on the contract has been to study the mechanism of boron hydride interconversions including deuterium isotope effects, sterically hindered amine reactions and finally interconversions involving tetraborine carbonyl and tetraborine-PF_3 addition compound.

2.34

Isomet Corp., Palisades Park, N. J.
PRODUCING AND SUPPLYING EXTREMELY PURE ANHYDROUS FERROUS HALIDE SALTS, H. W. Chandler. Project 7353(802A), Contract AF 33(616)-8187; ASD, ASRC.

The contractor will devise methods of preparing and storing extremely pure ferrous halide salts in the anhydrous state. The maximum impurity level in the salts as delivered will be on the order of 0.10%, including water. Ferric ion concentration will be in the low parts-per-million range. The program is based on development of a process for producing ferrous chloride, but is intended also to provide quantities of the other halide salts.

2.35

Johns Hopkins U., Baltimore, Md.
SPECTRA OF DOUBLY AND TRIPLY IONIZED RARE EARTHS, J. H. Dieke. Project 9768(803A), Grant AF AFOSR-62-238; SRPP, AFOSR.

The purpose of the work on this project is the production, measurement and interpretation of the spectra of the free divalent and trivalent ions of the rare earths. One of the chief aims is to be able to compare the energy levels of the free trivalent ions with those of the same ions incorporated in crystals in order to have an insight into the crystalline forces.

2.36

Kings Coll., London (Gt. Brit.).
INFLUENCE OF IONIC SOLUTES UPON RELAXATION TIMES, V. Gold. Project 9763(802A), Contract AF 61 (052)-458; SRC, AFOSR.

This is a comparative study of the octahedral complexes of nickel (II) and of analogous complexes of other transition metals, in order to establish the factors which govern the efficiency of relaxation catalysis by different complex ions. Also aqueous solutions will be investigated with a view to providing an independent line of evidence concerning the interaction. An additional purpose is to establish the scope and limitations of the "magnetometric titration" technique as an analytical tool.

2.37

Manchester U. (Gt. Brit.).
LINEAR BORON-NITROGEN POLYMERS, M. F. Lappert. Project 7342(802A), Contract AF 61(052)-419; ASRC, ASD.

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This research is directed towards the synthesis of boron and/or nitrogen monomers containing heteroatoms such as P, O, or S, and linkages such as aryl and diether types. It includes the determination of: (1) the chemical and physical properties of these monomers; (2) the polycondensation reactions of the monomers; and (3) the characterization of the resulting polymers.

2.38

Massachusetts Inst. of Tech., Cambridge.
DETERMINATION OF THE THERMODYNAMIC PROPERTIES OF INTERMETALLIC COMPOUNDS, M. B. Bever. Project 5620(802A), Contract AF 19(604)-5588; CRRC, AFCRL.

This research was originally concerned with the thermodynamic properties of compounds of magnesium with Group IV elements and has been extended to include the tellurides and selenides of antimony and bismuth and the solid solutions of binary compounds such as the series of solutions Bi_2Te_3-Sb_2Te_3 and Bi_2Te_3 - Bi_2Se_3. Heats of formation are determined in a metal solution calorimeter and heat capacities, heats of fusion and melting points in a constant temperature gradient calorimeter. From these data, the free energies of formation can be calculated by an approximate method due to C. Wagner.

2.39

Materialdyne Corp., Avon, N. Y.
THERMAL PROPERTIES OF ZIRCONIA, W. B. Crandall. Project 7022(802A),Contract AF 33(616)-8208; ARZ, ARL.

Research is being done on the thermal properties of zirconia in order to obtain a better understanding of the structure, polymorphy, and mechanisms of stabilization of this material. The areas of interest are (1) thermal expansion, (2) thermal diffusivity, and (3) elastic properties such as Young's modulus, modulus of elasticity in shear, and internal friction. In each case, zirconia in the monoclinic, tetragonal and cubic crystal structures and also oxygen-deficient zirconia will be studied from room temperature to 1200-1400°C. The three crystal structures are prepared by the addition of various oxides, i.e., MgO and CaO additions bring about the cubic structure, CeO_2 the tetragonal structure, and Al_2O_3 the monoclinic structure. Zirconia is made oxygen-deficient by metal additions to Ti or Zr and firing in vacuo. Different specimens made with all of these additions will be subject to the above tests and the results evaluated.

2.40

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
CRYSTALLOGRAPHY OF THE INTERMEDIATE PHASES IN THE BORON-GROUP IVB BINARY SYSTEMS, L. R. Bidwell. Project 7021(802A) Internal.

The occurrence and crystallography of compounds in the binary systems of boron with carbon and silicon and with their associated group IVB elements, i.e., germanium, tin, and lead, are being investigated. A compound identified as SiB_4 has been isolated and its structure has been determined to be rhombohedral V, similar to the well-known boron carbide, CB_4.

2.41

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
DETERMINATION OF THERMODYNAMIC QUANTITIES IN SOLID ALLOYS, R. A. Rapp. Project 7021(802A), Internal.

The determination of activities of the components and the relative partial and integral molar thermodynamic quantities in solid alloys is being conducted using emf measurements on a galvanic cell involving a solid electrolyte. From this investigation information concerning the effects of atomic size and the electronic and electrochemical characteristics of the constituents on the structure and reactivity of solid solutions and intermetallic compounds will be derived. The initial investigations will be concerned with the Fe-Si and Fe-Cr systems which are of particular scientific and practical interest.

2.42

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
STRENGTH OF METAL MODIFIED OXIDES, R. Ruh. Project 7024(802A), Internal.

It is well known that pure zirconia (ZrO_2) undergoes a polymorphic transformation when heated to elevated temperatures. When this material is cooled to room temperature and the reverse transformation occurs, the expansion of the material is so great that catastrophic cracking and shattering of the material occurs. It was discovered in this laboratory that this polymorphic transformation is rendered harmless by the addition of certain metals. We are presently investigating the mechanism by which these additions modify zirconia. It has been postulated that the addition of these substances so greatly increases the strength of the material that it is now completely thermal shock resistant. We have found that the addition of metals in solution in ZrO_2 apparently causes an anomalous increase in strength at temperatures above 500°C. We are now studying this anomaly in an attempt to determine its origin.

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2.43

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
FUNDAMENTAL CHEMISTRY OF BORON AND ITS COMPOUNDS, W. L. Ruigh. Project 7013(801A), Internal.

The basic chemistry of boron is distinguished by its ability to form hydrogen bridge bonds and to accept electrons to increase the valency shell from 6 to 8. The second property leading to the formation of "dative" bond complexes is the subject of the internal research program. The in-house research conducted by the task scientist has resulted in the successful isolation of an unstable crystalline product from the vapor phase reaction of acetone and boron trichloride. Structural studies primarily by infrared, indicate the material to be a 1:1 dative complex $(CH_3)_2CO$. In addition, preliminary studies have been carried out on the decomposition of B chlorovinyl boronic acid to acetylene, hydrochloric and boric acids. This work is related to the author's earlier studies on borazole and explains the marked lability of tri-B chlorovinyl- B -borazole even in neutral solutions. Results have been obtained showing that diethanolamine benseneboronate is monomolecular in alcohol solution. Letsinger reported the compound to be a trimer. Hein and Burkhart showed that the corresponding triethanolamine borate, having a similar "cage" structure with a transanular dative bond, was a monomer. Great interest attaches to these compounds because of their extraordinary stability to hydrolysis.

2.44

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
PHYSICAL AND MECHANICAL PROPERTIES OF GRAIN BOUNDARIES AND SINTERED BICRYSTALS, H. M. Tallan. Project 7022(802A), Internal.

There are many advantages to be gained by studying bicrystals formed by sintering two suitably polished single crystals. Among these are the ease of fabrication of samples, of controlling orientation and composition of the boundary, and of studying boundaries between two dissimilar materials. Following a thorough study of the technique of fabrication, including comparisons with otherwise similar grown-in boundaries, the program will be expanded to include the study of various physical and mechanical properties of grain boundaries.

2.45

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
CERAMIC AND METAL-CERAMIC SYSTEMS, B. C. Weber. Project 7022(802A), Internal.

A prominent characteristic of zirconia is its crystallographic polymorphy, the volume change accompanying the crystallographic inversion. Two approaches are under study: (1) thermal decomposition of the oxide in a high vacuum and (2) zirconium metal additions to zirconia. The study of zirconia systems resulting in monoclinic reaction products with unusually favorable properties, especially a high mechanical strength, will be continued. These systems include zirconia with alumina, silica, or ceria additions. An effort to grow single crystal zirconia is being sponsored. When such crystals are available, their physical and mechanical properties will be studied.

2.46

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
ULTRAVIOLET LIGHT FOR DISTINGUISHING THE VARIOUS CRYSTAL MODIFICATIONS OF CERAMICS, B. C. Weber. Project 7022(802A), Internal.

Past experiments have determined that pure monoclinic zirconia and monoclinic zirconia containing some specific major impurities fluoresce and phosphoresce strongly when exposed to ultraviolet light between 2600 and 3000 A^0. It has been observed, however, that some impurities, particularly CeO_2, eliminate the fluorescence. Elevated temperatures (200-300°C) and/or stress concentrations also appear to eliminate the fluorescence. The use of ultraviolet response as a test for the presence of monoclinic zirconia must therefore be used with caution. It has been concluded that the violet to purple appearance of stabilized cubic and tetragonal modifications of zirconia under ultraviolet light is a result of reflectance of the visible portion of the ultraviolet lamp spectrum, with possibly some red fluorescence in the violet hue. Surprisingly, the color reflected appears to be of some value in distinguishing between cubic and tetragonal modifications.

2.47

Miami U., Coral Gables, Fla.
MIXED REFRACTORY OXIDES, K. S. Vorres. Project 9762(802A), Grant AF-AFOSR-61-104; SRPS, AFOSR.

The objective of this research is to study systems of refractory oxides. These will (1) establish the importance of the different variables used in establishing a crystal structure; (2) investigate the phase behavior of different oxides at varying temperatures; and (3) study the solid state reactions of different oxides at varying temperatures. The systems studied will be mixtures of zirconium oxide, with other oxides of varying valence state, electronic configuration, ionic radius and melting point such as Na_2O, SrO, In_2O_3, SnO_2, PbO_2, Nb_2O_5.

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2.48

Michigan State U., East Lansing.
NEW SYNTHESIS METHODS FOR INORGANIC HETEROPOLYMERS, R. N. Haszeldine, J. B. Kinsinger. Project 7342(802A), Contract AF 33(616)-6943; ASRC, ASD.

This program involves two fields of research. The first portion shall initially include work concerned with combinations of chromyl chloride and difunctional silicon compounds through cocohalysis and other condensation reactions. The second portion will, in general, involve determination of the course of reaction and dependence of the products on experimental conditions by careful analytical techniques and physicochemical measurements.

2.49

Michigan U., Ann Arbor.
SINTERING OF METAL OXIDES, G. Parravano. Project 9762 (802A), Contract AF 49(638)-493; SRPS, AFOSR.

The sintering of microspheres of such metal oxides as V_2O_5, TiO_2, ZnO, MgO, NiO, and Fe_2O_3 is being studied in relation to the concentration of the defects present in their crystal lattices. The details of the formation of bonds between microspheres is being investigated in terms of whisker bridges between particles, surface diffusion, bulk diffusion, crystal orientation between particles, recrystallization of particles and polygonization, and modifications of chemical composition by the atmosphere environment. Later stages in sintering when residual pores in the compact are being absorbed will also be studied.

2.50

Milan U. (Italy).
NEW HYDRIDES OF TRANSITION METALS, L. Malatesta. Project 9762(802A), Grant AF-EOAR-62-34; SRC, AFOSR.

The research consists of the preparation and study of iridium carbonyl compounds, and of new coordination compounds of iridium and triaryl phosphines and isonitriles and triaryl-phosphines with rhenium carbonyl and rhenium carbonyl halides.

2.51

Motorola, Inc., Phoenix, Ariz.
SURFACE PROTECTION FOR SILICON DEVICES, S. Flaschen. Project 5621(802A), Contract AF 19(604)-8358; CERC, APCRL.

A theoretical and experimental investigation of the chemistry of silicon surfaces will be undertaken leading to a technique for treating the surface of silicon diodes and transistors. This treatment should render the devices comparable to or better than units hermetically sealed by existing techniques.

2.52

North Carolina U., Chapel Hill.
METAL-ION INTERACTION WITH COMPLEXING AGENTS, C. N. Reilley. Project 9763(802A), Contract AF 49(638)-333; SRC, AFOSR.

This is a study of the correlation between structures of new and of well-established analytically important chelonates and their reactivity with various metal ions from both a thermodynamic and kinetic viewpoint.

2.53

Northwestern U., Evanston, Ill.
COMPOUNDS OF THE PLATINUM METALS, F. Basolo. Project 9760(802A), Contract AF 49(638)-315; SRC, AFOSR.

Synthetic and kinetic studies of the platinum metal complexes, specifically the rhodium and iridium compounds, are under way. Emphasis is placed on the influence of inductive and steric effects on the rates of substitution, isomerization, racemization, inversion and isotopic exchange with these complexes.

2.54

Northwestern U., Evanston, Ill.
SURFACE OPTICAL PROPERTIES OF OXIDES AS A FUNCTION OF COMPOSITION, D. H. Whitmore, R. Fredricks. Project 7353(802A), Contract AF 33(616)-6194; ASRC, ASD.

The properties of non-stoichiometric, metallic oxides as single crystals or as polycrystalline bodies are to be studied at elevated temperatures for the development of a theory of correlation of their electronic and crystallographic structure and their composition. The effect of the concentration of defects, vacancies, or foreign ions will be emphasized since these imperfections affect their electric conductivity. The properties to be measured are the thermoelectric effect, conductivity, electromotive force, the dielectric constant (by microwave), and the Hall effect coefficient which permits evaluation of the density and the sign of the charge carriers, the ionization and gap energies, and provides a measure of the effective mass. The optical properties to be measured are the photoconductivity and the absorption spectrum in the ultraviolet and infrared as a key to the electron or center excitation. These measurements are to be made in isolated systems providing the greatest possible control for precise studies.

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2.55

Northwestern U., Evanston, Ill.
KINETICS OF METAL OXIDE REACTIONS, D. H. Whitmore. Project 9762(802A), Contract AF 49(638)-436; SRPS, AFOSR.

The influence of dislocation density and surface preparation on the oxidation kinetics and diffusion coefficients in single crystal spheres of rutile at higher temperatures will be continued. The electrical conductivity, thermoelectric power and Hall effect of metal-excess, nonstoichiometric oxides, such as Nb_2O_5 and TiO_2, will be studied as a function of temperature and defect concentration in order to formulate the trapping statistics applicable to the localized and non-localized impurity centers.

2.56

Ohio State U. Research Foundation, Columbus.
PHASE EQUILIBRIA BETWEEN BORON OXIDES AND REFRACTORY OXIDES INCLUDING SILICON AND ALUMINUM OXIDES, W. R. Foster. Project 7021(802A), Contract AF 33(616)-6509; ARZ, ARL.

The phase equilibrium relations in the binary systems B_2O_3 - SiO_2 and B_2O_3 - Al_2O_3 are being determined in a water-free atmosphere. Work will begin on the investigation of the Si-B-O system. Compatibility lines will be determined through 1900°C.

2.57

Olin Mathieson Chemical Corp., New Haven, Conn.
SUPEROXIDIZERS, J. Zaslowsky. Project 3827(801A), Contract AF 49(638)-1137; SRA, AFOSR.

The purpose of this contract is to investigate the feasibility of higher oxides, e.g., of hydrogen. Experiments described in literature shall be repeated in search of new and improved syntheses. The successful studies on the reaction of hydrogen atoms with ozone at low temperature shall be continued in an attempt to clarify the reaction mechanism, to identify the products, and to determine their physical and thermodynamical properties. The selective solubility of the products, a mixture of higher oxides (HO_2, H_2O_4), hydrogen peroxide and water in liquid oxygen, and other methods of isolation and concentration of higher oxides shall be investigated. Further studies will concern reaction of oxygen atoms with hydrogen peroxides, preparation of their compounds in the gas phase, and reaction of the higher oxides with amines.

2.58

Owens-Illinois Glass Co., Toledo, Ohio.
HIGH TEMPERATURE X-RAY DIFFRACTION, S. Lang. Project 7022(802A), Contract AF 33(616)-7470;ARZ, ARL.

The contractor will investigate the variable parameters influencing the accuracy and precision of high temperature x-ray data and the techniques of sample preparation. Zirconia will be studied to determine the temperature crystallographic relations of the modifications of zirconium dioxide; and the existence, limits, crystallographic forms and temperature dependence of possible oxygen-deficient and oxygen-rich materials of the general composition, $Zr\ O_2$. The reported existence, at high temperatures, of cubic zirconium dioxide will be investigated.

2.59

Pennsylvania State U., University Park.
PHASE EQUILIBRIA, REACTION MECHANISMS, AND KINETICS IN SOLID-PHASE REACTIONS FROM 1500° - 3000°C., R. Roy. Project 9762(802A), Contract AF 49(638)-957; SRPS, AFOSR.

Solid state reactions occurring above 1500°C will be studied to determine the structural steps by which any starting material proceeds to the equilibrium state, the details of the ionic movements involved in each of the steps as revealed by detailed x-ray crystal structure analysis, the explanation in terms of the defect structure of the solids and nucleation theory of the steps leading to equilibrium, and the kinetics of each step in the reaction.

2.60

Pennsylvania State U., University Park.
CHEMICAL PROPERTIES OF LABILE SPECIES, P. S. Skell. Project 9760(802A), Grant AF-AFOSR-62-52;SRC, AFOSR.

The object of this research is to study the chemical properties of condensed forms of carbon, metallic carbides, oxides, halides and sulfides in a condensed reactant phase. The species will be generated at high temperature, transported in vacuum and condensed directly into reactive systems.

2.61

Pittsburgh U., Pa.
INTERMETALLIC COMPOUNDS CONTAINING LANTHANIDES, W. E. Wallace. Project 9763(802A), Contract AF 49(638)-979; SRC, AFOSR.

The proposed research is a systematic study of several intermetallic compounds which have been prepared in this laboratory using the technique of levitation melting. Some have the formula AB_5 and the remainder the formula AB_2 in which A is a lanthanide element of La or Y, and B is Mn,Fe, Co or Ni. A series of studies has been initiated

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dealing with the structures and magnetic properties of these compounds.

2.62

Rensselaer Polytechnic Inst., Troy, N. Y.
KINETICS OF OXIDATION OF BORANES AND BORANE DERIVATIVES, W. Bauer. Project 9751(801A), Grant AF-AFOSR-262-330; SREP, AFOSR.

The objective of this work is delineation of the oxidation mechanisms of boranes and some alkylated derivatives. Rather detailed studies of the fast (explosive) oxidation of diborane, pentaborane and decarborane have been completed. The explosion-limit method is being extended to some alkyl boranes in this work, and the slow (non-explosive) oxidation of the boranes and derivatives will be more thoroughly investigated. The techniques of infrared and mass spectrometry are being used extensively in following the course of the oxidation reactions. The effects of temperature, pressure, concentration, surface area, and inhibitors are being studied to gain insight into the rather complicated mechanisms involved.

2.63

Research Inst., Temple U., Philadelphia, Pa.
PLASMA-JET CHEMISTRY, A.V. Grosse. Project 9750(801A), Grant AF AFOSR-62-196; SREP, AFOSR.

A new field of basic inorganic chemistry is open for investigation through the reaction of chemicals in the high temperatures of the plasma jet. Various metal oxides and salts in the solid, liquid and gaseous state, will be reacted with the plasma fluid. The plasma fluids that are to be utilized will be the plasmas of the noble gases, N_2, H_2, the halogens, methane and a 100% O_2 plasma.

2.64

Sheffield U. (Gt. Brit.).
PARAMAGNETIC RESONANCE IN RARE EARTH METALS, R. S. Tebble. Project 9760(802A), Grant AF EOAR-62-54; SRPS, AFOSR.

An investigation will be made into paramagnetic resonance in rare earth metals in the 8mm and 3 cm wave length regions, from room temperature down to liquid hydrogen or liquid helium temperatures, with the object of obtaining information about the nature of the interatomic interaction. The information to be obtained includes g values, the extent of the spin-spin and spin-lattice relaxations, and an estimate of the exchange fields in the antiferromagnetic state.

2.65

Southampton U. (Gt. Brit.).
STEREOCHEMISTRY OF COORDINATION NUMBER FIVE, G. W. A. Fowles. Project 9760(802A), Grant AF EOAR-62-48; SRC, AFOSR.

This is a study of the configuration of metal complexes of coordination number five, especially those of metals in the tervalent state. Compounds like vanadium trichloride-2 trimethylamine and titanium tetrachloride-trimethylamine will be prepared, their nature determined by analysis, magnetic susceptibility and molecular weight determinations and their structures established by dipole moment, absorption spectra and conductivity measurements.

2.66

Stanford Research Inst., Menlo Park, Calif.
SOLUBILITY OF METAL OXIDES IN HIGH TEMPERATURE-PRESSURE SOLVENT SYSTEMS, W. J. Fredericks. Project 4608(760E), Contract AF 19(604)-5697; CRRC, AFCRL.

It is the purpose of this program to determine the solubility, relative rate of solution, chemical processes involved, and if possible, the nature of the species present in solution under these conditions. The experimental program will include the measurement of solubility, relative rate of solution, ionic conductivity, and dielectric constant as a function of solution conditions, i.e., temperature, pressure, solvent density, and a solvent composition. The solutes to be investigated are oxides of the transition metals--titanium, chromium, manganese, iron, cobalt, nickel--the alkaline earth magnesium, the actinide thorium, the group IIIb metal aluminum, and the lanthanide gadolinium. The aqueous-based solvent will be varied in composition to determine the effect of pH and complexing agents on solubility.

2.67

Syracuse U., N. Y.
STRUCTURE AND MAGNETIC PROPERTIES OF TRANSITION AND LANTHANIDE METAL COMPOUNDS, W. A. Baker. Project 9762(802A), Grant AF-AFOSR-62-213; SRPS, AFOSR.

This study is concerned with the preparation of unusual oxidation states of transition and lanthanide metals, the subsequent study of their magnetic properties, and the consideration of the effects of structure on the magnetic properties. The halides of the metals are particularly well suited to this purpose. Such a study should yield valuable information about the nature of interactions in the solids, the type of bonding, and the extent of crystal field effects. Where possible, proven means of synthesis would be used. The magnetic properties would then be studied over a range of temperatures from 77°K to the point of instability of the halide. At the same time, the structures would be examined by powder techniques, also over a range of temperatures.

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2.68

Systems Research Lab., Dayton, Ohio.
ELECTRICAL BEHAVIOR OF REFRACTORY OXIDES, R. W. Vest. Project 7022(802A), Contract AF 33(616)-7748; ARZ, ARL.

The contractor is studying the electrical behavior of refractory oxides under varying conditions of temperature and atmosphere. Initially, the work will be limited to measurements on pure and oxygen deficient zirconia. The electrical measurements to be made include electrical conductivity, thermoelectric power, dielectric constant, and polarization voltages. Work will also be directed toward the successful growing of zirconia single crystals of sufficient size to make electrical determinations. It is hoped that single crystals of sufficient size for x-ray analysis can be grown.

2.69

Texas Technological Coll., Lubbock.
THERMAL REARRANGEMENT OF SOME COORDINATION COMPOUNDS, W. W. Wendlandt. Project 9760(802A), Contract AF 49(638)-787; SRC, AFOSR.

This research is the study of the kinetics and mechanism of rearrangement of coordination compounds, it is divided into four parts: (a) dehydration reactions of coordination compounds; (b) deamination reactions of coordination compounds; (c) formation of bridged complexes such as (en) 2 Cr<OH>Cr (en) 2 x 4(s); and (d) isomerization reactions of coordination compounds.

2.70

Texas U., Austin.
RARE EARTH PHOSPHIDES; SELENIDES AND TELLURIDES, E. J. Weiss. Project 9762(802A), Grant AF-AFOSR-62-237; SRPS, AFOSR.

This is a study of the crystal chemistry of the systems rare earth - group V and group VI elements. The rare earth elements gadolinium, erbium, neodymium and praseodymium together with lanthanum will be reacted with selenium, tellurium and phosphorus under conditions of controlled atmosphere and temperature over a complete range of compositions. The first portion of the work will be a survey of the phases present in the binary systems Gd-Se, Gd-Te, Gd-P, La-Se, as well as a determination of the extent of isomorphism at several elevated temperatures in the sub-liquids region of the system. As part of this investigation the physical properties of the synthesized materials will be investigated. Resistivity measurements on sintered specimens will be carried out to determine the value for the material and also to determine the optimum conditions for sintering as evidenced by these measurements. Thermo-electric measurements at room temperature will be obtained on all synthesized materials. It is hoped that during the course of this work it will become possible to perform these measurements on single crystals. The thermo-electric power measurements on these refractory materials will be obtained at elevated temperatures.

2.71

Uppsala U. (Sweden).
METALLIC PHASES IN SYSTEMS OF TRANSITION METALS WITH NON-METALS, G. Hägg. Project 9762(802A), Contract AF 61(052)-40; SRPS, AFOSR.

The purpose of this work is to investigate binary and ternary systems of transition metals with such non-metals as boron, silicon and phosphorus when such systems have semi-metallic properties. X-ray diffraction methods are being used to analyze the phases and determine their limits of homogeneity. By studying ternary systems, a gradation in properties from one binary system to another becomes possible and a step forward in understanding the role of each element in the transition metal compounds is anticipated.

2.72

Uppsala U. (Sweden).
SOLVATES OF ARSENIC CHLORIDE AND PHOSPHORUS AND SELENIUM OXY-CHLORIDES, J. Lindquist. Project 9760(802A), Contract AF 61(052)-43; SRC, AFOSR.

The scope of this research project is to determine which solvates exist for $AsCl_3$, $POCl_3$, and $SeOCl_2$ and to determine the crystal structures of suitable chosen compounds by x-ray crystallographic methods.

2.73

Utah U., Salt Lake City.
CHEMICAL KINETICS OF BORON HYDRIDE REACTIONS, G. R. Hill. Project 9760(802A), Contract AF 49(638)-28; SRC, AFOSR.

This project involves theoretical and experimental investigations on the kinetics of molecular rearrangement and decomposition of the boron hydrides. The effect of pressure and radiation on the rates of chemical reactions will also be investigated.

2.74

Washington State U., Pullman.
REACTIONS OF NITRYL HALIDES, H. H. Batey. Project 9760(802A), Contract AF 49(638)-36; SRC, AFOSR.

A study of the chemical properties of nitryl

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fluoride and nitryl chloride to arrive at an understanding of their true role in the family of nitrogen compounds. Attempts are to be made to prepare the fluoride without the use of elemental fluorine.

2.75

Washington U., Seattle.
EQUILIBRIA AND PREPARATIVE METHODS FOR BORON AND SILICON COMPOUNDS, D. M. Ritter. Project 9762(802A), Contract AF 49(638)-937; SRC, AFOSR.

The objective of this research is to study quantitatively, reactions of the methyldiboranes. Also an examination of the effect of a homologous series of substituents upon certain of the equilibria is being made. Where possible there will be ascertained the influence of individual bond energies as driving forces in these reactions. New pure boron-silicon bonded compounds will be studied. The possibility of preparing polyboron compounds containing carbon and hetero atoms is being investigated.

2.76

Wisconsin U., Madison.
HIGH TEMPERATURE CHEMISTRY, J. L. Margrave. Project 7013(801A), Contract AF 33(616)-6384; ARC, ARL.

An experimental research program on the high temperature chemistry of boron and other light elements has been pursued along the following avenues: (a) mass spectrographic investigations of vapors containing boron-oxygen-fluorine to determine the species formed in both systems, (b) high temperature infrared spectroscopy of boron and other light element compounds, (c) investigation of high temperature chemical reactions, and (d) calculation of high temperature thermodynamic properties of gaseous atoms and ions.

2.77

Yale U., New Haven, Conn.
MECHANICAL PROPERTIES OF INTERMETALLIC COMPOUNDS, R. B. Gordon. Project 9760(802A), Contract AF 49(638)-786; SRPS, AFOSR.

An investigation will be carried out of some selected intermetallic compounds in order to determine mechanical properties such as elastic and plastic behavior, as they relate to crystal structure, nature of atomic bonding and grain boundary energies and orientations. Calculations and experimentation will begin with compounds having ionic binding and will be extended to compounds having more complicated binding forces.

See also: 1.15, 1.2, 1.4, 1.34, 1.43-46, 1.52, 1.8, 1.9, 3.30, 3.69, 3.72, 3.142, 4.19, 4.62, 5.8, 5.14, 5.26, 6.11, 6.43-44, 6.53, 6.92; 6.98, 6.118, 6.136, 8.13, 9.3, 9.28, 9.36-37, 9.68, 10.25, 11.70, 12.53, 14.4, 14.8, 14.11, 14.60, 14.86, 15.18, 23.8, 24.54.

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3. PHYSICAL CHEMISTRY AND CHEMICAL PHYSICS

Adsorption; Catalysis; Electrochemistry; Electrolytes, Liquids, and Solutions; Excitation of Gases; Molecular Structures; Photochemistry; Reaction Kinetics; Interaction of Gases with Surfaces.

3.1

Alfred U.,N.Y.
DEFECT SOLID STATE AND CATALYSIS, T. J. GRAY. Project 9761(802A), Contract AF 49(638)-288; SRC, AFOSR.

The correlation between the chemical-physics of the defect solid state and adsorption and catalytic processes occurring at the surface of the catalyst is being studied. Contact potentials, photoconductivity, luminescence, and photoelectromagnetic effect as modified during catalytic processes occurring at the surface of semiconducting solids will be investigated simultaneously. The bibliography of catalysis is being prepared and maintained.

3.2

Arizona U., Tucson.
PHOTOCONDUCTIVITY IN ORGANIC SOLIDS, G. Tollin. Project 6694(750F), Contract AF 19(604)-8475; CRZA, AFCRL.

A working hypothesis relating to the production and transport of charge carriers in organic and bio-organic solids is to be developed. The work includes the synthesis of organic complexes modeled on photoactive biological systems and the determination of their photoconduction, dark conductivity and flash photoactivation behavior. From these and electron spin resonance studies, conclusions are to be drawn regarding the relation of electronic, atomic, and molecular structure to conductivity.

3.3

Armour Research Foundation, Chicago, Ill.
PHASE MIGRATION IN A MONOTHERMAL FIELD, T. A. Erickson. Project 9751(801A), Contract AF 49(638)-1121; SREP, AFOSR.

An attempt will be made to extend the ground work for application of thermodynamics to steady state processes by studying the effect of temperature and pressure on the forced vaporization of several liquids. The phenomena will be investigated both theoretically and experimentally, under a steady-state thermodynamic condition. The experimental data will be evaluated to extend the application of, and basic concepts for a new science of irreversible processes namely, steady-state thermodynamics.

3.4

Baylor U., Waco, Tex.
ELECTROCHEMISTRY OF HYDROGEN AND ORGANIC COMPOUNDS, T. C. Franklin. Project 6694(750F), Contract AF 19 (604)-8414; CRZA, AFCRL.

The research is divided into two areas: (1) The investigation of the mechanisms of the electrolytic oxidation of organic compounds. The organic compounds are the low molecular weight alcohols, aldehydes and carbon monoxide. Various parameters are being studied to elucidate the mechanism of the oxidation of these compounds. The products of the oxidation will be determined by controlled potential oxidations. (2) The investigation of the competitive processes involving hydrogen at the surface of solid metal electrodes. The study includes the identification of the different forms of hydrogen that are oxidized at the electrode surface. The effect of organic additives on this process is being studied.

3.5

Birmingham U. (Gt. Brit.).
CHARACTERISTICS OF EASILY IONIZABLE CHEMICALS, J. Sayers. Project 7635(770A), Contract AF 61(052)-269, Grant AF-EOAR-61-15; CRZA, AFCRL.

Measurements of the rate of loss of electrons and ions in discharge afterglows have been made by many investigators, but the precise determination of the processes involved and their rates is in many cases uncertain. One of the major problems is the role played by impurities. To reduce this problem, Prof. Sayers' group have designed and built considerably better vacuum systems than they have used hitherto. Specially designed mass spectrometers are used to study the number density of the afterglow ions as a function of time. It is planned to measure the recombination and charge transfer coefficients of several ions of importance in the upper atmosphere.

3.6

Bonn U. (Germany).
PHOTOCHEMICAL INVESTIGATIONS IN THE FAR ULTRAVIOLET, W. E. Groth. Project 7635(770A), Contract AF 61(052)-381; CRZA, AFCRL.

It is planned to continue development of high intensity windowless light sources in the 1000 Å region and to use such sources for photochemical studies of the simple gases. The photodecomposition of ammonia will be further investigated in order to compare the products and quantum yields in different wavelength regions. Studies of photoionization phenomena in the simple gases with mass spectrometric observation of the resulting

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ions will be continued. The recently developed vacuum ultraviolet flash lamp and a field emission ion source will be used in a study of the primary products and the subsequent fast kinetic processes involving radicals, ions, highly excited molecular species. A quadrupole mass filter coupled to a conventional mass spectrometer will be used to study ion-molecule reactions.

3.7

Brown U., Providence, R. I.
INTERMOLECULAR FORCES IN LIQUIDS AND SOLIDS, R. H. Cole. Project 9760(802A), Contract AF 49(638)-31; SRC. AFOSR.

This program is aimed at a better understanding of the relation between molecular structure and intermolecular order in condensed phases and their effect on the dielectric behavior of the system. Specific investigations include the systems of sulfuric acid, liquid alkyl halides, solid solutions of hydrogen halides in noble gases, and substituted amides. Appropriate microwave equipment for the relaxation studies will be designed and constructed.

3.8

Buffalo U., N. Y.
DIELECTRIC CONSTANT OF HYDROGEN - BONDED LIQUIDS, W. Dannhauser. Project 9763(802A), Contract AF 49(638)-939; SRC, AFOSR.

It is the prime purpose of the research to extend measurements of the dielectric constant of hydrogen-bonded liquids as a function of temperature and to analyse the resulting data in terms of molecular association as a specific function of molecular geometry.

3.9

California Inst. of Tech., Pasadena.
ABSOLUTE INTENSITY MEASUREMENTS AND GAS EMISSIVITIES AT ELEVATED TEMPERATURES AND PRESSURES, S. S. Penner. Project 9751(801A), Contract AF 49(638)-984; SRPP, AFOSR.

This research concerns shock tube studies of equilibriated and reacting gases to determine the rate processes contributing to relaxation phenomena in chemiluminescent radiation, infrared emission, and the lifetimes of vibrationally excited molecular species. Particular emphasis is on the time-dependent estimates of spectral and integrated absolute intensities behind shock fronts at high temperatures for both gas mixtures and for those including volatile salts of metals such as iron pentacarbonyl, $Fe(CO)_5$. Theoretical studies will also be conducted to relate shock front parameters such as population temperatures, composition profiles, and relaxation times to both prediction and determination of radiative lifetimes of excited species.

3.10

California U., Berkeley.
SPECTROSCOPIC AND THEORETICAL STUDIES OF MOLECULES, G. C. Pimental. Project 9760(802A), Contract AF 49 (638)-944; SRC, AFOSR.

A variety of techniques will be used to investigate the spectra of series of related species with the aim of learning systematic dependence of bonding and structure on molecular orbital occupancy. Quantum mechanical consideration will be given such molecular structures and bonding. A new type of infrared detector, based on the properties of active nitrogen which has been frozen quickly at 4°K., is under development for possible unique usefulness in the problems involved.

3.11

California U., Los Angeles.
DISSOCIATION AND RECOMBINATION STUDIES OF NITROGEN AND OXYGEN, J. Kaplan. Project 8605(804A), Contract AF 19(604)-2143; CRZI, AFCRL.

Experimental investigations are made of the chemical reactions which may occur in the upper atmosphere. Particular emphasis is placed upon dissociation and recombination studies of nitrogen and oxygen, and the emission from these gases in different wavelength regions of the spectrum.

3.12

California U., Los Angeles.
X-RAY STUDIES OF UNUSUAL ORGANIC MOLECULES, K. N. Trueblood. Project 9760(802A), Contract AF 49 (638)-719; SRC, AFOSR.

This research encompasses the determination by X-ray diffraction techniques of the precise molecular structures of a variety of novel organic molecules of significance in valence theory, and further development of the use of high speed computers for direct methods of structure determination.

3.13

California U., Riverside.
PHOTOPOTENTIAL MECHANISMS, J. N. Pitts. Project 6694 (750F), Contract AF 19(8069; CRZA, AFCRL.

The work involves subjecting alcohol solutions of bensophenone and anthraquinone compounds to high intensity ultraviolet radiation and measuring electrochemically the photopotentials produced.

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3.14

California U., Riverside.
ELECTROCHEMISTRY OF DISSOLVED GASES, D. T. Sawyer. Project 6694(750F), Contract AF 19(604)-8347; CRZA, AFCRL.

The objective of the contract is the elucidation of the mechanism of the oxidation or reduction of dissolved gases at electrode surfaces. The effects of varying the supporting electrolyte, pH, electrode material and electrode preconditioning on the current-voltage-time relationship are being studied for various gases. Emphasis is placed on those gases which are oxidants or reductants in fuel cells. The electrode materials being used include platinum, gold, silver, nickel, palladium, iridium, rhodium, tungsten and tantalum. The electrochemical investigations of hydrogen at platinum electrodes have been completed.

3.15

California U., Riverside.
THERMODYNAMICS OF LIQUID-LIQUID CRITICAL MIXING REGION, H. H. Schmidt. Project 9760(802A), Contract AF 49(638)-284; SRC, AFOSR.

This is a study of the equilibrium heat capacity of the systems carbon tetrachloride-perfluoromethylcylohexane and aniline-cyclohexane in a range of temperatures and compositions covering the liquid-liquid critical mixing region. Partial vapor pressures of such systems using the particular pair nitrobenzene normal pentane will be measured. Surveys of similar critical systems are being made to identify others which will be helpful for evaluating present theories of the liquid state by heat capacity and vapor pressure measurements.

3.16

Cambridge U. (Gt. Brit.).
THERMAL DIFFUSION IN ELECTROLYTE SOLUTIONS, J. N. Agar. Project 7364(802A), Contract AF 61(052)-99; ARC, ARL.

The primary objective of the work is to measure the Soret coefficients of various classes of electrolyte solutions as a function of temperature and concentration. The following classes of system are being examined: (1) strong electrolytes in water, (2) weak electrolytes in water, and (3) electrolytes in non-aqueous solvents. A sufficient number of systems will be examined to determine whether any generalities in behavior exist on the basis of the foregoing classification. Supplementary measurements are made of the isothermal diffusivities of the systems which are investigated. The experimental data are interpreted to define the conventional thermodynamic parameters of the solutions (heats of transport, activity coefficients, and the like). Experimental apparatus has been constructed and calibrated. The technique consists of periodic measurements of resistivity along the diffusion coordinate, which is related to the concentration gradients by means of an elegant and somewhat elaborate theory. This method is potentially a very exact one.

3.17

Carnegie Inst. of Tech., Pittsburgh, Pa.
"HOT" RADICAL REACTIONS IN FLASH PHOTOLYSIS, G. J. Mains. Project 9763(802A), Grant AF-AFOSR-62-51; SRC, AFOSR.

It is planned to investigate systematically the flash photolysis of mercury diethyl and diethyl ketone over the temperature range 25 - 250°C to ascertain the temperature dependence of the flash photolysis products. "Hot" reaction products should, of course, exhibit no temperature dependence. The effects of inert gases on the temperature-independent reaction products will be studied over a wide range of pressures. Because of virtual exclusion of radical-molecule type reactions, organic vapors such as methane and neopentane are expected to behave as essentially inert gases. A study of the effects of free radical scavengers on the flash photolysis products is planned.

3.18

Catholic U. of America, Washington, D. C.
METAL-HYDROGEN ALLOYS, G. W. Castellan. Project 9761(802A), Contract AF 49(638)-475; SRC, AFOSR.

The objective of the investigation is to study the electrochemical reactions of hydrogen on the sur-

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ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
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AMRL- 6570th Aerospace Medical Research Laboratories
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faces of metals such as palladium which dissolve hydrogen at ordinary temperatures, and contrast this behavior with that of metals which do not dissolve hydrogen. The kinetics of the reactions will be investigated. At a later stage, the corresponding systems using deuterium instead of hydrogen will be studied.

3.19

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
LIQUID-PHASE THERMAL DIFFUSION, J. A. Bierlein. Project 7013(801A), Internal.

The scope of this effort covers the measurement of Soret coefficients in binary liquid mixtures. Some theoretical refinements have been made which increase the power and accuracy of the Gouy interferometric technique developed previously in this work. Application of the improved theory requires the use of tabulations of the incomplete Airy integral, a mathematical function which has not previously been investigated. In cooperation with the Applied Mathematics Research Branch, ARM, suitable tables of this function have been computed.

3.20

Chicago U., Ill.
PHOTOIONIZATION IN GASES AND CHEMICAL PROCESSES INDUCED BY PHOTOIONIZATION, M. G. Inghram. Project 7635(770A), Contract AF 19(604)-8011; CRZA, AFCRL.

Experimental determination of photoionization efficiencies of various gases as a function of wavelength of ionizing radiation, and of the chemical properties of photo-ions produced such as specific rate constants for unimolecular dissociation. Photoionization potentials of a number of free radicals have been determined and ion-dissociation rates at elevated temperatures have been measured. Work has shown that photoionization at threshold does not represent adiabatic (0-0) transitions.

3.21

Chicago U., Ill.
ELECTRONIC PROPERTIES OF ORGANIC MOLECULES, D. R. Kearns. Project 9760(802A), Contract AF 49(638)-923; SRC, AFOSR.

This research is an investigation of the electronic properties of organic charge transfer complexes both theoretically and experimentally. A theory of charge transfer complexes will be extended in an attempt to explain such things as paramagnetism in complexes composed of diamagnetic components, such as chlorophyll as the electron donor and some electron acceptor. The electronic properties of any given complex are directly related to electronic properties of the component species, so it is necessary to consider the properties of the individual molecules. The experimental investigations will be conducted by use of electron spin resonance and other spectroscopic techniques.

3.22

Chicago U., Ill.
PROPERTIES OF SOLUTIONS OF METAL DISSOLVED IN MOLTEN SALTS, N. H. Nachtrieb. Project 9760(802A), Contract AF 49(638)-1076; SRC, AFOSR.

It is proposed to study physico-chemical properties of solutions of metals dissolved in molten salts to clarify the understanding of the state of the solute metal: its state of oxidation, degree of association with solvent ion species, the contribution which it makes to the electrical conduction mechanism, its effect on the structure of the liquid state, and the possibility that interesting phenomena may be found in the transition interval between metallic (electronic) and electrolytic (ionic) conduction. The planned approach is essentially non-thermodynamic, and includes the study of the polarographic behavior of metal-salt systems, their absorption spectra, the kinetics of metal-cation exchange, x-ray diffraction studies of the structure, and a search for photo-conductance phenomena and related semiconducting behavior. If preliminary studies indicate their feasibility, electron paramagnetic resonance and nuclear magnetic resonance measurements may be undertaken for determining the energy states of the electrons contributed by the solute metal and to obtain information on the nature of the bonding which exists among the atoms.

3.23

Chicago U., Ill.
RATE AND MECHANISM OF RECOMBINATION OF MOLECULAR FRAGMENTS ON SURFACES, F. F. Rieke. Project 7353(802A), Contract AF 33(616)-7106; ASRC, ASD.

This program is designed to determine the effect of surface properties on the discharge of and/or recombination of, or reaction with molecular fragments in order to establish the kinetics and mechanism of the reactions occurring at the surface. The state of the molecular fragments and of the surfaces will be studied to determine their effect on the reaction paths. Various gas phase species, both molecular and atomic, along with various substrates having differing surface properties will be investigated to

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establish generally applicable conclusions. It is anticipated that during the latter phases of this contract the methods involved will be used to help characterize surface structures being investigated under other research programs.

3.24

Cincinnati U., Ohio.
ENERGETICS OF THE COMBINATION OF A PROTON AND HYDRIDE ION, R. E. Dessy. Project 9760(802A), Contract AF 49 (638)-824; SRC, AFOSR.

The objectives of this research are to study the mechanisms by which hydride ions combine with a proton; to provide information concerning the acidity of the terminal acetylenes, especially the effects of changing the substituent groups along with the deuterium isotope effects. These reactions will be studied by the use of volumetric analysis, and manometric methods.

3.25

Columbia U., New York.
MOLECULAR COLLISION PROCESSES AT LOW PRESSURES, R. Bersohn. Project 9760(802A), Contract AF 49(638)-785; SRC, AFOSR.

This research is both a theoretical and experimental investigation of the chemical aspects of optical pumping - - - collision processes which involve depolarization of an atomic spin by a buffer molecule, modification of the wave function of an atom by collision with a buffer molecule, and depolarization of atoms and radicals by collision with each other. An attempt will be made to detect radicals at very low concentrations through their depolarizing effect on a dilute gas of polarized alkali atoms.

3.26

Columbia U., New York.
CHEMICAL BOND ENERGIES, B. P. Dailey. Project 9760 (802A), Contract AF 18(600)-1152; SRC, AFOSR.

The project involves a study of the structures -- bond angles, bond distance, coupling constants and barriers to internal rotation -- of complex organic molecules. Included are organic acids, aromatic derivatives and halogen substituted hydrocarbons. The experimental techniques include microwave, direct quadrupole, and nuclear magnetic resonance spectroscopy.

3.27

Columbia U., New York.
MICROWAVE SPECTROSCOPY AT HIGH TEMPERATURE, B. P. Dailey. Project 9763(802A), Contract AF 49(638)-953; SRC, AFOSR.

This is a study of chemical bonding and vibrational states in molecules and in their unstable intermediates formed at temperatures up to 1000°C. The types of compound being investigated include organics whose low vapor pressures preclude microwave spectroscopy at ordinary temperatures. Metal compounds, e.g., hydrides, alkali amides, alkali hydroxides and other more complex than diatomic, and organo-metallics like lithium alkyls will be studied.

3.28

Columbia U., New York.
PHYSICS AND CHEMISTRY OF GASES AT HIGH TEMPERATURES, P. Kusch. Project 9767(803A), Contract AF 49(638)-557; SRPP, AFOSR.

High-temperature, high-resolution atomic and molecular beam sources and spectrometers have been constructed for the investigation of the physics and chemistry of gases and simple molecules having appreciable vapor pressures only at elevated temperatures. Studies will also be made of single crystal evaporation processes, and the formation of metastable states from an initial $^1S_0$ state. This work is expected to provide new dissociation data and improved theoretical models of phase equilibria, internal interactions and population balances in metastable states.

3.29

Cornell U., Ithaca, N. Y.
KINETICS OF CHEMICAL REACTIONS IN GASES AT HIGH TEMPERATURES, S. H. Bauer. Project 7013(801A), Contract AF 33(616)-6694; ARC, ARL.

Investigation of the chemical kinetics of gaseous reactions at high temperatures using multiple and single pulse shock tubes. For example, studies of the rate of dissociation of $(CN)_2$ to CN, studies of the rate of equilibration of C_2 between triplet and singlet states, studies of the degradation of simple hydrocarbons at temperatures of 2000°K - 4000°K and studies of the rate

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of growth of condensed ring systems and of the formation of solid carbon from pyrolyzed hydrocarbons.

3.30

Cornell U., Ithaca, N. Y.
HIGH-TEMPERATURE REACTIONS OF GASES WITH METALLIC OXIDES AND SALTS, D. R. Bidinosti. Project 9763(802A), Grant AF-AFOSR-60-25; SRC, AFOSR.

This research was directed toward the investigation of the gaseous products produced when a reactant gas such as water vapor comes in contact with metallic oxide at high-temperature. The existence of gaseous metal hydroxide species which have been demonstrated in flame spectroscopic studies was studied. The data will permit computation of heats of formation and other thermochemical functions for these high-temperature species.

3.31

Cornell U., Ithaca, N. Y.
ORGANIC ELECTRO-OXIDATIONS, D. H. Geske. Project 9763 (802A), Grant AF-AFOSR-61-18; SRC, AFOSR.

This is an investigation of a useful but poorly understood reaction, the Kolbe oxidation and related syntheses, by new techniques of electrochemistry. The techniques involve polarography, chronopotentiometry, voltammetry and even electron spin resonance, all in organic media.

3.32

Cornell U., Ithaca, N. Y.
SOLUTE SPECIES IN CONCENTRATED AQUEOUS SOLUTIONS, R. A. Plane. Project 9760(802A), Contract AF 49(638)-279; SRC, AFOSR.

Experiments are being conducted to improve understanding of concentrated aqueous solutions. The hydration of ions is being studied by employing O^{18}, an oxygen isotope, as a tracer. The study of complex ions in solution by Raman spectra is being carried forward. Oxygen isotopes will be used to characterize solute species, such as chromic polymers and thorium compounds.

3.33

Cornell U., Ithaca, N. Y.
INVESTIGATION OF ATOMIC PHENOMENA OCCURRING ON OR NEAR THE SURFACE OF SOLIDS BY METHODS OF ULTRAHIGH VACUUM ELECTRON DIFFRACTION AND ELECTRON MICROSCOPY, B. M. Siegel. Project 9761(802A), Grant AF-AFOSR-62-7; SRPS, AFOSR.

Studies on the surfaces of solids utilizing ultimate techniques for examining surfaces free of contaminating materials and gases will be undertaken. A combination of electron optical devices, the electron microscope and electron diffraction camera, are combined with ultrahigh vacuum procedures to make fundamental observations on solid surfaces which are "atomically clean," or on surfaces subjected to controlled surface interactions with pure gaseous phases. The surface structure of certain metals will be characterized both in single crystals and in deposited films. The nucleation and growth of metal crystals and the oxide phases on these crystals will be investigated.

3.34

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
REDUCTION OF METALS IN FUSED SALTS, J. W. Reishus. Project 7353(802A), Internal.

The ultimate aim of this effort is the determination of the reduction mechanism of metal ions in fused salt solvents. To date only $LiClO_4$ has been determined experimentally to exhibit the thermal stability required of a solvent system. Information will be gathered concerning the nature of ions present in the perchlorate melts, the electro-valency of the solvent, the extent of dissociation of added salts, energies of activation for conducting ions present, the extent of deviation from ideality shown by the system, nature of ionic conduction processes and the structure of the metals. Research will be conducted on the mechanism and kinetic parameters for the electrodeposition of metal ions in the fused perchlorate solvents.

3.35

Electronics Technology Lab., ASRME, ASD, Dayton, Ohio.
CRYSTALLINE MATERIAL BOMBARDMENT, E. B. Henschke. Project 4152(803A), Internal.

Experiments are being performed to ascertain the importance of threshold energies in the various mechanical collision theories of cathode sputtering. Several theories have been advanced to explain the different threshold energies encountered. There is good theoretical reason to believe that threshold energies, as measured by various techniques, appear to differ because of basic sputtering phenomena rather than because of differences in measuring methods. Sputtering rates and threshold energies of a variety of metals bombarded by noble gas ions have been determined. Theoretical studies concerning the shape of the yield curve at below and near threshold energies are in progress. Sputtering at various angles of incidence and with monoenergetic ion beams will be attempted using newly designed beam sources.

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3.36

Florida State U., Tallahassee.
IONIZATION PROCESSES IN NITROGEN-RING COMPOUNDS, M. Kasha. Project 9760(802A), Contract AF 49(638)-712; SRC, AFOSR.

It has been observed experimentally that the molecules in a condensed phase (solid solution in rigid glass solvents) can be photo-ionized at very low energies compared with the known ionization potentials, and that the susceptibility to photo-ionization is very sensitive to molecular movement. Therefore, the gaseous ionization potentials of certain aromatic nitrogen compounds and the photo-ionization limits in condensed phases are being studied.

3.37

Florida State U., Tallahassee.
NMR STUDY OF THE STRUCTURE AND REACTIVITY OF MOLECULES, R. A. Kromhout, E. Grunwald. Project 9760(802A), Contract AF 49(638)-278; SRC, AFOSR.

The program involves a comprehensive study of the NMR spectra of amines and acid salts. Specifically, rates and mechanisms of protolysis (i.e., hydrogen transfer) involving N-H bonds, rates of complex formation of amines with metal ions and with electron acceptor acids and the complexing of amines or ammonium ions with other molecules are under study.

3.38

Free U. of West Berlin (Germany).
CALCULATION OF COLLISION CROSS-SECTION, G. Ludwig. Project 9767(803A), Contract AF 61(052)-217; SRPP, AFOSR.

Under this contract it is planned to compute the collision cross-section for gas reactions. The preliminary phase will be concerned with the reactions involving H_2 and H. In the H_2 molecule spin flip is important only when the molecule has a repelling force in the other spin state. The problem of dissociation reduced to one of multichannel scattering with no further physical assumptions is equivalent to a stationary Schrodinger equation. A later objective is to apply the results to oxygen and nitrogen reactions.

3.39

General Atomics, San Diego, Calif.
INTERACTION OF HYDROGEN AND OXYGEN ATOMS WITH SURFACES, W. L. Fite. Project 9783(806A), Contract AF 49(638)-356; SREM, AFOSR.

The principal objective of this program is the study of the interactions of atoms and molecules with solid surfaces. Of major importance is the determination of the way in which chemically-unstable gases (such as atomic oxygen and hydrogen in the high upper atmosphere) interact with vehicle surfaces under conditions of high vacuum and free molecular flow. Predictable interactions of particular interest include: (1) reassociation of atoms into molecules, (2) energy transfer between the gas and surface, (3) dissociation, and (4) chemical reactions between the gas and the surface. This research utilized modulated atomic beam techniques, usually with reflected beam techniques and mass-spectrometric detection, these techniques being quite different from those usually applied to this class of problems. Because of this new approach, a number of apparently new discoveries have been made, and some contradictions with widely accepted work have been found. In consequence, the fundamental investigation of unexpected gas-surface interaction phenomena has become an additional objective of the research.

3.40

General Dynamics Corp., San Diego, Calif.
CHEMICAL REACTIONS USING MODULATED FREE RADICAL BEAMS, W. L. Fite. Project 9750(801A), Contract AF 49(638)-301; SRE, AFOSR.

The present objective of this work is to study the detailed kinetics of interaction of atomic and radical species with molecules in the gas phase. Previously, the work was directed toward studies of condensation of atomic hydrogen from a beam onto a surface at liquid helium temperature; this work has been carried as far as is reasonable. Pulsed beams of atoms are being crossed with beams of "target" molecules. Number and kind of particles in the incident beams and in the product at various angles is being obtained. These data will lead to calculation of momentum interchange (scattering), activation energy of reactions, and reaction cross-sections. During the past year, a great many experiments and revisions of apparatus have been made in the attempt to obtain the desired accuracy of measurement, for beams of O crossing H_2 beams of H crossing D_2.

3.41

General Electric Co., Pittsfield, Mass.
DEVELOPMENT OF A RESEARCH TOOL TO MEASURE ENERGY OF ADHESION, F. F. Carini. Project 7022(802A), Contract AF 33(616)-5291; ARC, ARL.

The adhesion energies of monomolecular films on metals are being investigated by measuring the energies needed to remove such a film from the metal. Films of radioactively-labeled stearyl alcohol and stearic acid are transferred to metal substrates using the Langmuir-Blodgett technique. Films of radioactive iodine are deposited from the vapor phase and their thickness determined by polarized light ellipsometry. The film is then removed by bombardment with a homogeneous low energy argon ion beam, the degree of removal at various beam energies being followed by radiocounting. A spectrum of the

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extent of film removed as a function of energy has been observed for stearic acid on platinum which shows that a small portion of the film adheres very tenaciously. The case of film removal has been shown to depend upon the particular crystal face of the metal from which the film is removed. The method gives information concerning the range of adhesion energies with which films are absorbed on substrates.

3.42

General Electric Co., Schenectady, N. Y.
INTERACTIONS OF GASES WITH NON-METALLIC SURFACES, G. Ehrlich, O. A. Vermilyea. Project 9761(802A), Contract AF 49(638)-791; SRC, AFOSR.

This is a study designed to establish the nature of the binding sites, as well as to see a possible correlation between interatomic spacings on the surface, and the adsorption process. Anticipated research involves adsorption of carbon monoxide on metals and mobility of atomic hydrogen on non-metallic surfaces. Studies of the adsorption of atomic and molecular hydrogen on ionic salts (alkali and alkali earth halides) and on elemental semiconductors are being done.

3.43

General Telephone Labs., Bayside, Long Island, N. Y.
ADSORPTION OF GASES ON SOLIDS IN HIGH VACUUM, T. Polanyi. Project 5634(803A), Contract AF 19(628)-331; CRRC, AFCRL.

The objective of this investigation is to establish the laws governing adsorption of gases in the very low pressure range. Theoretical treatments of surface problems, i.e., physical adsorption, chemisorption, photoelectric and thermionic work functions, reflection of electrons at surfaces, etc., are receiving new impetus owing to the progressive development of more refined quantum mechanical models of the surface and the availability of computing facilities. Experimentally, investigations of surfaces are very exacting; ultra-high vacuum techniques must be used and the condition of the samples must be carefully investigated as to surface conditions.

3.44

Georgia U., Athens.
THERMODYNAMIC STABILITY SCALE OF STABLE, ISOLABLE FREE RADICALS, R. Lamb. Project 9760(802A), Grant AF-AFOSR-62-33; SRC, AFOSR.

The equilibrium constants will be determined by spectrophotometric measurement in the visible of the concentration of the colored free radicals. The effects of solvent and temperature on the stability constants, F_n, will be investigated. When possible, the rate constants, k_n and k_{-n}, will also be determined. It can be shown that the difference between two stability constants, $F_{\Delta s}$, is nothing more than a difference in the corresponding "hydrogen atom affinities" F_{H_n} is the standard free energy change. The highest priority will be given to establishing a stability scale for known stable free radicals. Assuming success is encountered in this endeavor, attempts will be made to synthesize new stable free radicals so as to extend the stability scale.

3.45

Group for the Advancement of Spectroscopic Methods (France).
MOLECULAR ENERGY LEVELS, G. Amat. Project 8603(804A), Contract AF 61(052)-369; CRZC, AFCRL.

To perform a detailed investigation of the effects of resonances in polyatomic molecules on the energy levels of these molecules and the effect on the detailed structure of the absorption bands of these molecules. Also to use these results to obtain a better understanding of molecular structure. For example, they have applied these results to explain certain anomalies in rotational spectra of molecules. Also they have determined for certain classes of molecules the effect of perturbations on the rotational "constants" of the molecule.

3.46

Harvard U., Cambridge, Mass.
AURORAL PROCESSES, N. Carlton. Project 7661(770A), Contract AF 19(604)-4984; CRZI, AFCRL.

This work consists of a laboratory study of reactions produced by heavy atoms, excitation of atmospheric gases by electron impact and study of rapid fluctuations in auroral emissions.

3.47

Harvard U., Cambridge, Mass.
STRUCTURES OF BIOLOGICALLY ACTIVE MOLECULES, W. N. Lipscomb. Project 9760(802A), Contract AF 49(638)-809; SRC, AFOSR.

This is a study of detailed three-dimensional molecular structure of several types of biologically important organic substances, using advanced x-ray diffraction techniques which have been recently strengthened by this same investigator. The structures of some naturally-occurring biologically-active polypeptides will constitute one principal objective. The structural analysis of cellobiose, casimidine hydrochloride and dibromomenthane will be completed. A protozoan enzyme study will also be undertaken.

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3.48

Hawaii U., Honolulu
PHOTOIONIZATION AND ULTRAVIOLET ABSORPTION PROCESSES, K. Watanabe. Project 7635(770A), Contract AF 19(604)-4576; CRZA, AFCRL.

Investigates absorption processes and measures absorption coefficients and photoionization potentials of gases in the spectral region below 2000 Å, with a view to developing broad band proportional gas multiplication detectors. Absorption coefficients of N_2 and O_2 in the region 850-1000 Å have been measured and K-values computed, with much greater accuracy than previously because of high resolution used. Absolute photoionization yields and thresholds of several compounds have been determined.

3.49

Illinois U., Urbana.
FILMS OF SURFACE ACTIVE SUBSTANCES ON A METAL SURFACE, H. A. Laitinen. Project 7022(802A), Contract AF 33 (616)-5446; ARC, ARL.

Adsorption processes occurring at electrode surfaces in solutions are being investigated using polarization capacitance and polarographic measurements. The adsorption of camphor on a dropping mercury electrode is of particular interest, since it occurs rapidly enough that interference from unavoidable impurities in the solution is negligible. Data from the adsorption of camphor on mercury should permit evaluation of the model for adsorption at an electrode-solution interface. A related objective of the study is to determine the correspondence between the measured polarization capacitance and the degree of surface coverage. The effect of adsorbed camphor on the kinetics of the ferric-trisoxalate-ferrous-trisoxalate system is also being studied. The objectives of the study are to better understand adsorption on electrode surfaces, how it affects kinetics of electrode processes, and how it is related to polarization capacitance measurements.

3.50

Imperial Coll. of Science and Tech., London (Gt. Brit.).
ADSORPTION PHENOMENA ON IONIC ADSORBENTS, F. C. Tompkins. Project 8620(804A), Contract AF 61(052)-190; CRZH, AFCRL.

This work entails an examination of the adsorption mechanisms and structure of water layers with homoionic surfaces, with smaller lattice spacing and higher valent cations than in sodium chloride, with the objective of finding a two dimensional spacing approximating the fastest growth plans of ice. Also under consideration is a study of the two dimensional phase changes of adsorbed water layers and a study of the factors affecting the equilibrium adsorption, isosteric heats, and kinetics of adsorption and growth of micro-crystalline iodide films. In addition to classical adsorption techniques, measurements of dipole moments are being used to determine the orientational changes.

3.51

Indiana U., Bloomington.
SPECTROMETRIC STUDIES OF FAST REACTIONS, E. J. Bair. Project 9763(802A), Grant AF-AFOSR-62-38; SRC, AFOSR.

Support is requested for programs on fast, high resolution absorption measurements. These include: (1) elucidating detailed quantitative mechanisms and rates of the individual chemical processes which contribute to over-all results of complex reactions; and (2) determining the distribution of energy in reaction systems and its rate of change. The objectives include: (a) mechanisms of complex free radical reactions, e.g., of HCO, NH_2 and CN; (b) translational energy distributions and their rate of change; (c) internal energy distributions and their rate of change; (d) flash heating experiments (absorption by a neutral material, which transfers the energy as heat to the reactive gas); (e) flash flash photolysis systems; and (f) fast reaction measurements in the vacuum ultraviolet.

3.52

Indiana U., Bloomington.
ELECTROCHEMISTRY OF FUSED SALTS, R. L. Seifert. Project 9763(802A), Contract AF 49(638)-313; SRC, AFOSR.

It was proposed to investigate a pulse current method for accurate evaluation of the standard hydrogen electrode potential, for fused salt cells in which the galvanic cell reaction is the formation of the salt from its constituent elements, and to develop an electronic technique for checking the reversibility of the fused salt cells.

3.53

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
AFTERGLOW STUDIES, F. J. Le Blanc. Project 7661(770A), Internal.

The changes in the character of the emission spectra of the afterglow, produced in a vacuum system, are measured when the parameters (e.g. pressure, temperature and composition) are varied. The end involved is an understanding of the excitation mechanism.

3.54

Iowa State Coll., Ames.
HEAT CAPACITY LAG IN GASES, S. Legvold. Project 9751 (801A), Grant AF-AFOSR-61-87; SRFP, AFOSR.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARN- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

This theoretical and experimental research program concerns investigations of the heat capacity lag in heavy gases at ultrasonic frequencies. The basic objective is to examine and interpret the dispersion of sound at these high frequencies in heavy vapors and gas mixtures. Recent studies have been performed on mixtures of halo-methanes, ethanes and ethane derivatives. Work has also been undertaken on mixtures of ethylene and argon. The recent work has concerned measurements of singly dispersive gases. Future work will be directed towards similar measurements on mixtures of dispersive with non-dispersive gases and mixtures of two or more dispersive gases.

3.55

Kansas U., Lawrence.
LOW TEMPERATURE VOLTAMMETRY, R. N. Adams. Project 9763(802A), Grant AF-AFOSR-62-14; SRC, AFOSR.

This is a study of electrode processes of organic compounds at temperatures so low that the rates of mass transport are comparable to the rates of the electrode processes. Such processes in semifluid and rigid solvents will also be examined. By slowing these processes with low temperatures and simultaneously observing the electrode interface layers by various means, there may result characterisation of some free radical intermediates.

3.56

Kansas U., Lawrence.
BRIDGE MECHANISM IN ELECTROCHEMICAL OXIDATION AND REDUCTION OF METAL IONS, R. T. Iwamoto. Project 9763 (802A), Grant AF-AFOSR-61-8; SRC, AFOSR.

This is an investigation to obtain better understanding of the mechanism of inorganic reactions by studying the effects of solvents organic nitriles on the electrochemical behavior of metal ions. The use of nonaqueous solvents and an electrode for one of the reactants of a redox reaction will alleviate a great deal of the problem in studying the ligant effect in redox reactions of metal ions because they can readily be placed in the coordination sphere of the metal ion by using it as the solvent. Because a large number of attractive organic materials are solids, a new solvent system which will enable the use of solid substances will be developed.

3.57

Kansas U., Lawrence.
PHOTOLYSIS STUDIES UTILIZING RADIOTRACERS, F. S. Rowland. Project 9760(802A), Grant AF-AFOSR-62-15; SRC, AFOSR.

Photolysis of radioactive molecules will be studied using the combined analytical techniques of gas chromatography and gas proportional counting. This offers several possibilities for verification and extension of the present information on the reactions of thermal atoms and radicals. These possibilities depend essentially on (a) the increase in sensitivity of detection arising from the radio activity, and (b) the existence of isotopic effects in the reaction rates of atoms and radicals. The planned detection system involves the gas proportional counting of the separated components from a photolysed sample immediately after separation on an appropriate gas chromatographic column. The initial experiments would be carried out with radioactive acetone since the photolysis of both ordinary and deuterated acetone has been widely used as a source of methyl radicals and for information about methyl radical reactions.

3.58

Kent State U., Ohio.
ELECTROLYTES IN PURE ACETIC ACID, R. T. Meyers. Project 9760(802A), Contract AF 49(638)-641; SRC, AFOSR.

The common theory is that ionic solutes exist in solvents of low dielectric constants, mostly as ion pairs. This explains the decrease in equivalent conductance as the concentration of the electrolyte is increased. At higher concentrations larger charged aggregates appear which increases the equivalent conductance. There seems to be no reason why such aggregates should be more stable than individual ions. The research will be directed toward verifying or disproving the existence of such charged aggregates and toward ascertaining the actual physical state of dissolved electrolytes in acetic acid.

3.59

Laboratoire Mediterraneen de Recherches Thermodynamiques, Nice (France).
DESIGN CONSTRUCTION AND TESTING OF A MOLECULAR BEAM, F. M. Devienne. Project 9781(806A), Contract AF 61 (052)-561; SREM, AFOSR.

A high-speed molecular beam will be designed and constructed which will be generated through an exchange of momentum between high-speed ions in a beam crossed with a low-speed beam. Upon completing the generator, experiments will be performed toward establishing its operating parameters and capabilities. Then tests will be initiated to determine accommodation coefficients on surfaces, the dispersion of molecules after collision with surfaces, and evaporation of superficial layers from the solid surfaces.

3.60

Leicester U. (Gt. Brit.).
METALS IN NON-METALLIC SOLVENTS, M. C. R. Symons. Project 9760(802A), Grant AF-AFOSR-62-64; SRC, AFOSR.

The purpose of this research is to study the nature of metals dissolved in non-metallic solvents. Studies will be performed on rigid solutions with varying cations, solvents, and additives to prevent crystallization of

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CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
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CRZG- Terrestrial Sciences Lab
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CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

the solvent (solvents will be NH_3, ND_3, NH_3 amine and NH_3-ether). In favorable cases spin resonance spectra of rigid solutions will be taken and effects of visible and ultraviolet light investigated. Such studies may shed light on so-called "monomer" species in solution and, if polar, non-reacting molecules are present, unusual new species may be formed. It is also planned to investigate the possibility of equilibria such as $2Na^{\circ} \rightleftharpoons Na^{+}$ solvated Na^{-} solvated, the part they may play in diamagnetic solutions, and possible similarities between these solutions and electron-excess centers in ionic crystals. It is hoped that a system will be found in which, at sufficiently low temperatures, reaction rates can be measured, and hence ideas obtained on the structure of the transition state. Such information could then be related to the reactants.

3.61

Liege U. (Belgium).
RELATIONS BETWEEN COMETARY, SOLAR AND UPPER ATMOSPHERIC PHYSICS, P. Swings. Project 8605(804A), Contract AF 61(052)-24; CRZI, AFCRL.

Excitation mechanisms and monochromatic fluorescence of the molecules common to aurorae, twilight and comets are studied as an aid to identifying emissions in aurorae. In addition, cometary spectra are analyzed in order to understand certain combustion and other spectroscopic phenomena.

3.62

Maine U., Orano.
ORDERING OF MOLECULES IN THE ANISOTROPIC LIQUID PHASE OF LIQUID CRYSTALS, E. F. Carr. Project 9760(802A), Grant AF-AFOSR-61-45; SRPS, AFOSR.

The plan for this project is to investigate binary mixtures when at least one of the components is a liquid crystal. The presence of a small percentage of a second component will affect the temperature range of the anisotropic phase and the ordering of the molecules in this phase. This project will mainly involve the effect on the ordering. The ordering as a function of the external magnetic field strength at given temperatures will be studied with microwave dielectric techniques. The temperature dependence of the ordering in the presence of a high magnetic field will be investigated with nuclear magnetic resonance techniques. The microwave dielectric measurements will also provide information about the relaxation times due to the permanent electric dipole moments. Additionally, a better understanding of the anisotropic liquid phase might lead to a better understanding of the process of melting or supercooling.

3.63

Manchester U. (Gt. Brit.).
PLANETARY SPECTRA, Z. Kopal. Project 8602(804A), Contract AF 61(052)-379; CRZE, AFCRL.

Laboratory studies are being made of the luminescence spectra of various materials as stimulated by X-ray, ultraviolet and particulate radiation of the sort expected from the sun, at the surface of the moon, and top of planetary atmospheres. This will provide knowledge of the basic processes by which solar radiations react with these materials and will provide knowledge of the effect of these processes on the spectra of these materials.

3.64

Marquardt Corp., Van Nuys, Calif.
DETERMINATION OF SPUTTERING YIELD OF MATERIALS EXPOSED TO DIRECTED HIGH ENERGY CESIUM AND/OR XENON ION BEAMS, E. T. Pitkin. Project 7116(801A), Contract AF 33(616)-8120; AEM, ARL.

Experiments are to be conducted to determine the sputtering yield of various metallic and non-metallic material surfaces exposed to directed high energy cesium and/or xenon ion beams. Sputtering yields are determined as functions of kinetic energy of impinging ions, angle of incidence of the ion beam, and surface material. Accompanying secondary electron emission is being determined.

3.65

Martin, Glenn L., Co., Baltimore, Md.
EFFECT OF SURFACE FILMS ON THE MECHANICAL PROPERTIES OF METALS, I. R. Kramer. Project 7353(802A), Contract AF 33(616)-7976; ASD, ASRC.

The purpose of the continuation of this program is to investigate the role of surface active agents on the physical and chemical behavior of solid materials, and to investigate the phenomenology of surface sensitivity of the inelastic properties of metal single crystals to provide useful knowledge concerning the mechanisms of strain hardening and fracture. Work in progress has shown that the surface sensitivity of a metal to the surface active agents changes the deformation characteristics of face-centered cubic metals, e.g., Al, Cu. The phenomenon appears to be controlled by the rate of dissolution of the metal and the solubility limit of the metal soap in the surface active agent.

3.66

Massachusetts Inst. of Tech., Cambridge.
PHOTOCATALYZED DECOMPOSITION OF WATER AND THE ELECTRON TRANSFER PROCESS IN ORGANIC COMPOUNDS, L. J. Heidt. Project 6694(750F), Contract AF 19(604)-5712; CRZA, AFCRL.

The investigation is a study of the production of hydrogen and oxygen from aqueous solutions containing photocatalytic agents. The research has been directed toward

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the elucidation of the chemical mechanism. An increase in the production of hydrogen from the ferrous system has been obtained by decreasing the pH of the initial solution. The mechanisms of inter and intramolecular electron transfer in organic compounds are currently being studied. The investigation includes the study of the changes of the absorption spectra of the organic species with substituents, positions of substituents, solvent effects, temperature, etc.

3.67

McMaster U. (Canada).
SOLUTION IN NON-AQUEOUS SOLVENTS, R. J. Gillespie. Project 9761(802A), Grant AF-AFOSR-62-21; SRC,AFOSR.

The objectives are to obtain information on the ionization of electrolytes, on solvent-solute interactions (i.e. solvation) and other factors contributing to non-ideality, on proton-transfer processes such as are involved in the mechanism of conduction of the H_3O and OH^- ions in water and in the ionization of acids and bases, and generally on the "structures" of such solvents and their solutions. It is proposed to obtain this information by studies of electrical conductivities, freezing-point depressions, viscosities, densities, and chemical shifts in proton magnetic resonance spectra. Further measurements on solutions solvents such as anhydrous hydrogen fluoride, difluorophosphoric acid, perchloric acid, fluorosulfuric acid, and nitric acid are proposed. The second aspect of the work is the use of non-aqueous solvents for the study of new molecular and ionic species, and for carrying out reactions of easily hydrolysed, highly oxidizing, or otherwise reactive substances. A third aspect of the work is to study and if possible measure the very great proton availability of anhydrous-acids and solutions in such acids.

3.68

Mellon Inst. of Industrial Research, Pittsburgh, Pa.
STATISTICAL PROBLEMS IN PHYSICAL CHEMISTRY, B. D. Coleman. Project 9760(802A), Contract AF 49(638)-541; SRC, AFOSR.

The following problems are being considered: (1) mechanical breakdown phenomena; (2) stochastic processes and nucleation theory; and (3) problems in polymer chemistry. (1) the theoretical work is concerned with the calculation, using the recent generalizations of the theory, of the distribution of lifetimes for individual filaments and for filament bundles under various time-dependent loads; (2) a study will be made of the nucleation of phase transitions to develop a mathematical description of the process; (3) an investigation of theoretical problems connected with the thermodynamics of dilute solutions of high polymers is being made; and (4) theories of simple fluids and viscoelastic fluids have been formulated and are being tested.

3.69

Michigan U., Ann Arbor.
MOLECULAR FRAGMENTS IN SHOCK WAVES, R. S. Berry. Project 9760(802A), Contract AF 49(638)-538; SRC, AFOSR.

This project was directed toward observing and characterizing certain chemical species which are present in gases at temperatures beyond those attainable with furnaces by the use of shock wave techniques. Information about these species should deepen our understanding of the interaction of electrons with atoms, and of the chemical bond itself. The systems studied were alkali halides, and boron compounds.

3.70

Michigan U., Ann Arbor.
PROCESSES OCCURRING IN LUMINOUS SHOCK WAVE IN GASES, O. LaPorte. Project 9767(803A), Contract AF 49(638)-439; SRPP, AFOSR.

The object of this research is to investigate the properties of gases at high temperature and pressure using a shock tube. The properties of the gas are being studied by observing the spectrum of the radiation and how it changes with respect to position along the tube and time. The degree of ionization, the shock velocities for different gas compositions and the general dynamical properties of ionized gases are also among the things being studied.

3.71

Michigan U., Ann Arbor.
STIRRED FLOW REACTOR TECHNIQUE IN HETEROGENEOUS CATALYSIS; G: Parravano. Project 9763(802A), Contract AF 49(638)-606y SRC; AFOSR:

The experimental determination of the kinetics of heterogeneous catalytic reactions is the most powerful method for studying the nature and mechanism of heterogeneous catalysis. Such a study of catalytic reaction provides a relationship between the extent of conversion and pressure, temperature, composition and contact time, the purpose being to establish a rate equation which will represent the experimental data. For many catalytic reactions the experimental data obtained with a standard flow reactor would be of little value in producing fundamental information. These difficulties are overcome by the use of the stirred flow reactor. A small stirred flow reactor to carry out kinetic investigations of selected heterogeneous catalytic reactions has been designed and constructed. Polymerization studies of hydrocarbons and electrolyses reactions are underway.

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3.72

Milan U. (Italy).
METAL CORROSION, G. Bianchi. Project 9761(802A), Contract AF 61(052)-260; SRC, AFOSR.

Electrochemical processes basic to corrosion phenomena are here under close scrutiny. Oxygen and hydrogen-peroxide reactions with non-metals, metals and metal oxides are being studied, including interactions of electrochemical processes with reactions of oxidising solutions.

3.73

Minneapolis-Honeywell Regulator Co., Hopkins, Minn.
PROPERTIES OF SINGLE CRYSTAL TELLURIUM, A. Nussbaum. Project 9760(802A), Contract AF 49(638)-908; SRPS, AFOSR.

Exceptionally large and perfect crystals of tellurium which are suitable for a meaningful study of structure sensitive properties have been prepared. The objective of this research is to elucidate the physical optical and electrical properties of tellurium under a co-ordinated program whose aim is to understand the behavior of charge carriers and the interaction of these carriers with applied electrical, optical, and thermal energy and with imperfections in the lattice. The initial problem with tellurium is the one of dislocations and surface imperfections. It is therefore necessary to explore the nature and extent of these irregularities in the lattice. The electrical properties of significance include the resistivity, Hall coefficient, and magnetoresistivity over an extended temperature range. The optical work will proceed along three main lines, measurement of absorption coefficient, interpretation of photoconductivity spectral response, and determination of minority carrier lifetime by photoconductive decay.

3.74

Minnesota U., Minneapolis.
NON-RADIATIVE ELECTRON TRANSFER IN ORGANIC LIQUIDS, S. Lipsky. Project 6694(750F), Contract AF 19(604)-8356; CRZA, AFCRL.

The work of the contract is concerned with the study of non-radiative electronic energy transfer in organic liquids of high donor concentration. Experiments include: (1) the determination of self-quenching constants for benzene, ortho-xylene and phenylcyclohexane from approximately 10^{-2}M (in cyclohexane or hexane) to pure liquid; (2) transfer rate constant measurements of the three aforementioned liquids to suitable "acceptors" such as p-terphenyl, biphenyl and biphenyloxazole; (3) oxygen quenching constants for the above series of solutions; and (4) the quenching of electronic energy transfer in organic liquids. The solvent is a benzene-cyclohexane mixture and the quenchers are dibromomethane and bromobenzene.

3.75

Minnesota U., Minneapolis.
PROPERTIES OF INHOMOGENEOUS SYSTEMS, S. Prager. Project 9760(802A), Contract AF 49(638)-720; SRC, AFOSR.

This research is concerned with the calculation of the bulk behavior of systems whose local properties vary from point to point, to establish bulk elastic constants for composite materials and to calculate the viscosity of inhomogeneous liquids and rate of reactions occurring in emulsions or catalyst beds. New procedures will be developed for obtaining molecular orbitals and the calculations will be extended to polyelectronic molecules.

3.76

Mississippi U., Oxford.
SPECTROPHOTOMETRIC AND NON-SPECTROPHOTOMETRIC STUDIES OF SOLUTIONS, P.A.D. De Maine. Project 9763(802A), Grant AF-AFOSR-62-19; SRC, AFOSR.

The investigator has proven that there is a sharp contradiction to accepted notions reported frequently in the literature. This clearly indicates that the prevalent views about the effect of dielectric constant on absorption bands in the ultra-violet and infrared spectral regions are without adequate foundation. His new qualitative theory appears to explain these data, without contradicting the basic laws of electromagnetics. The results of many other investigators also appear to support this theory. He proposes the careful re-examination of suitable systems, previously studied by spectroscopic methods, simultaneously by non-spectrophotometric and spectrophotometric methods. The second step will be to examine the new data with special reference to recent spectroscopic theories about complex formation.

3.77

National Bureau of Standards, Washington, D. C.
STUDY OF ELECTROCHEMICAL PHENOMENA AT AN ELECTRODE BY MEANS OF NEGATIVE PRESSURE OF LIQUIDS, A. Brenner. Project 7353(802A), Contract AF 33(616)-6107; ASRC, ASD.

The phenomena of negative pressure of liquids shall be employed in electrochemical studies to investigate various electrode processes such as potential for bubble formation and the kinetics of electrode processes or bubble formation.

3.78

New York U., N. Y.
GAS DISCHARGE PHENOMENA, L. Bornstein. Project 9767

ARL- Aeronautical Research Laboratories
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(803A), Contract AF 49(638)-943; SRPP, AFOSR.

This work involves research on the dissociation and recombination of atomic hydrogen. Also included is an investigation of the Franck-Carlo process which allows for the production of atomic hydrogen by photodissociation through a secondary process. This process is at present of some interest to upper atmospheric research because it represents a means of producing atomic hydrogen by the use of solar ultra-violet and can therefore be used in satellites, without need for power supplies, as a Lyman-alpha detector. Work will be extended to atomic oxygen and nitrogen and to the investigation of optical and electronic pumping schemes.

3.79

New York U., N. Y.
FORCES IN HYDROGEN BONDING, E. S. Campbell. Project 9760(802A), Contract AF 49(638)-969; SRC, AFOSR.

The electrostatic interactions between water molecules constitute an important part of the hydrogen bonding in ice crystals. Those interactions will be calculated on the basis of the charge distribution obtained through quantum mechanics using a recently recognized valid model for electron density.

3.80

New York U., N. Y.
PHOTOVOLTAIC EFFECTS IN CADMIUM SULFIDE CRYSTALS, H. Kallmann. Project 6694(750F), Contract AF 19(604)-5495; CRZA, AFCRL.

A comprehensive study of photovoltaic effects in various phosphors is being performed, notably doped zinc-cadmium sulfide powders. Absorption and fluorescence data are correlated with spectral dependence of photovoltaic activity in an analysis of the processes which are involved in the generation of electricity by optical excitation of charge carriers. Measurements are made on evaporated layers of varying composition, thickness and shape.

3.81

Northwestern U., Evanston, Ill.
HETEROGENEOUS CATALYSIS IN LIQUID SYSTEMS, R. L. Burwell. Project 9761(802A), Contract AF 49(638)-935; SRC, AFOSR.

The studies in heterogeneous catalysis in the liquid phase can make marked contributions to the development of the overall theory of catalysis. Studies in liquid phase reactions offer two prospects. First, the application to the liquid phase of existing theoretical knowledge derived from vapor phase studies. Second, the extension of existing theoretical knowledge of the relationship among kinetics, stereochemistry structural variations and isotopic exchange.

3.82

Northwestern U., Evanston, Ill.
MONOENERGETIC PHOTOLYTIC REACTIONS, E. W. Schlag. Project 9760(802A), Grant AF-AFOSR-62-84; SRC, AFOSR.

It is planned to study the various uni- and bimolecular reactions for such molecules as isobutene in which free radical effects would probably not play such an important role, particularly at low temperature. Another area in which it is anticipated to initiate work is the study of the decomposition of photo-excited molecules from their threshold energies to successively shorter wavelengths and as a function of pressure and temperature. This should give us detailed information of the specific reaction rates of excited states in relation to the stabilizing transitions.

3.83

Northwestern U., Evanston, Ill.
MEASUREMENT OF GAS VISCOSITY UP TO 1000 ATMOSPHERES, G. Thodos. Project 9750(801A), Contract AF 49(638)-891; SREP, AFOSR.

An apparatus has been constructed for the measurement of gas viscosities at high pressures by the capillary tube method. Measurements of viscosities of gases, particularly the first few members of homologous series, will be made in order to determine the parameters in semi-theoretical equations, such as derived by Chapman, Hirschfelder, and others. The calculation of transport properties in general (thermal conductivity and diffusion coefficients as well as viscosity) will be greatly improved by such experimental measurements. Based on some results previously obtained with NH_3 in this apparatus, Dr. Thodos has devised an excellent semi-empirical relationship between viscosity and density. The proposed experiments will help test the general validity of this predicting relationship.

3.84

Norwegian Defense Research Establishment, Oslo (Norway).
SELF-DIFFUSION IN LIQUIDS, B. Otter. Project 7013 (801A), Contract AF 61(052)-343; ARC, ARL.

Preliminary measurements have been made on the self-diffusion coefficients of benzene and n-hexane, and on the mutual diffusion coefficient of binary mixtures of these compounds, at 25°C. The measurements were made by diffusion of deuterium-labelled compounds from a capillary into a surrounding non-labelled bulk of liquid for a measured period of time. Composition of the material in the capillary after diffusion was determined by micro-densitometry,

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using an electromagnetic float.

3.85

Nottingham U. (Gt. Brit.).
KINETICS OF INTERFACIAL TRANSFER PROCESSES IN AQUEOUS-NON-AQUEOUS LIQUID SYSTEMS, D. G. Tuck. Project 7023 (802A), Grant AF-EOAR-62-53; ARC, ARL.

The contractor shall study the kinetics of transfer of species in two phase liquid systems. Some of the systems to be studied shall include water, tri-n-butyl phosphate; nitric acid, tri-n-butyl phosphate; iodine, carbon tetrachloride, water; chromium (VI) organic - iron (II) redox.

3.86

Ohio State U. Research Foundation, Columbus.
PHOTOSENSITIZED REACTIONS, J. G. Calvert. Project 6694(750F), Contract AF 19(604)-6644; CRZA, AFCRL.

The investigation is a study of the basic mechanism of the formation of hydrogen peroxide from oxygen and water in the presence of photosensitizers. The photosensitizers are cadmium sulfide, cadmium selenide, and cadmium telluride. Preliminary results have shown that the quantum efficiency of hydrogen peroxide formation in the CdS-O_2-H_2O system is significantly higher in runs of short duration than in extended runs. Promising results have been obtained with cadmium telluride but not with cadmium selenide. Emphasis is now being placed on the study of the semiconducting properties of these photocatalysts. The determination of the Hall effect parameters on these crystals is now being studied.

3.87

Oklahoma U. Research Foundation, Norman.
OPTICAL RELAXATION OF EXCITED ATOMS, R. Fowler. Project 9751(801A), Contract AF 49(638)-639; SRPP, AFOSR.

Under this project, improved cylindrical light sources excited by electrons moving axially inward have been constructed along with accessory equipment to record and analyse the optical emission of excited gases during the relaxation processes after excitation of the gases is removed. A quantitative comparison of decay processes in the millimicrosecond region will be made also in the overlap region of relaxation times in the fractional millimicrosecond region where line broadening techniques apply. Theories developed will be applied to gas discharges, luminous shock front and plasma decay phenomena in pure and mixed gases. It is expected that new understanding will develop of processes involving persistent afterglow in atmospheric gas constituents where short-lived relaxation processes are followed by metastable excited states. The atomic transition probabilities will also apply to quantum level devices.

3.88

Oklahoma U. Research Inst., Norman.
THEORETICAL DETERMINATION OF OPTICAL EXCITATION CROSS SECTIONS IN ATOMIC GASES, C. C. Lin. Project 9767(803A), Grant AF-AFOSR-62-66; SRPP, AFOSR.

This is a complementary program to that of St. John at University of Oklahoma and concerns the study of spectra resulting from atomic and molecular collisions. In particular, this research concerns studies of emissions resulting from the direct excitation by electron impact and transfer of excitation to the triplet levels from singlet levels. It is also planned to investigate the transfer mechanisms of excitation among singlet levels. These studies will include an examination of transfer mechanisms creating excited states in gases at elevated temperatures. These latter studies will require extensive modification of existing vacuum and gas handling systems which will be done towards the end of the current grant.

3.89

Oklahoma U. Research Inst., Norman.
OPTICAL EXCITATION CROSS SECTIONS IN ATOMIC COLLISIONS, R. M. St. John. Project 9767(803A), Grant AF-AFOSR-62-67; SRPP, AFOSR.

Magnetic field selection of bombarding electron velocity is being used for accurate measurements of excitation cross-sections of atomic gases. A large-aperture optical system with photomultiplier detector is being used to permit the use of reduced working pressures of the atomic gases corresponding to pressures equivalent to extreme altitudes. Initial studies include light gases and the easily vaporizible elements starting with mercury and sodium. Improved cross-sections for electron-gas collisions and the distribution of secondaries decaying with optical emission transitions are expected from this research. Extreme low pressure range stability is expected.

3.90

Oregon State Coll., Corvallis.
STRUCTURE AND DYNAMICS OF MOLECULES BY ELECTRON DIFFRACTION, K. Hedberg, L. Hedberg. Project 9760(802A), Contract AF 49(638)-783; SRC, AFOSR.

The research is a study of the structure and dynamics of molecules. The vibrational potential functions for molecules in selected environments will be deduced from the fundamental vibrational frequencies obtained from spectroscopic experiments. Research

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ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRME- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAE- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
BSD- Electronics Systems Division
BSBR- Operational Applications Lab

will include studies on nitrogen pentoxide, nitrogen sesquioxide and disiloxane.

3.91

Oregon U., Eugene.
REACTIONS OF NON-POLAR MOLECULES AT POLARIZING SURFACES, L. H. Klemm. Project 9761(802A), Contract AF 49(638)-473; SRC, AFOSR.

This research is a study of the steric relationships between an adsorbed or chemically reacting substrate, such as a polynuclear aromatic hydrocarbon and a polarizing surface. It is planned to gain information on surface geometry of adsorbed molecules by direct studies, in situ, using ultraviolet and infrared spectroscopy and by the indirect methods of correlation of chemical structure with (a) adsorbability in chromatography, (b) rate of reaction and entropy of activation in catalytic hydrogenation, and (c) half-wave reduction potential in polarography.

3.92

Oxford U. (Gt. Brit.).
REACTIONS OF ATOMS AND RADICALS WITH VARIOUS MOLECULES, J. W. Linnett. Project 9751(801A), Grant AF-EOAR-62-6; SREP, AFOSR.

The work is concerned with generation of atomic species and measurement of their recombination rates on various surfaces, and their rates of reaction with certain radicals and molecules in the gas phase. Also, diffusion coefficients for atomic species in molecular gases are being measured. Hydrogen atoms have been generated at 50-60% concentration by electrodeless discharge, and the efficiency of various surfaces for recombination of these atoms has been measured by a temperature probe technique. Using essentially the same methods, a study of the recombination of O atoms in the gas phase has been completed. The kinetics of reaction of O atoms with CO has also been undertaken. Values of diffusion coefficients of O in O_2 have been obtained, but have been disappointly inconsistent, because of an unexpected difficulty in obtaining steady conditions. In further work, both gas phase and surface recombinations have been extensively studied with a wide variety of diluent gas molecules and surfaces. Now some work is also being pursued with the intent of discovering the mechanism of attack by oxygen atoms of metal surfaces.

3.93

Paris Observatory (France).
AURORAL EXCITATIONS, L. Herman. Project 7661(770A), Contract AF 61(052)-17; CRZI, AFCRL.

This work is the study of auroral and night airglow emissions produced in the laboratory. Under controlled conditions the various line and band systems are produced and their excitation conditions determined.

3.94

Pennsylvania State U., University Park.
SURFACE-POTENTIAL BARRIER IN METALS, P. H. Cutler. Project 9763(802A), Grant AF-AFOSR-61-100; SRPS, AFOSR.

This theoretical study will utilize a new 1-dimensional model for the surface potential barrier in metals for the computation and evaluation of the reflection coefficient of low energy electrons incident on a metal surface; the inelastic scattering of slow electrons from metal surfaces; the Fowler-Nordheim current density formula; and the factorization contribution in the Makinson theory of the surface photoelectric effect.

3.95

Pennsylvania State U., University Park.
STUDY OF METAL SURFACES BY THE FIELD EMISSION MICROSCOPE, E. W. Mueller. Project 9761(802A), Contracts AF 18(603)-672, AF 49(638)-504, AF 18(603)-673; SRPS, AFOSR.

The work involves experimental research along the following lines: (1) investigation of the behavior of adsorption layers of non-metals such as H_2, O_2, C, B, Si, S, and H_2S and metals like Al, Fe, Co and Ni on single crystal metal tips of W, Mo, Ta, Nb and Pt with the field emission microscope; (2) study of the diffusion, heat of the activation and surface migration of adsorbed metals at high temperatures plus the subsequent formation of alloys; (3) investigation of the velocity distribution and the polarization of field electron emission; (4) study of the field strength at which the tearing off effect occurs for various adsorbed materials on different metals; (5) study of the temperature influence and possible dependence of optical excitation of the adsorbed atoms; and (6) study of methods for obtaining maximum resolution of the atomic structure of metal surfaces. The field emission microscope is a powerful tool for the investigation of metal surfaces with respect to atomic structure, adsorption, catalysis, and some problems of gas-surface dynamics and radiation damage.

3.96

Pennsylvania State U., University Park.
PHYSICAL PROPERTIES OF ISOTOPICALLY SUBSTITUTED FLUIDS, W. A. Steele. Project 9763(802A), Grant AF-AFOSR-61-27; SRC, AFOSR.

This research concerns a study of the classical theorem of corresponding states predicts that the

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CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
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equilibrium physical properties of a fluid depend only upon the reduced temperature and volume, and not upon molecular mass. Thus, changes in physical properties upon isotopic substitution can often be ascribed to changes in intermolecular potential energy curves. It is proposed to carry out measurements on selected systems in order to obtain quantitative estimates of this change.

3.97

Pennsylvania U., Philadelphia.
MECHANISM OF ELECTRODE REACTION INVOLVING O_2 EVOLUTION OF OXIDE FILM FORMATION, J. Bockris. Project 7353 (802A), Contract AF 33(616)-8150; ASRC, ASD.

The anodic oxidization of oxygen ions to form gaseous molecules or the oxidation of the electrode to form oxide films is to be studied to elucidate the basic mechanism whereby oxygen is evolved at an electrode or incorporated into an anodic film on the electrode. The role of the anions shall be illuminated to provide a basic foundation for subsequent effort of controlling the properties of anodic films by incorporation of solutions components.

3.98

Pennsylvania U., Philadelphia.
MECHANISM OF THE HYDROGEN EVOLUTION REACTION, J. Bockris. Project 7353(802A), Contract AF 33(616)-5681; ASRC, ASD.

An investigation of the mechanism of the evolution of hydrogen and reduction of hydrogen ion, occurring at a metallic cathode, will be conducted to describe on a molecular scale the processes involved by which hydrogen atoms enter metals during electrochemical reactions. The nature of the rate-determining step in these reactions will be established by various critical measurements such as the correlations of the differential hydrogen overvoltage with current density, hydrogen ion concentration, the pressure of hydrogen, respectively, as well as by the use of isotopes. New criteria of mechanism will be devised for the pH range of 3 to 11 where there is little precedent at present. The solutions to be studied will be varied not only with respect to the pH but also with respect to the presence of inert co-reducing cations and various anions in order to study the effect of the latter on the mechanism. The range of electrode materials will include noble, soft, and transition metals under various conditions of surface-treatment to determine the surface-chemical factors that affect the electrode reaction.

3.99

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
PHOTOCHEMICAL PROCESSES, R. E. Huffman. Project 7635(770A), Internal.

Laboratory determination of total cross sections of atmospheric gases for absorption of simulated solar radiation throughout the vacuum ultraviolet region but principally in the "windowless" region below 1100Å. This will be done using wavelength continuous (continuum) light sources which are necessarily being developed as the initial phase of this study. Application of similar techniques to the study of atomic oxygen and atomic nitrogen processes with particular emphasis on excited states of reactants and products. Determination of ionization cross sections and continued development of light sources for spectroscopy and photochemical investigations.

3.100

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
ION DISSOCIATION AND CHARGE CHANGING COLLISION STUDIES, W. W. Hunt. Project 7635(770A), Internal.

Unimolecular and collision induced ion dissociations and charge transfer processes are studied in a time-of-flight apparatus in which the ions are produced either by photon or electron bombardment. Specific rate constants for dissociation are measured as a function of ionizing energy and charge transfer cross sections measured as a function of incident ion energy. Equipment is now in partial operation, and preliminary measurements have been made of the charge transfer cross section of N_2^+ in N_2 at 2700 volts.

3.101

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
ION-MOLECULE REACTIONS, J. F. Paulson. Project 7635(770A), Internal.

Reactions among those ions and molecules expected to exist in normal or artificially perturbed atmospheres will be studied. Such reactions include the excitation or ionization process itself, subsequent charge exchange or de-excitation, and synthetic reactions occurring in mixtures of ions, radicals, and neutral molecules. A mass spectrometer will be used to study the reactions between low energy ions and neutral species. Reaction cross sections, charge exchange and total scattering cross sections will be measured for low energy ions. Photoionization and photolysis techniques will be used in order to differentiate between reactions resulting from ion-neutral and neutral-neutral interactions in systems containing both species.

3.102

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
PHOTOEXCITATION MECHANISMS, K. P. Quinlan. Project 6694(750F), Internal.

The study is concerned primarily with the basic mechanisms of the photogalvanic effect. Research

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ESKR- Operational Applications Lab

is currently being carried out on the photosensitized thionine-ferrous system. Polarographic investigations on purified thionine alone and in the presence of ferrous ion will help to clarify the part that complexation plays in the mechanism. It is hoped that these results and those previously obtained will lead to a better understanding of photogalvanic systems and to the development of a practical energy converter. Other systems, e.g. zinc oxide, dyes, chlorophyll, etc. which exhibit the photogalvanic effect will also be investigated. Studies of the charge transfer phenomenon, potentials of excited states, light sensitive electrodes and sensitization of electrode material by adsorption of dyes will be undertaken.

3.103

Photochemistry Lab., CR2, AFCRL, Bedford, Mass.
STRUCTURE OF ATMOSPHERIC GAS MOLECULES, Y. Tanaka. Project 8627(804A), Internal.

This research is primarily concerned with the structure of atmospheric gas molecules such as O_2, N_2, NO, NO_2, H_2O, CO, CO_2, O_2 and others. The purpose is to uncover basic, fundamental knowledge concerning the internal structure of the molecules of which the atmosphere is composed; this involves the investigation of such properties and characteristics of atoms and molecules such as energy states, perturbations of states, electron transitions, transition probabilities, etc. Many new energy states have been discovered for nitrogen, and the related potential curves have been derived. An extensive study is now underway concerning the nature and characteristics of the spectra of the other atmospheric gas molecules.

3.104

Physics, Engineering and Chemistry (P.E.C.) Corp., Boulder, Colo.
THE PHOTOCHEMICAL DECOMPOSITION OF WATER, R. E. West. Project 6694(750F), Contract AF 19(604)-8420; CRZA, AFCRL.

The objective of this research is to improve the efficiency of the utilization of solar energy by the decomposition of water into hydrogen and oxygen. The photochemical decomposition of water is carried out in the presence of certain metallic cations, e.g. ferrous and ceric. The current investigation includes a thorough survey of metallic ions and other sensitizing materials (dyes) for this decomposition. The following parameters will be studied: Temperature, various materials for possible catalytic activity, absence of oxygen, various wavelengths, and control of the redox potential during irradiation. Correlations of the quantum yield of gas with the various parameters are being sought. These studies should lead to a better understanding of the mechanism of the reactions and to the development of better sensitizers.

3.105

Pittsburgh U., Pa.
STRUCTURE OF CRYSTALLINE HYDRATES, G. A. Jeffrey. Project 9760(802A), Contract AF 49(638)-456; SRC, AFOSR.

The objective of the research is to obtain a more complete understanding of the ways in which water molecules can form crystalline structures with organic ions or molecules. Structure of these compounds will be determined by x-ray analysis in order to provide a basis for an exploration of their existence as stable crystals in terms of structure and chemical binding. Another objective is to study possible correlations between the water structure in these compounds and those in other systems not necessarily stable. Alkyl ammonium and sulfonium ion hydrates are the substances being studied.

3.106

Pittsburgh U., Pa.
EXCITED STATES, J. Rosenberg. Project 6694(750F), Contract AF 19(604)-8354; CRZA, AFCRL.

The research is a survey of the role of charge transfer in the photochemistry of some simple inorganic systems and of several aspects of fluorescence quenching in organic dyes. The contract activity includes searches for such intermediates of the type I $(H_2O)^-$ or Fe^{+3} (H_2O^-) in the flash photolysis of I^- or Fe^{2+} respectively. Such information will be necessary in the establishment of the mechanism of electron transfer reactions. In the case of the organic dyes, the fate of electronic excitation energy in a poly-component system can be followed in part by observing fluorescence quenching. Since the nature of the quenching act itself is not well understood, studies will be performed to determine whether self-quenching results from charge transfer between like molecules, from induced singlet-triplet transitions, or from some other physical process. Another quenching process which will be studied is sensitized fluorescence.

3.107

Polytechnic Inst. of Brooklyn, N. Y.
RELATION OF CHEMICAL COMPOSITION, STRUCTURE AND PHYSICAL ENVIRONMENT TO VISCOSITY, THERMAL CONDUCTIVITY & DIFFUSION, F. C. Collins. Project 7013(801A), Contract AF 33(616)-3894; ARL, ARC.

Theoretical research is being conducted on the molecular interpretation and explanation for the viscosity and thermal conductivity of liquids. The central concept of this work is that the instantaneous mean velocity of the molecules in a fluid, rather than the classical idea of time-averaged forces,

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can be made the basis for correlating and predicting its transport properties. It has been shown that the time-averaged force is proportional to the mean velocity and that each transport property can be analysed by use of a proper theoretical constant of proportionality which leads to a corresponding time-averaged force. In the limit of vanishing mean velocities, this approach leads to kinetic expressions identical with those of more conventional theories, but at higher velocities this is not so. It appears that macroscopic transport coefficients predicted from the new procedure are often in better consonance with experimental data than estimates made in other ways.

3.108

Polytechnic Inst. of Brooklyn, N. Y.
ADSORPTION OF HIGH POLYMERS, F. R. Eirich. Project 9761(802A), Contract AF 49(638)-331; SRC, AFOSR.

This is an investigation of the adsorption of high polymers in which such phenomena as multiple chain adsorption, layer thickness effects and non-localised, non-counterionic, non-Van-der-Waal's forces are considered. A study of the implications of molecular structures capable of forming complex bonds with metallic or polar surfaces is included.

3.109

Polytechnic Inst. of Brooklyn, N. Y.
CHEMICAL REACTIONS OF ELECTRONICALLY EXCITED MOLECULES, R. A. Marcus. Project 9760(802A), Contract AF 49(638)-772; SRC, AFOSR.

This is an investigation of the chemical reactions of electronically-excited molecules. The study makes use of special conditions of flash photolysis. In chemical reactions of excited molecules with added gases, the excited molecules are produced when light is absorbed. Specifically, the photochemical reaction of electron deficient compounds and short-lived intermediates occurring in gaseous boron hydrides will be studied. Reactions of other excited molecules, formed by photolysis, with added oxygen, hydrocarbons and other gases will be investigated.

3.110

Polytechnic Institute of Brooklyn, N. Y.
FREQUENCY RESPONSE OF THE ADSORPTION ON SOLID CATALYSTS, L. M. Naphtali. Project 9763(802A), Contract AF 49(638)-337; SRC, AFOSR.

This research involves a study of the effect of cyclic variations in pressure on the adsorption of gases on a solid catalyst surface. The influence of changes of frequency of the variations will be determined. This is a new approach to the study of catalysts: the separate study of different types of catalytically active areas in one catalyst.

3.111

Polytechnic Inst. of Brooklyn, N. Y.
PHOTOCHEMICAL REACTIONS IN PLASTICS, G. Oster. Project 9760(802A), Contract AF 49(638)-293; SRC, AFOSR.

This research undertakes a systematic study of the ultraviolet photochemistry of plastics, particularly polyethylene, with the addition of certain ultraviolet absorbing substances. It will determine the effects of ultraviolet light on the internal viscosity of plastics and the extent of chemical reactions of substances incorporated in the plastic.

3.112

Politechnico di Milano (Italy).
HYDROGEN EVOLUTION, R. Piontelli. Project 7353(802A), Contract AF 61(052)-144; ASRC, ASD.

The electrochemical evolution of hydrogen from metal cathodes is being studied as a function of crystallographic orientation. Various metals from the three groups: noble, transition, and soft are to be studied on their major crystal planes in various electrolyses employing high purity techniques. Work is in progress on Zn, Cd, and Ni and essentially completed on Sn crystals.

3.113

Princeton U., N. J.
KINETICS AND MECHANISM OF ELECTROLYTIC FILM FORMATION REACTIONS, C. G. Enke. Project 9761(802A), Contract AF 49(638)-973; SRC, AFOSR.

This research involves an attack on the general problem of electrolytic film formation and film-electrode interactions, using relaxation methods of electrochemistry and taking as specific points of departure silver chloride film on silver and the kinetics of exchanges on platinum, as affected by surface oxidation.

3.114

Princeton U., N. J.
PHOTONOMETRIC TITRATIONS, C. Enke. Project 9763(802A), Contract AF 49(638)-467; SRC, AFOSR.

An investigation of the reaction that is promoted by the absorption of the energy from the photon, and a study of the mechanism of the photolysis reaction. Photonometric titrations of other photosensitive systems will be investigated, as well as the use of gamma-emitting isotopes as a substitute for the ultraviolet radiations.

3.115

Purdue U., Lafayette, Ind.

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AEDC- Arnold Engineering Development Center
AEOR- Research Division
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APGC- Air Proving Ground Center
PGMR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

SYMPOSIUM ON HIGH TEMPERATURE SOLUTION CHEMISTRY, J. W. Cobble. Project 9760(802A), Grant AF-AFOSR-62-161; SRC, AFOSR.

The following topics will be covered: (a) conductivity and hydration numbers of electrolytes in super-heated steam; (b) high temperature solution equilibria; (c) thermodynamic properties of ions up to 200°C.; (d) heat capacities of electrolytes by the integral heat method; and (e) limiting law for conductivities above 100°C and others.

3.116

Rensselaer Polytechnic Inst., Troy, N. Y.
FUNDAMENTAL ATOM CHEMISTRY - SURFACE - CATALYZED EXCITATION, P. Harteck. Project 9763(802A), Contract AF 49(638)-928; SRC, AFOSR.

The object of this research is to conduct a comprehensive and detailed investigation of the nature of surface-catalysed excitation. A systematic evaluation of specific surfaces suitable for SCE for example Ag, Ni and Co will be studied in mixed streams of N- and O-atoms. The exact role of the surface will be evaluated by the use of X-rays and electron probes. This research is not connected with ordinary discharge effect, coronas, or plasma type excitation. The surfaces are essentially cold and experiments have been made where the surfaces have been maintained below room temperature. It should help to explain many phenomena of catalysis in general and be of great help in the study of atom reactions and the kinetics of excited species.

3.117

Rensselaer Polytechnic Inst., Troy, N.Y.
STRUCTURE AND PROPERTIES OF MOLTEN SALTS, G. J. Janz. Project 9760(802A), Contract AF 49(638)-978; SRC, AFOSR.

This is a study of ion-ion and ion-molecule interactions in molten salts, in order to clarify unsatisfactory theory of conductance, viscous flow and fusion, as well as build our general understanding of these substances.

3.118

RIAS, Inc., Baltimore, Md.
PHYSICAL AND CHEMICAL PROPERTIES OF COMPLEX MOLECULES AT SURFACES, R. H. Aranow. Project 9761(802A), Contract AF 49(638)-735; SRC, AFOSR.

The investigation concerns the properties of long chain hydrocarbon molecules and their behavior at surfaces. Micellar systems, the clusters of complex molecules in colloids, for cases just above the critical micelle concentration will be studied. Detailed study is also being made of the expansion patterns of protein monolayers. This is related to fluid instability, occurring commonly with bulk fluids.

3.119

Rochester U., N. Y.
PHOTOCHEMICAL PROCESS IN COMPLEX MOLECULES, W. A. Noyes. Project 9760(802A), Contract AF 49(638)-679; SRC, AFOSR.

This study is concerned with the primary photochemical dissociation of several complex molecules. The dissociation products will be identified, an attempt will be made to understand the mechanism by which the photochemical reactions take place, rate constants will be determined, and a systematic study of the energy transfer in the polyatomic molecules will be done.

3.120

Royal Inst. of Tech. (Sweden).
HYDROLYSIS EQUILIBRIA OF IONS, L. G. Sillen. Project 9760(802A), Contract AF 61(052)-162; SRC, AFOSR.

The investigation aims at discovering the species and equilibria involved in the hydrolysis of cations and anions in aqueous solution. The research includes x-ray crystal structure work on hydroxide salts, study of molybdate and wolframate systems by spectrophotometric methods, and a calorimetric study of hydrolysis reactions.

3.121

Royal Inst. of Tech., Stockholm (Sweden).
SPECIES OF THE TRANSITION ELEMENTS IN SOLUTIONS, L. G. Sillen. Project 6694(750F), Contract AF 61(052)-417; CRZA, AFCRL.

The objective of this investigation is a study of the chemistry of transition elements which may possibly be used as photocatalysts. A study of the equilibra and spectra of the species formed in aqueous solutions is being undertaken. The investigation is primarily concerned with the chemistry of rhodium and ruthenium. Methods for the preparation and analysis of certain oxidation states of each element have been attained. Hydrolysis constants of these oxidation states are being sought (Rh(III) and Ru(IV)). Similar studies with palladium have been initiated.

3.122

Sheffield U. (Gt. Brit.).
LOW LEVEL EXCITATION AND ENERGY TRANSFER, G. Porter. Project 6694(750F), Contract AF 61(052)-32; CRZA, AFCRL.

Study the radiationless transitions in certain molecules where the triplet state is known and seek the triplet

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state spectra in simpler molecules. These investigations are being carried out both in the gas phase and in solution and the effects of additives such as paramagnetic gases and ions are also being studied insofar as they may contribute to an understanding of the mechanism. The kinetics of triplet conversion are being studied by flash photolysis and photoelectric spectrometry. The search for triplet states of simpler molecules will involve low temperature phosphorescence studies and the probable extension of flash photolysis techniques into the vacuum ultra-violet region.

3.123

Southampton U. (Gt. Brit.).
ELECTRONICALLY EXCITED STATES OF ORGANIC MOLECULES AND THEIR REACTIONS, R. C. Cookson. Project 6694(750F), Contract AF 61(052)-191; CRZA, AFCRL.

The objective of this research is an examination of the photochemical transformations of unsaturated systems which might lead to high-energy compounds (where the excess energy is in the form of bond strain or rehybridization of some of the atoms, rather than in unstable free atoms, radicals, ions, or long-lived excited states). The research includes an investigation of electronic interaction between unconjugated chromophores in the ultraviolet absorption spectra of organic compounds, especially those that seem to be due to charge transfer. The extent of interaction, measured by the frequency and intensity of the absorption maximum, is examined as a function of the electronic and geometrical arrangement of the interacting electron systems.

3.124

Stanford U., Calif.
MACROMOLECULAR RESEARCH, P. Flory. Project 9763(802A), Grant AF-AFOSR-62-131; SRC, AFOSR.

A program will be conducted on macromolecular research. The theory of network elasticity will be investigated along three main postulates: (a) that the chains may be treated as independent entities which contribute additively to the elastic free energy; (b) that the chain vector probability distribution is adequately represented by the Gaussian function; and (c) that the displacement of network functions is affine with respect to the macroscopic deformation. The crystalline state in polymers will be examined so as to correlate morphology and stability with crystallization conditions. A study of the processes of mechanochemical transformations in polymeric materials will be investigated. This offers possibilities for conversion of chemical to mechanical energy. This research will contribute in our polymeric material program as to crystalline structure, deformation, fatigue and chemical and mechanical energy of macromolecules.

3.125

Stanford U., Calif.
STRUCTURE OF LIQUIDS, C. Pings. Project 9760(802A), Contract AF 49(638)-469; SRC, AFOSR.

This is an investigation by x-ray and neutron diffraction of the structure of liquids using argon, neon, nitrogen, methane and water, simple substances whose temperature ranges require complicated equipment. The radial distribution function is being determined as a function of thermodynamic state, giving special emphasis to detailed studies near the regions of the critical state and phase boundaries.

3.126

Syracuse U., N. Y.
MOLECULAR VIBRATIONS IN LIQUIDS, E. Fishman. Project 9760(802A), Contract AF 49(638)-3; SRC, AFOSR.

This is a study of the transfer of vibrational energy within and between molecules in liquids. Theoretical work will be undertaken to evaluate the magnitude of the terms in the approximate calculation of spectral frequency shifts as a function of intermolecular forces and to carry out detailed calculations for each type of intermolecular force. Carbonyl and nitride compounds are being studied.

3.127

Technical U., Trondheim (Norway).
MOLECULAR STRUCTURES BY GAS PHASE ELECTRON DIFFRACTION, O. Bastiansen. Project 9760(802A), Contract AF 61(052)-72; SRC, AFOSR.

Precision measurements of carbon-carbon bond distances as a function of the environment of the carbon atoms, precise structural studies of larger aromatic molecules, and the accurate positioning of hydrogen atoms in organic molecules are being made by electron diffraction studies.

3.128

Technion Research and Development Foundation (Israel).
MICROWAVE STUDIES OF ADSORBED MOLECULES, M. Folman. Project 7022(802A), Contract AF 61(052)-308; ARC, AEL.

Research on the properties of adsorbed molecules is under way using microwave spectroscopy. Observations are made with ammonia adsorbed on porous Vycor glass, the measurements being performed in the 1 cm wavelength region. It is hoped to ascertain how the inversional vibration of the ammonia molecule is affected in the adsorbed state. Later work will be extended to

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RAE- Directorate of Engineering
RAEA- Advanced Development Lab
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AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
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other polar molecules with pure rotational spectra in the microwave region. The objective of the study is to advance microwave spectroscopy as a tool to study the nature of adsorbed species.

3.129

Technische Hochschule, Munich (Germany).
HYDROGEN EVOLUTION, O. Kandler. Project 7353(802A), Contract AF 61(052)-305; ASRC, ASD.

The general area of the mechanism of hydrogen reaction at metallic surfaces shall be studied by using pulse techniques to investigate the types and extent of surface layers present and the effects of these on the hydrogen reaction at metal-solution interfaces. Among the factors to be considered are the effects of foreign atoms or ions, the effects of extensive solution clean up, the effects of electrode surface treatment, both anodic and cathodic conditions, and the effects of prior hydrogen penetration into the electrodes. Previous work has emphasized the noble metals, current work will emphasize Fe, Cd, Zn, Ti, Ni. Initial results on platinum have established the potential regions over which the various surface layers are stable, and the extent of surface coverages. The rate of formation and destruction of these layers has established that the adsorption of hydrogen or oxygen on platinum is irreversible.

3.130

Texas A and M Research Foundation, College Station.
ELECTRONIC SPECTRA OF SIMPLE MOLECULES AND VACUUM ULTRAVIOLET, J. B. Coon. Project 9751(801A), Contract AF 49(638)-816; SRPP, AFOSR.

This work will consist of the study of the absorption spectra of selected polyatomic molecules such as H_2O, D_2O, H_3, Nd_3, H_2, CO_2 and C_2H_4 in the region from 1000 to 2000 Angstroms. These data will be correlated with current theories of molecular structure and calculations concerning these shapes of the potential energy function will be carried out.

3.131

Texas A and M Research Foundation, College Station.
VIBRATIONAL STRUCTURE OF THE ELECTRONIC SPECTRA OF MOLECULES, J. B. Coon. Project 9751(801A), Contract AF 49(638)-593; SRPP, AFOSR.

This project deals with experimental and theoretical studies of the excited electronic states and electronic transitions of simple polyatomic molecules. The characteristics of interest are the oscillator strengths, polarizability and symmetry. The experimental work will be done by means of near-ultraviolet, and visible spectroscopy. The results of the analysis of these spectra will be used to verify the theoretical work. Of special interest will be the cases of double-minimum potentials and the improvement of application of the Franck-Condon principle.

3.132

Tufts U., Medford, Mass.
SOLID STATE SURFACES CONTAINING ADSORBED MOLECULES, M. K. Wilson. Project 5620(802A), Contract AF 19 (604)-4063; CRR, AFCRL.

The long-range objective of this research is to use infrared spectrometry as a tool for studying gases adsorbed on surfaces in an attempt to understand the forces present at the surfaces of solids. These forces are being explored through the effect they have upon the vibrational spectra of adsorbed molecules. The major efforts to date have been in modifying spectrometers for use with solid samples at various temperatures. An external source unit for a prism-grating spectrophotometer has been constructed and tested and the spectrophotometer is being converted to full grating operation. Because of the interest in the germanium-hydrogen system, considerable time has been spent trying to understand the shift of Ge-H stretching and bending frequencies caused by changes in the environment. The relatively simple series of compounds GeH_4, $GeCl_4$, and the partially chlorinated species have been subjected to detailed normal coordinate analyses with both valence-bond and Urey-Bradley type force fields. This work is virtually completed. Considerable work has been done on producing GeO_2 gels which appear to be similar in character to silica gels with the additional virtue that they are transparent to much lower frequencies in the infrared.

3.133

Universitets Kjemiske Institutt, Blindern (Norway).
MOLECULAR STRUCTURES, O. Hassel. Project 9760(802A), Contract AF 61(052)-71; SRC, AFOSR.

The research involves a study of the structure of molecular addition compounds using x-ray and electron diffraction, dipole moment and spectroscopic measurements. The addition compounds are formed from electron donor molecules such as ethers and amines and electron acceptor molecules like iodine or chlorine. These structural studies may lead to greater understanding of chemical bonding and the factors influencing energy transfer in organic molecules.

3.134

University of Southern California, Los Angeles.
THIN LIQUID FILMS, K. J. Mysels. Project 9761(802A), Contract AF 49(638)-309; SRC, AFOSR.

This is an investigation involving thin films and surface and solution chemistry. It is a study of the behavior of thin lamellae which form the body of foams, are the last separation of discrete emulsion droplets,

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SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

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CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astroenvironmental Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRE- Geophysics Research Directorate
CREA- Photochemistry Lab
CRRC- Thermal Radiation Lab
CRRE- Research Instrumentation Lab
CRRG- Terrestrial Sciences Lab
CRRH- Meteorological Research Lab
CRRI- Ionospheric Physics Lab
CRRR- Sacramento Peak Observatory

and are intermediate in any atomization or spraying of liquids. An objective of this research is to obtain and to apply new tools for the study of surface phenomena and of particle interaction.

3.135

University of Southern California, Los Angeles.
PHOTOIONIZATION PHENOMENA AND INTERACTION OF MOLECULES WITH ULTRAVIOLET RADIATION, G. L. Weissler. Project 7635(770A), Contract AF 19(604)-6119; CRZA, AFCRL.

Determines cross sections, threshold wavelength, and wavelength dependence of ionization and excitation of molecules by vacuum ultraviolet radiation. Dispersed vacuum ultraviolet radiation between 500-1000 Å has been used to excite N_2, CO, and O_2 into upper electronic states of the corresponding molecular ions and variations in intensity of fluorescence intensity from these levels have been measured. Various thin films have been tested for transparency in this wavelength region.

3.136

University of Western Ontario (Canada).
GAS SCINTILLATIONS FROM IONIZING RADIATION, R. W. Nicholls. Contract 9774(804A), Grant AF-AFOSR-61-88; SRPP, AFOSR.

A combined theoretical and experimental investigation of laboratory astrophysical processes particularly of radiation degradation processes for molecular and atomic gases will be made using revised electron and ion accelerators and radioactive materials as ionizing sources. Improved high aperture optics and photo counting spectrographic techniques will be used to investigate the threshold of ion pair production in simple atomic and molecular gases. The study will be extended to the study of luminosity or scintillations resulting from the optical decay of excited states of the target gas produced by kinetic energy loss from the electron component of the ion pairs, to molecular potentials, Franck-Condon factors and to electron-hydrogen excitation cross sections.

3.137

Washington State U., Pullman.
INTERACTION OF ACTIVATED ATMOSPHERIC GASES WITH SOLID SURFACES, E. E. Donaldson. Project 7635(770A), Contract AF 19(604)-6166; CRZA, AFCRL.

The aim of this contract was to investigate the interaction, including adsorption, of atmospheric gases with solid surfaces. These phenomena are of considerable importance with regard to the performance of satellites. The effect of atmospheric drag on satellites (particularly at high altitudes) can be appreciably charged by gas interaction and adsorption on its surface. The interactions of ions, excited and activated species with surfaces differ from those of normal ground state atoms and molecules. One of the principal aims of the contract was to investigate these differences.

3.138

Washington State U., Pullman.
INTERACTION OF ACTIVATED GASES WITH SOLIDS, E. E. Donaldson. Project 9761(802A), Grant AF-AFOSR-62-86; SRC, AFOSR.

This proposal is concerned with experimental and theoretical investigations of the interaction of gas molecules not in their ground state with solid surfaces. It is proposed that three related studies be undertaken on activated H_2, O_2 and CO: (1) study the chemical sputtering of certain solid surfaces to determine the nature of the sputtered particles, the nature of the surface damage produced by sputtering, how the sputtered particles affect surfaces on which they deposit and whether or not the sputtered products are charged; (2) study to identify the activated species in H_2, O_2, and CO by measuring the threshold electron bombarding energy required to produce activation; and (3) measure adsorption rates of activated H_2, N_2, O_2, and CO to determine how the activated gas particles interact with surfaces.

3.139

Washington U., Seattle.
VAN DER WAALS FORCES IN CONDENSED SYSTEMS, G. O. Halsey. Project 9761(802A), Contract AF 49(638)-723; SRC, AFOSR.

This research is a study of dilute solutions of light atoms in the liquid rare gases and the interaction of impurities in the solid state of the rare gases. Studies are also made on the interaction of rare gases with surfaces.

3.140

Washington U., Seattle.
MOLECULAR ELECTRONIC STATES, W. T. Simpson. Project 9760(802A), Contract AF 49(638)-677; SRC, AFOSR.

By means of absorption spectrography, polarized emission, absolute intensity measurements, and reflection measurements, the experimental work on electronic spectra of molecules and molecular crystals is being performed. Correlative quantum mechanical calculations will be carried out to enhance the theoretical understanding of the electronic processes through comparison between theory and experiment. This research will test the validity of quantum mechanical predictions of the behavior of molecules containing light atoms, such as beryllium.

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ARE- Metallurgy & Ceramics Research Lab

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3.141

Weizmann Inst. of Science (Israel).
MECHANO-CHEMISTRY OF COUPLED CONTRACTILE AND CHEMICAL RATE PROCESSES, A. Katchalsky. Project 9777(805A), Grant AF-EOAR-62-58; SRLA, AFOSR.

The aim of the proposed research is to investigate, both theoretically and experimentally, the coupling of chemical reactions proceeding in an elastic gel with the rate of contraction induced by the reaction. The study is intended to go beyond the investigations of equilibrium mechano-chemistry which established the thermodynamic relations governing reversible transformations of chemical energy into mechanical performance. It intends to evaluate the transient forces and dimensional changes which develop during irreversible processes, and to elucidate their relation to the velocities of chemical reactions and flows of matter taking place in the contractile system. As model systems, Dr. Katchalsky will investigate swollen polyelectrolyte gels which will be made to interact with a flux of oppositely charged macromolecules. The results of the experiments will be analyzed by the methods of the thermodynamics of irreversible processes.

3.142

Wisconsin U., Madison
CHARGE TRANSFER COMPLEXES, E. M. Kosower. Project 9760(802A), Contract AF 49(638)-282; SRC, AFOSR.

The research involves a study of the charge-transfer spectra of complexes of simple halide donors with transition metal ions. The findings should provide accurate information on the exchange contribution to molecular binding energy.

3.143

Yale U., New Haven, Conn.
KINETICS OF UNIMOLECULAR AND HALOGEN ATOM REACTIONS, J. P. Chesick. Project 9760(802A), Contract AF 49 (638)-722; SRC, AFOSR.

The objective of this work is to investigate the kinetics of reactions in the gas phase. Systems are being studied which will yield information pertinent to theories of unimolecular reactions, for example, cyclic hydrocarbons and olefins. Another goal of this work is to study the non-steady state chemical kinetics of reactions initiated by flash photolysis, for example, the recombination of chlorine atoms.

See also: 1.2, 1.14, 1.15, 1.19, 1.25, 1.55, 1.57 1.61, 2.41, 2.69, 4.09, 4.40, 4.49, 4.54, 4.84, 4.94, 5.29, 5.44, 7.16, 7.18, 7.26, 7.28, 7.44, 8.11, 8.18, 8.23, 8.36, 9.69, 14.4, 14.24, 14.38, 14.45, 14.54, 14.81, 14.96, 14.109, 14.110, 16.11, 16.110, 19.76, 22.4, 22.66, 22.80, 22.112, 23.20

4. PHYSICAL AND CHEMICAL METHODS OF ANALYSIS AND MEASUREMENT

Analytical Chemistry; Chromatography; Electron Spin Resonance; Nuclear Magnetic Resonance; Infrared Spectroscopy; Mass Spectrometry; Microwave Spectroscopy; Neutron Activation Analysis; Spectroscopy; X-ray Analysis.

4.1

Astrosurveillance Sciences Lab., CRR, AFCRL, Bedford, Mass.
NUCLEAR MAGNETIC RESONANCE, D. Parnell. Project 5633(803A), Internal.

It is apparent that the theoretical model for nuclear magnetic resonance is inadequate for high temperature dynamic systems. There has been some experimental evidence which supports this view, but additional measurements are needed to verify the modifications which are required. In order to take advantage of available high temperature gaseous systems, experiments will be designed to make pertinent measurements on jet engines. This will later be extended to other high temperature gases for further verification.

4.2

Battelle Memorial Inst., Columbus, Ohio.
INFRARED ABSORPTION SPECTRA OF SELECTED AROMATIC COMPOUNDS WITH PARTICULAR EMPHASIS ON ALKYL SUBSTITUTED MONO AND DIHYDRIC PHENOLS, R. Jacobson. Project 7367(802A), Contract AF 33(616)-7612; ASRC, ASD.

This research program is designed to gain the maximum information about the sensitivity of long wavelength infrared absorption for characterization of subetituents on aromatic rings, and for elucidation of structural differences existing between the solid and liquid states of aromatic compounds. The present contract proposed to: (1) eliminate certain discrepancies that have arisen; and (2) make the far infrared region useful from an analytical standpoint and affording the chemist greater insight into molecular structure.

4.3

Bell and Howell Co., Pasadena, Calif.
ION-MOLECULE REACTION STUDIES, D. Perkins. Project 7023(802A), Contract AF 33(657)-8249; ARC, ARL.

This effort shall comprise research necessary to effect the realization of a significant improvement in the state-of-the-art of instrumentation for the study of ion-molecule reactions. The effort shall be directed toward elimination of restrictions existing in current studies of these phenomena using conventional, single stage mass spectrometers. This work shall consist of detailed design studies, the construction of breadboard models in accordance with these designs, and evaluation of these components. The feasibility of such an instrument having been proven, an experimental model which will permit a definitive study of ion-molecule reaction phenomena will be constructed and its operability demonstrated.

4.4

Birmingham U. (Gt. Brit.).
MICROWAVE SPECTROSCOPY, J. Sheridan. Project 9767 (803A), Contract AF 61(052)-241; SRPP, AFOSR.

The study of microwave spectroscopy has helped in determining the configuration of many molecules. The present work will be concerned with very short wavelengths in the millimeter range and the results used to analyze molecules as to their internuclear distance, nuclear quadrupole, molecular dipole moments and thermodynamic properties.

4.5

Birmingham U. (Gt. Brit.).
MILLIMETER WAVE METHODS AND MICROWAVE SPECTROSCOPIC STUDIES, J. Sheridan. Project 9767(803A), Grant AF-EOAR-62-1; SRPP, AFOSR.

Molecular properties of highly volatile substances, such as dipole moments and thermodynamic constants, are being studied by microwave spectroscopic techniques. These investigations provide information essential to the determination of the configuration of complex molecules.

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4.6

Boston Coll., Chestnut Hill, Mass.
METHODS FOR ANALYZING CONCENTRATIONS OF IMPURITIES IN ELECTRONIC MATERIALS, J. J. Devlin. Project 5620(802A), Contract AF 19(604)-8819; CRRC, AFCRL.

The object of this research is the investigation of those parameters which will, by proper control and manipulation, lead to an increase in the sensitivity for commercially available spectrographs for the determination of trace constituents in solid state materials. Recent investigations sponsored by this laboratory have shown that under favorable conditions the sensitivity can be increased by several orders of magnitude as was shown by increasing the limit of detectability of arsenic in silicon carbide from 10 ppm to 0.1 ppm. In order to achieve this result, the fastest commercially available spectrograph was used and emphasis will be on studies using this instrument. Conditions to be studied are: arcing conditions, optimization of the optical properties of the spectrograph, volatilization rates of traces in various matrices, elimination of interferences and the study of other parameters affecting sensitivity.

4.7

Brandeis U., Waltham, Mass.
CRYSTAL FIELDS AND EXCHANGE INTERACTION BY MEANS OF ELECTRON PARAMAGNETIC RESONANCE, F. Dorain. Project 7885(802A), Contract AF 33(616)-6401; ARX, ARL.

The object of this research is to use electron paramagnetic resonance to study the crystal fields and exchange interactions of doped cadmium and zinc compounds. It will include Mn^{++} doped CdS, CdTe, $CdCl_2$ and CdI, and also Mn^{++} and Fe^{++} doped cubic ZnS; both cubic and hexagonal ZnS will be used to show the effects of stacking faults. An attempt will also be made to use electron resonance to observe the unpaired spins produced by establishing excitons in CdS by irradiation with high power mercury lamps. This investigation of excitons will include work on ZnS and ZnO also, if indicated by the other results.

4.8

California Inst. of Tech., Pasadena.
STRUCTURE OF LIQUIDS, C. J. Pings. Project 9760 (802A), Contract AF 49(638)-800; SRC, AFOSR.

This is an investigation of the structure of liquids by means of X-ray and neutron diffraction. New apparatus advances enable these techniques to be used to determine the radial distribution function as a function of pressure and temperature, near the critical state and at phase boundaries. First liquid metals, then other substances are being studied. Interactions between unlike molecules in liquids will be determined.

4.9

Catholic U. of America, Washington, D. C.
RELAXATION RATES OF INFRARED TRANSITIONS, K. Herzfeld. Project 7670(770A), Contract AF 19(604)-5558; CRZC, AFCRL.

The objective of the work is to conduct studies and experimental investigations to determine, with infrared spectrometric equipment, the relaxation process of molecular gases. Gases are excited by microwave pulses, and the population of the different states measured as a function of time. The study will include ionized gases and the observation of very short relaxation times. Installation of a 1.8 meter Ebert with a 15,000 l.p.i. grating has been completed. A single beam grating monochromator has been adapted to study pressure broadening in the wings of CO_2. The optical system has been completed and a wavelength calibration is under way. A first series of water absorption measurements for the range of 7500 Å has been made.

4.10

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
CHEMISTRY OF ORGANIC AND INORGANIC COMPOUNDS OF METALS, R. W. Moshier. Project 7023(802A), Internal.

Our present program encompasses interest in compounds possessing measurable vapor pressure which will be studied by the gas chromatographic technique. The goal here is the utilization of the technique for the separation of metals difficult to separate by other means, and of the application in macro separations and in analytical chemistry. If the compound possesses optical or structural isomerism, resolution and separation of these will be attempted. Metallo-organic compounds will be used to synthesize desired derivatives of the organic compound in cases where preparation of the derivative is simple using the metallo-organic compound but impossible when using the organic compound alone. Covalent metal compounds of the metals possessing quadrupole moment will be synthesized. This will determine the classes of compounds suitable for measurement by those scientists interested in the exploitation of quadrupole moment. Exploratory work will deal primarily with the less familiar metals.

4.11

Chicago U., Ill.

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CRI- Geophysics Research Directorate
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CRIC- Thermal Radiation Lab
CRIE- Research Instrumentation Lab
CRIG- Terrestrial Sciences Lab
CRIM- Meteorological Research Lab
CRII- Ionospheric Physics Lab
CRIR- Sacramento Peak Observatory

HIGH RESOLUTION SPECTROGRAPHIC STUDIES OF ATMOSPHERIC GAS MOLECULES, R. S. Mulliken. Project 8627 (804A), Contract AF 19 (604)-6662; CRAZ, APCRL.

The research effort consists of experimental and theoretical investigations into the structure of atmospheric gas molecules. The greater portion of this effort is experimental and involves the use of large, high resolution spectrographs for the purpose of obtaining high resolution spectrograms, both in emission and absorption, of atmospheric gas molecules under a variety of conditions of excitation and pressure. This high resolution spectroscopy makes possible measurements of great precision of the atomic and molecular spectra which are of interest in the research under this task. These high precision measurements in turn lead to more accurate values for molecular energy levels, molecular constants, and other parameters needed in the understanding of the structure of atmospheric gas molecules.

4.12

Colorado U., Boulder.
MAGNETIC INTERACTION OF ELECTRONS AND NUCLEI IN SOLIDS, W. H. Tanttila. Project 9760(802A), Grant AF-AFOSR-62-345; SRPS, AFOSR.

The nuclear resonance line widths will be studied as a function of paramagnetic ion concentrations ($< 4\%$ Mn^{++}) in crystals such as LiCl, LiF, and CaF_2. Electric quadrupole transitions between magnetic spin levels of Cl^{35} in a single crystal of sodium chlorate will be studied at 78°K using large, ac electric fields. An attempt will be made to induce spin transitions between the +1/3 and -1/2 nuclear magnetic levels of F nuclei in LiF by ultrasonic techniques.

4.13

Colorado U., Boulder.
NUCLEAR RESONANCE ON AL IN SYNTHETIC RUBY, W. H. Tanttila. Project 9763(802A), Contract AF 49(638)-611; SRPS, AFOSR.

The primary aim of this research is to study the interaction between the Cr ion and the Al nuclei in synthetic ruby. This interaction will be studied as a function of temperature. The relaxation process of the Al should be governed at some low temperature by the relaxation of the Cr ions via their mutual interaction. By studying the temperature dependence of the relaxation time and the line width of the Al nuclear resonance below the temperature, one should be able to get information on the interaction energy and the Cr ion relaxation time. Additional information on spin conduction by the nuclear system will of course be possible to obtain. The approach will be as follows: first the line width and quadrupole interaction energy will be studied as a function of temperature and orientation for several single crystals (not more than four) of different Cr ion concentration. These experiments will be done using continuous resonance absorption (marginal oscillator with phase sensitive detection). Following this pulsed nuclear induction will be used to study the relaxation time as a function of temperature, crystal orientation, and Cr ion concentration. Following these experiments, it is possible that from the results continuous absorption experiments may be indicated on several of the samples to look at the line widths of the nuclear resonance. The samples will range in Cr ion concentration from about .1% to 5%. The pulsed experiments will be done on about 8 samples of different Cr ion concentration.

4.14

Columbia U., New York.
ELECTRON SPIN RESONANCE IN GASES, G. K. Fraenkel. Project 9763(802A), Contract AF 49(638)-520; SRC, AFOSR.

This important and productive research is concerned with four applications of the technique of electron spin resonance: (1) relaxation phenomena of free radicals; (2) paramagnetic resonance of gases; (3) double resonance experiments; and (4) studies of complex ions. The spin resonance technique is extremely sensitive and useful in studying free radicals and ions.

4.15

Cornell U., Ithaca, N. Y.
STUDIES OF THE SURFACE OF SOLIDS WITH THE MASS SPECTROMETER AND FIELD EMISSION MICROSCOPE, R. C. Bradley. Project 9761(802A), Contract AF 49(638)-748; SRPS, AFOSR.

This research includes (1) an experimental study of the secondary ion emission from single crystal copper and molybdenum surfaces; (2) a theoretical study of the whole problem of secondary ion emission in an effort to arrive at a better understanding of what is involved in the process; (3) a study of sputtering and ion reflection; (4) a study of the kinetics of the formation and removal of the oxides and carbides; and (5) an investigation of the surfaces of some binary alloys to determine how the composition is modified by temperature, ion bombardment, and environment.

4.16

Cornell U., Ithaca, N. Y.

AEL- Aeronautical Research Laboratories
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AES- Hypersonics Research Lab
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AEML- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESDR- Operational Applications Lab

ANALYTICAL APPLICATIONS OF FLAME SPECTROSCOPY, W. D. Cooke. Project 9763(802A), Contract AF 49(638)-484; SRC, AFOSR.

This research is concerned with the development of new methods of atomic and molecular spectra and the application of such procedures to analytical problems. The procedures proposed will avoid some of the problems in flame chemistry such as flame fluorescence spectroscopy and impact excitation.

4.17

Dayton U., Ohio.
APPLICATION OF ION-EXCHANGE METHOD FOR ACCURACY OF ANALYSIS OF ALLOYS, C. Michaelis. Project 7364(802A), Contract AF 33(616)-5612; ARC, ARL.

Ion-exchange materials are used to determine the separation behavior of simple metal ions and coupled metal ions. Investigations are confined to metals systems whose composition constitute the alloys superior in very high strength, high temperature resistance, and high corrosion resistance. Investigations are also limited to the use of commercially available ion-exchange resins. By this means an appropriate solution of several metals will be separated into several solutions each of which contains quantitatively all of one or two metals easily and accurately determinable by accepted analytical procedures. The study will determine the appropriate resin, the parameters of the solvent, the elution rate, the capacity of the system, and the partition values of the systems.

4.18

Dayton U., Ohio.
ULTRA SHORT TIME RESOLUTIONS OF OPTICAL SPECTRA, W. G. Rambauske. Project 7073(806A), Contract AF 33(616)-6766; ARH, ARL.

A new method of accomplishing beam motion was proposed by the contractor. In this method, the beam is reflected from a mirror which oscillates about an axis in the plane of the mirror. The mirror is driven by a piezoelectric transducer, and is tuned to resonate at the driving frequency. Sweeps through an angle of one radian are obtained at 1300 cps. Several oscillating mirrors are placed in optical series to obtain writing rates in excess of 10^6 cm/sec with a 1-meter optical lever arm. An additional mirror placed at right angles to the main-sweep mirrors is used to deflect the beam of the spectrograph slit in a manner analogous to the formation the Lissajous figures, thus providing shuttering action and preventing multiple exposures. The work leading to the design of these devices has included a literature survey and theoretical evaluation of existing and proposed methods for obtaining time-resolved spectrograms, and experimentation and improvements upon helium-turbine-mirror and image-dissection camera techniques. The main program principally concerned the development, testing, and evaluation of piezoelectric, piezostrictive, magnetostrictive, and electromagnetic drives for oscillating mirrors, although auxiliary timing, triggering and monitoring circuits and equipment were also designed and tested. High-speed time-resolved spectra were obtained, and the mechanical and optical parameters of the devices were measured.

4.19

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
MASS SPECTROMETRIC ANALYSIS OF REFRACTORY METALS, W. L. Baun. Project 7367(802A), Internal.

The objective of this research is to analyze and develop basic analytical techniques for refractory metals using the new solid source double focusing mass spectrometer. Emphasis is placed on trace element analysis and the determination of the state of trace elements in tungsten. Investigations of single crystal and polycrystalline materials will be undertaken. Analysis of dispersed second phases and other components purposely added to tungsten will be studied.

4.20

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
INFRARED AND RAMAN SPECTRA, F. Behnke. Project 7367(802A), Internal.

The purpose of this work is to conduct fundamental studies of the infrared and Raman spectra from 1-50 microns of certain classes of aliphatic and aromatic derivatives to establish a better understanding as to the relationship between frequency and intensity of characteristic absorption and the nature of the substituents bonded to aromatic rings or other functional structures. The scope of the effort includes detailed assignments for simple molecular, empirical aromatic derivatives such as substituted benzenes, heterocyclic and polynuclear compounds; the calculation of thermodynamical functions; and the determination of the basic structure parameters of molecules from vapor spectra (moments of inertia, barriers to rotation, etc.). Studies dealing with intermolecular forces and their effects on spectra, solvent effects, adsorption effects, etc. Particular attention will be given to Raman and far infrared studies dealing with impurity absorption in solids, correlation of intramolecular forces (steric factors) with spectra, spectra-structure correlations, correlation of reactivity with Raman spectra, and the effects of temperature on spectra.

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CRZA- Photochemistry Lab
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CRZR- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZM- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

4.21

Duke U., Durham, N. C.
MICROWAVE, MILLIMETER WAVE, AND RADIOFREQUENCY SPECTROSCOPY, W. Gordy. Project 9768(803A), Contract AF 49(638)-765; SRPP, AFOSR.

This research employs new instrumentation and experimental techniques for studying the effects of extreme temperatures and high energy radiation on the microwave properties and magnetic resonance of matter. Also included are theoretical analyses of the results. Some of the materials considered are organic molecules and other biological substances; flames, crystals, liquids (possible fuels) gases and free radicals. The production and measurement of sub-millimeter waves is also being studied as is the superconductivity and dielectric dispersion of substances at these short wavelengths.

4.22

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
IDENTIFICATION OF SINGLE CRYSTALS BY X-RAY SPECTROSCOPY, J. A. Bruce. Project 5621(802A), Internal.

The purpose of this research is to provide a means of identifying small single crystals by X-rays. An X-ray fluorescence method has been devised, by which small single crystals containing the same elements but in different proportions, may be separated, analyzed, and identified. This method is rapid and non-destructive and is well suited for small samples on which further investigations must be made. Improved methods of crystal orientation and identification are being developed.

4.23

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
ANALYSIS OF SEMICONDUCTOR AND MAGNETIC MATERIALS, J. P. Cali. Project 4608(760E), Internal.

The object of this effort is to devise analytical methods for materials in the class of semiconductors and magnetics. The materials under investigation are either elemental or compound in type and are solid-state in nature. Typical materials are ruby, garnets, silicon carbide, silicon slums, magnesium, tin, graphite and nickal. The analytical techniques applied are emission spectroscopy, neutron activation, calorimetry, spectrophotometry, and gravimetric or volumetric wet methods. The effort comprises the preparation, sampling, and detection of impurities at the part per billion level where necessary and at higher levels when required.

4.24

Electronics Material Sciences Lab., CRR, AFCRL; Bedford, Mass.
EXCITATION PROCESSES IN EMISSION SPECTROSCOPY, J. P. Cali. Project 5620(802A), Internal.

The detection limits of emission spectroscopy can be improved over the existing ppm levels by improving the efficiency of sample excitation. It is proposed to investigate novel methods of excitation using radio-frequency and high amperage spark discharge methods in order to volatilize more efficiently and ionize solid state materials. Studies will be made of the use of inert ambients or vacuum to minimize background or noise levels and of novel electrode geometries to distill preferentially individual components of a matrix.

4.25

Electronic Material Sciences Lab., CRZC, AFCRL, Bedford, Mass.
INFRARED RATE PROCESSES OF VARIOUS REACTING SYSTEMS, R. L. Clarke. Project 8658(804A), Internal.

Determine laboratory techniques and develop procedures for experimental measurement of pertinent parameters involved in the reaction of atmospheric planetary gases resulting in infrared chemi-luminescent emissions. This will include selection of reacting gaseous systems and assembly of equipment for carrying out the reactions. In particular the determination of reaction kinetics and amount and character of infrared emission are required. A typically representative system might be an experimental study of the reaction kinetics and infrared radiation produced by the reaction of nitric oxide with ozone.

4.26

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
EXCITATION PROCESSES IN EMISSION SPECTROSCOPY, J. J. Fitzgerald. Project 5620(802A), Internal.

The detection limits of emission spectroscopy can be improved over the existing ppm levels by improving the efficiency of sample excitation. It is proposed to investigate novel methods of excitation, using radio-frequency and high amperage spark discharge methods in order to volatilize more efficiently and ionize solid state materials. Studies will be made of the use of inert ambients or vacuum to minimize background or noise levels and of novel electrode geometries to distill preferentially individual components of a matrix.

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ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
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RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

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4.27

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
PARAMAGNETIC RESONANCE STUDIES, I. Lessin. Project 5621(802A), Internal.

The objective of this work is to investigate properties and phenomena exhibited by single crystals of electronically active materials by means of magnetic spin resonance techniques. Over a period of years an excellent capability for spin resonance research has been developed. Present emphasis has been on a theoretical and experimental determination of the energy state configuration and wave functions of iron as a "guest" in Al_2O_3 host lattices. A report incorporating computed data for energy levels and wave functions as a function of field and angle is in preparation. This will be followed by a second report discussing experimental results and physical implications including those for a K band maser based on Fe^{3+} in Al_2O_3.

4.28

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
MASS SPECTROGRAPHIC ANALYSIS OF SOLIDS, B. Rubin. Project 5620(802A), Internal.

Ultra-sensitive methods of analysis such as neutron activation or cyclotron reactions have inherent disadvantages. In some cases, the sensitivity is low due to the short half-lives of products, low capture cross-sections or interfering and competing reactions. Furthermore, the procedures may be time-consuming, and expensive. To overcome many of these disadvantages, mass spectrography for the analysis of impurities in solid-state electronic materials can be used. It is the purpose of this program to investigate mass spectrography as a technique for detecting impurities in the part per billion range in electronic solids. Emphasis will be placed on improving the excitation source by studying the possibility of ion-sputtering and electron bombardment. The detection end will be investigated in an attempt to improve the loss in vacuum due to the plate emulsion by the use of dry plates. The analytical section will be improved by the possible use of better focusing methods in conjunction with new and improved magnetic fields. Standardization and calibration will be carried out in conjunction with neutron activation analysis. Materials to be studied will include semiconductors and magnetics. It is expected the sensitivity range for all elements of interest will be in the part per billion range, that the resolution will be improved concurrently and that the mass range will also be extended.

4.29

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
NEUTRON ACTIVATION ANALYSIS VIA GROUP SEPARATION, B. Rubin. Project 5620(802A), Internal.

Neutron activation analysis is currently carried out by irradiation of a sample with thermal neutrons, followed by dissolution of the sample and chemical separation of each of the elements of interest. This is a time-consuming and tedious process. The object of this research is to cut down the time and effort involved by separating the impurity elements into select groups of three or four elements and identifying the members of the groups by gamma ray spectrometry or careful analysis of the decay curves of the group.

4.30

Electronics Technology Lab., ASEME, ASD, Dayton, Ohio.
INTERACTION OF ENERGY LEVELS, L. M. Politzer. Project 4150(803A), Internal.

During the early part of the year it was established that one type of transmission spectroscope for investigation of absorption in liquids would not work in the manner desired. The system was redesigned and while awaiting the arrival of needed parts an investigation of non-linear effects in superconducting cavities was started. This investigation should be completed in the next few weeks and spectroscopy of liquids resumed. The non-linear effects may provide a new and efficient method of frequency conversion for microwaves and also a possible harmonic generator. In any event it will provide some information on the relaxation time of the super-conducting state.

4.31

Franklin Inst., Philadelphia, Pa.
IDENTIFICATION OF ELECTRON PARAMAGNETIC AND NUCLEAR PARAMAGNETIC ELEMENTS BY MAGNETIC RESONANCE, A. Heaves. Project 7021(802A), Contract AF 33(616)-7605; ARZ, ARL.

The techniques of nuclear magnetic resonance (NMR) and electron spin resonance (ESR) are being applied to the direct identification of hydrogen in sapphire and estimates of the concentration of hydrogen present. The failure to observe a proton resonance to date is in accord with present theoretical estimates of the hydrogen concentration in "as grown" crystals ($\leq 10^{17}$ /cm^3) and the known limit of sensitivity of NMR techniques. Since the hydrogen concentration in

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deformed crystals may be several orders of magnitude higher, proton resonances will be sought in suitably bent crystals. ESR spectra observed to date are extremely complex and indicate the presence of several paramagnetic impurities. A doublet with low field splitting (10-50 Gauss) in the vicinity of g = 2 has been observed quite consistently. This field splitting is in accord with theoretical estimates of the electron-proton distance for hydrogen in the vicinity of a dislocation. The ESR studies of the behavior of this doublet will continue with particular emphasis on the effects of deformation, thermal treatment in vacuum to decrease the hydrogen content, and replacement of the hydrogen with deuterium.

4.32

Georgia Inst. of Tech., Atlanta.
MASS SPECTROMETRIC STUDY OF ION-MOLECULE REACTIONS OCCURRING AT THERMAL ENERGIES, D. W. Martin. Project 9767(803A), Grant AF-AFOSR-62-306; SRPP, AFOSR.

An ion may change its identity in a number of ways after ionization by such mechanisms as charge transfer, chemical reaction, dissociation, or interaction with metallic surfaces. The problem of identification following such changes is the subject of this investigation. Present work covers precise mass spectrographic studies of ion-molecule reactions occurring under thermal equilibrium conditions.

4.33

Hebrew U. (Israel).
SOFT X-RAY AND FAR ULTRAVIOLET SPECTROSCOPY, B. S. Fraenkel, E. Alexander. Project 9763(802A), Grant AF-EOAR-62-33; SRPS, AFOSR.

An apparatus for generating radiant energy in the soft X-ray and far ultraviolet region (10 to 1000 Å) has been developed. This region of the electromagnetic spectrum has long been a neglected area for research because no reliable source was available. It is planned to exploit this wavelength region by performing experiments in vacuo in five areas, namely: (1) fluorescent soft X-ray solid state spectroscopy; (2) soft X-ray spectroscopy will be extended to elements not yet investigated, e.g., gallium; (3) absorption curves of the optimum thickness can be made with different orientations; (4) soft X-ray spectroscopy of organic crystals by the fluorescent radiation technique will avoid destruction of crystal by direct electron bombardment and may contribute to knowledge of problems of energy exchange; and (5) the spectroscopy of multiply-ionized gases with the sliding spark method may contribute to the solution of problems concerned with thermonuclear energy.

4.34

Huffman Microanalytical Labs., Wheatridge, Colo.
ANALYTICAL RESEARCH DATA FOR DETERMINING EVALUATION AND INTERPRETATION OF MOLECULAR STRUCTURES, E. W. D. Huffman. Project 7023(802A), Contract AF 33(616)-6742; ARC, ARL.

This contract calls for the performance of quantitative chemical microanalyses and physical measurements on chemical compounds to be supplied by the Chemistry Research Branch, Aeronautical Research Laboratory. When standard analytical methods do not provide results which are within the limits of accuracy and precision of standard chemical practices, research shall be done to devise new methods to bring the results within such limits.

4.35

Illinois U., Urbana.
SOLID STATE STUDIES BY RADIOACTIVE METHODS, H. Frauenfelder. Project 9761(802A), Contract AF 49 (638)-1048; SRPS, AFOSR.

Using methods involving radioactive atoms for the investigation of surface and solid state properties, the following areas of research are to be studied: (1) sticking probabilities of metal atoms on clean monocrystals as a function of surface orientation, surface temperature, and direction of incident beam; (2) sticking probabilities of radioactive gases on clean monocrystal surfaces; (3) internal magnetic fields in ferromagnets as a function of crystal structure, specimen size, orientation, and temperature; (4) internal magnetic fields and electric field gradients in ferro-electrics; (5) Mössbauer effect of atoms sitting on surfaces; and (6) Mössbauer effect of atoms in thin films. All surface work will be performed in ultra-high vacuum systems at pressures of about 10^{-10} mm Hg or lower.

4.36

Illinois U., Urbana.
NEW SPECTROCHEMICAL METHODS, H. V. Malmstadt. Project 9763(802A), Contract AF 18(603)-137; SRC, AFOSR.

This research concerned the development of new emission and absorption spectrochemical methods, techniques, and applications, such as molten state excitation technique of emission spectrochemical analysis, and absorption and phosphorescent spectra under high pressure.

4.37

Institut National des Sciences Apliquees (France).

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FREE RADICAL SPECTROSCOPY, M. Peyron. Project 6694 (750F), Contract AF 61(052)-497; CRZA, AFCRL.

The physical and chemical properties of free radicals are to be studied by means of emission and absorption spectroscopy. The free radicals are to be stabilized in a suitable matrix at liquid helium temperature. In particular, studies will be made on the diffusion and recombination of nitrogen atoms and other unstable species within the solid.

4.38

Isomet Corp., Palisades Park, N. J.
SUITABLE DISPERSING OR ANALYZING CRYSTAL "CRYSTAL GRATING" OR COMBINATION THEREOF FOR STUDY OF X-RAY SPECTROSCOPY, W. Ruderman. Project 7367(802A), Contract AF 33(657)-7756; ASRC, ASD.

The contractor shall provide the necessary personnel, equipment, facilities, and materials to be used for basic research in the development of X-ray analyzing crystals with 2d spacings of 25 to 100 Å. These crystals are to be suitable for use in the study of L spectra shifts and fine structure for such metals as iron, manganese, chromium, and titanium, and K spectra for elements such as nitrogen, oxygen, and carbon.

4.39

Johns Hopkins U., Baltimore, Md.
THEORETICAL INTERPRETATIONS OF INFRARED SPECTRA, W. S. Benedict. Project 8603(804A), Contract AF 19 (604)-6130; CRZC, AFCRL.

The goal of this research is to interpret theoretically various aspects of the infrared spectra of simple molecules, particularly those of importance in the atmospheres of the earth and planets. The studies will include analysis of high resolution spectra in terms of energy levels and of intensities of lines and bands. The analysis and interpretation of the vibration-rotation bands of NH_3, and its isotopic modifications is being carried out in great detail. A tabulation of all the water vapor lines in the pure rotation band has been prepared, giving the position, intensity, and width of each observable line as a function of temperature in the range of atmospheric interest 200-320°K. Dr. Benedict has recently completed a thorough detailed analysis of some of the infrared bands of H_2O, D_2O, CO_2, HDO, and some analyses of the Coriolis interactions in H_2O and D_2O. He is also carrying out a study of the variation of line widths with rotational quantum number.

4.40

Johns Hopkins U., Baltimore, Md.
MICRO-CATALYTIC CHROMATOGRAPHY, P. H. Emmett. Project 9761(802A), Contract AF 18(603)-129; SRC, AFOSR.

A study of catalytic reactions by an entirely new technique and procedure. Micro quantities of reactants placed in a stream of carrying-gas flowing over a catalyst and through a chromotographic column will enable one to determine the exact identity and amounts of all of the reaction products in a very short time. The method will be extended to the study of high pressure reactions.

4.41

Johns Hopkins U., Baltimore, Md.
SPECTRAL STUDY OF FREE RADICALS AND REACTIVE MOLECULES AT 4°K, Project 9760(802A), Contract AF 49 (638)-468; SRC, AFOSR.

This research is directed toward the determination of pure rotational spectra of small radicals such as NH, CH, BH, and OH in inert gas matrices at 4°K. Larger radicals such as NH_2, CH_2, BH_2, are also being sought. Far infrared as well as "fundamental" infrared, vibrational-rotational spectra of species such as CF_2, CF_3, CCl_2, $SiCl_2$, etc., in inert gas matrices at 4°K, will be obtained to determine the change in such spectra with thermal depopulation of excited states.

4.42

Johns Hopkins U., Baltimore, Md.
FAR INFRARED SPECTROSCOPY, Project 9768(803A), Grant AF-AFOSR-62-135; SRPP, AFOSR.

A special interferometer for the far infrared spectrum has been built by the principal investigator and is being used to study widths and strengths of ammonia lines at about 500 microns and will be used to study submillimeter harmonics. A spectroscopic study has been made of the pressure broadening of the pure rotation line of ammonia at 20 cm^{-1} and that of hydrogen chloride at 40 cm^{-1}.

4.43

Kansas U., Lawrence.
PHOTOMETRIC TITRATIONS OF ORGANIC GROUPS, C. A. Reynolds. Project 9763(802A), Contract AF 49(638)-472; SRC, AFOSR.

This project deals with the adaption of the photometric titration technique to the analysis of several organic functional groups, thereby improving the speed and accuracy of this type of analysis. The general method of attack will be the same regardless of the specific titration reaction employed.

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4.44

Laboratoire National d'Essais (France).
INFRARED SPECTRA OF VARIOUS CRYSTALLINE SOLIDS, A. Hadni. Project 5634(803A), Contract AF 61(052)-518; CRRC, AFCRL.

This group has developed four far infrared spectrometers operating from 50 microns to the microwave region. With these instruments, they have obtained far infrared spectra of various inorganic crystals such as NaCl and KBr from 250 to 650 microns and various alkaline earth arsenites up to 150 microns.

4.45

Little, Arthur D., Inc. Cambridge, Mass.
FAR INFRARED SPECTRA OF SELECTED CRYSTALS, H. H. Blau. Project 5634(803A), Contract AF 19(604)-8504; CRRC, AFCRL.

The objective of the research is to obtain infrared absorption and reflection spectra of selected crystals out to 200μ or farther at several temperatures between 4°K and 300°K and possibly higher. Initially spectra will be taken at room temperature but as soon as possible low temperature spectra, down to 4°K will be obtained.

4.46

London U. (Gt. Brit.).
ELECTRON SPIN RESONANCE SPECTRA OF METAL COMPLEXES, D. J. Millen. Project 9760(802A), Grant AF-EOAR-62-26; SRC, AFOSR.

This is an investigation of the bond character in transition metal complexes by examining the hyperfine structure in electron spin resonance spectra.

4.47

Massachusetts Inst. of Tech., Cambridge, Mass.
OPTICAL GRATING RESEARCH, G. Harrison. Project 7649(770A), Contract AF 19(604)-7997; CRZR, AFCRL.

The diffraction grating is the most important single component of any spectrographic instrument. The quality of these gratings determines the effectiveness of the instruments at the Sacramento Peak Observatory in obtaining the best possible spectral data. MIT is designing and developing interferometric control equipment which has advanced and is continuing to advance the state of the art of grating ruling.

4.48

Massachusetts Inst. of Tech., Cambridge.
REACTOR SPECTROMETRY, DOSIMETRY AND NEUTRON ACTIVATION ANALYSIS, T. J. Thompson, M. C. Rasmussen. Project 5620(802A), Contract AF 19(604)-7492; CRRC, AFCRL.

The object of this work is to investigate neutron dosimetry and spectrometry for the purpose of establishing inter-reactor standards and on the development of methods of neutron activation analysis for trace impurities in electronic solid state materials. The neutron activation technique is used in cases where the half-lives of the impurities are so short that their detection must be accomplished at the reactor site using gamma-ray spectrometry. With the aim of investigating fully the neutron flux spectrum from one beam port, a fast neutron chopper is being modified and installed at the MIT reactor. A slow neutron chopper, to extend the range of neutron energies investigated, is in preliminary design. A hot cell is being constructed at the MIT reactor and the existing pneumatic facilities are being modified to terminate inside the hot cell to allow handling of high activities of isotopes with short half-lives. The results of the work with neutron flux spectra will be applied to the establishment of inter-reactor standards of measurement. The neutron activation analysis work will be applied to developing methods for rapid and accurate determination of trace impurities in electronic components.

4.49

Mellon Inst. of Industrial Research, Pittsburgh, Pa.
NUCLEAR MAGNETIC RESONANCE, A. A. Bothner-By. Project 9763(802A), Contract AF 49(638)-980; SRC, AFOSR.

This research is directed toward establishing and testing of absolute theories of proton shielding and spin-spin coupling of highly resolved, accurately calibrated proton magnetic resonance spectra of selected olefins, alkanes and other organic molecules, and complete analysis to determine the fundamental parameters ν_i and J_{ij}. Preliminary results on 6 spectra have demonstrated this to be entirely feasible. In addition the effects of the following structural features on spin-spin coupling and proton shielding will be examined; cis-trans isomerism, degree of branching, steric interference, small-ring strain, polarizable-group proximity and ionic character in the molecule.

4.50

Mellon Inst. of Industrial Research, Pittsburgh, Pa.
INFRARED SPECTROSCOPY OF SOLIDS, R. M. Hexter. Project 9760(802A), Contract AF 49(638)-542; SRC, AFOSR.

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The infrared spectra of pure and mixed crystals of simple molecules such as methane, silane, germane, water, ammonia and the methyl halides are being investigated for the purpose of exploring motions of these molecules where situated in the close proximity dictated by the crystal arrangement characteristic of the solid state. Rotation of water and ammonia molecules dissolved in solid inert gases has been demonstrated conclusively. The infrared spectra of these solids yield important information on the forces acting between molecules and on the effects of these forces on molecular oscillations.

4.51

Metal Hydrides, Inc.
SPECTROGRAPHIC ANALYSIS OF SEMICONDUCTOR AND RELATED MATERIALS, D. Littlehale. Project 4608(760E), Contract AF 19(604)-3469; CRRC, AFCRL.

The objectives of this contract are the development of spectrographic techniques for the analysis of trace impurities in semiconductor and related materials and the analysis of those samples submitted by the Air Force Cambridge Research Laboratories. The significant results have been the successful determination of ultra trace impurities in semiconductor and other high purity metals in the part per billion range. Future consideration will be concerned with investigating the use of a high speed spectrograph and moving plate exposures. Also, the continuing problems of improving the separation techniques and purifying the necessary reagents are to be studied. Much effort will be expended in the field of gaseous reactions.

4.52

Michigan State U., East Lansing.
PARAMAGNETIC RELAXATION AT VERY LOW TEMPERATURES, R. D. Spence, J. A. Cowen. Project 9763(802A), Contract AF 49(638)-613; SRPS, AFOSR.

This research includes investigation of the following: (1) electron spin-lattice and lattice heat bath relaxation by means of low field, low frequency paramagnetic resonance; (2) color centers or other radiation induced damage; (3) nuclear relaxation as a function of paramagnetic centers; (4) interaction between relaxation times of paramagnetic impurities and nuclear spin precession times when they are of similar duration; (5) antiferromagnetic relaxation examined by a proble nucleus of paramagnetic center; (6) use of second sound below 2.2°K to conduct relaxation energy to a detector; (7) electron-nuclear coupling in a variety of systems; (8) coupling and relaxation of nuclear paramagnetic systems in irradiated crystals; and (9) possibility of significant polarization or alignment of radioactive nuclei.

4.53

Michigan U., Ann Arbor.
ELECTRIC FIELD-INDUCED SPECTRA, C. W. Peters. Project 8603(804A), Contract AF 19(604)-6125; CRZC, AFCRL.

Study of novel means of exciting or measuring infrared spectra. Studies have been made on the production of electric field induced vibration-rotation absorption in homonuclear diatomic molecules (such as H_2 and D_2), interferometry, derivative absorption spectroscopy, far infrared and stark effects in various molecules such as NH_3 and H_2O.

4.54

Minnesota U., Minneapolis.
STRUCTURAL INVESTIGATIONS OF LARGE MOLECULES BY X-RAY DIFFRACTION, B. Crawford. Project 9760(802A), Contract AF 49(638)-485; SRC, AFOSR.

The research will involve the determination of the structure of a very low molecular weight enzyme "tetrahymena proteinase." It is expected that the detailed stereochemistry in the 3-dimensional arrangement of atoms in this enzyme and some of the smaller molecules will be solved. The details of the molecular configurations will be closely related to the chemical mode of action of these molecules, and should contribute to the general theory of the relationship of structure to chemical reactivity.

4.55

Minnesota U., Minneapolis.
POLAROGRAPHY AND AMPEROMETRY IN NON-AQUEOUS SOLVENTS, I. M. Kolthoff. Project 9763(802A), Contract AF 49 (638)-519; SRC, AFOSR.

This is a systematic study of the polarography and amperometric behavior of inorganic constituents in non-aqueous solvents with emphasis on analytical applications. Procedures may be developed for the polarographic and amperometric determination of such ions as magnesium and the rare earths, which cannot be determined in aqueous media.

4.56

Minnesota U., Minneapolis.
ABSORPTION LINE SHAPES, C. A. Mead. Project 9760 (802A), Contract AF 49(638)-940; SRC, AFOSR.

This entails the application of a theory, developed by the investigator, which involves the shape of the "resonance-broadened" absorption line for a monatomic gas at low temperature. This theory enables one to calculate the detailed shape of the line rather than only the width. The theory is to

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be extended to cover a wider variety of conditions (e.g. higher temperatures) and a wider class of substances, such as molecular gases and solids. The systems being studied and extended are theoretical models based on monatomic gases.

4.57

Minnesota U., Minneapolis.
ELECTRON-SPIN RESONANCE STUDIES OF SELECTED SOLIDS, T. M. Sanders. Project 9763(802A), Contract AF 49 (638)-811; SRPS, AFOSR.

The donor conduction band in germanium and other semiconductor materials will be studied by electron-spin resonance and spin relaxation measurements in crystals under tensile strain. The surface states of germanium, in which the electron density has been enhanced by electrostatic charging will be explored by resonance techniques. Polarized nuclear targets will be produced by saturation of electron-spin resonance.

4.58

Monsanto Chemical Corp., Dayton, Ohio.
HIGH TEMPERATURE GAS LIQUID CHROMATOGRAPHY SUBSTRATES, E. S. Blake. Project 7023(802A), Contract AF 33 (657)-7444; ARC, ARL.

This contract calls for a fundamental investigation of high temperature gas chromatography substrates. Attempts will be made to synthesize and study the properties of thermally stable materials which are potentially superior substrates. Attempts will also be made to separate inorganic compounds by gas chromatography substrates. Attempts will be made to synthesize and study the properties of thermally stable materials which are potentially superior substrates. Attempts will also be made to separate inorganic compounds by gas chromatography, with particular emphasis on metal chelate compounds.

4.59

National Bureau of Standards, Washington, D. C.
HIGH RESOLUTION STUDIES, E. K. Plyler. Project 8603(804A), Contract CSO and A 60-530; CRZC, AFCRL.

The goal of this research is high resolution precision spectroscopy of gases in emission and absorption. The near infrared (1-5 microns) is the region of interest in the electro-magnetic spectrum. In recent months, Dr. Plyler's group has worked in close collaboration with Dr. Benedict at John Hopkins to study intensively the IR bands of various gases including H_2O, D_2O and NH_3.

4.60

New York U., N.Y.
LOW-FREQUENCY ABSORPTION SPECTRA, Y. Beers. Project 9768(803A), Contract AF 49(638)-259; SRPP, AFOSR.

To extend the studies of absorption of vapors and gases to the low microwave and ultra-high frequency regions and to develop instruments and techniques for using this radiation as a tool in studying the properties of gases, liquids and vapors. The rotational transitions, the doubling transitions, the pure quadrupole transitions and the inversion spectra of heavy ammonia and other gases will be studied. These transitions will be checked as to their possible use as frequency standards. The principal object of this research is the study of molecular spectra at frequencies below 6,000 megacycles, actually down to about 300 mc. This involves techniques of high resolution spectroscopy. One improvement is the use of a parametric amplifier which is believed to be the first such use in spectroscopy. In addition to the work on gases, research on nuclear resonance in solids has been initiated.

4.61

New York U., N. Y.
SUB-MILLIMETER AND INFRARED REGIONS OF THE ELECTRO-MAGNETIC SPECTRUM, J. H. Rohrbaugh. Project 5634 (803A), Contract AF 19(604)-2673; CRRC, AFCRL.

Applying techniques extrapolated from millimeter and sub-millimeter spectroscopy which have been obtained during the past twelve years at New York University will investigate the long infrared spectra of reflection and absorption for various crystals at certain temperatures from liquid helium to room temperature and above. The reflectivity and absorption properties will be measured with various layer thicknesses of known values and down to values of very low transmissibility.

4.62

North Carolina U., Chapel Hill.
ULTRASONIC WAVE VELOCITY AND NUCLEAR MAGNETIC RESONANCE IN CRYSTAL, C. V. Briscoe. Project 9760(802A), Grant AF-AFOSR-62-336; SRPS, AFOSR.

The investigation involves measurements using an ultrasonic pulse technique of the elastic constants of several of the alkali halides not previously studied, for example Cs, Rb, Ag, and Tl. The measurements are being made over the temperature range 4.2°K to 300°K. In addition it includes an investigation into the influence of impurity atoms on the elastic constants. These impurities are of two kinds

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RAGR- Advanced Studies Office
RAE- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
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(1) paramagnetic ions such as iron and chromium and (2) other alkali metals and halogens, for example, adding K to NaCl or Cl to Kd. The same very pure specimens will be used in both experiments.

4.63

Ohio State U., Columbus.
FAR INFRARED SPECTROSCOPY, E. E. Bell. Project 8603 (804A), Contract AF 19(604)-4119; CRZC, AFCRL.

The goal of this research is the study of the far-infrared spectral region, that is, the region extending beyond 50 microns. This involves the design and construction of spectroscopic apparatus and accessories for this region, but is primarily aimed at studies of the molecular absorption in this region by molecules of the atmosphere. The effort of the past year has involved the construction and testing of a new far-infrared spectrometer using an interference modulator as an order sorter.

4.64

Oxford U., (Gt. Brit.).
INTENSITIES OF INFRARED BANDS, H. W. Thompson. Project 7603(804A), Contract AF 61(052)-202; CRZC, AFCRL.

This is a study of the intensities of entire absorption bands in the infrared. The region of primary interest is 1 to 15 microns. Primary emphasis has been on absorption bands of liquids and solutions, but some studies are made on gases and solids.

4.65

Paris U. (France).
X-RAY SCATTERING BY POINT DEFECTS, A Guinier. Project 9763(802A), Grant AF-AFOSR-62-51; SRPS, AFOSR.

This investigation will utilize the fact that the X-ray scattering by point defects varies very slowly with the angle of scattering. Hence it is possible to obtain reliable data by measuring the scattering in a solid angle much larger than usual. A preliminary study will be made for the selection of the most advantageous wave length. The observation of defects will begin with those defects for which the expected scattering is high, a solid solution containing a small percentage of solute, and progressively move to the more difficult cases.

4.66

Paris U. (France).
FAR INFRARED SPECTROSCOPIC INSTRUMENTATION, J. Lecomte. Project 8603(804A), Contract AF 61(052)-137; CRZC, AFCRL.

The research is directed toward studies of a basic nature in the spectral region beyond 15 microns; this involves obtaining spectra of gases, solids and liquids in that spectral region. Since spectroscopy in this region is difficult, improvements on old techniques are required as well as studies of new and more effective techniques. Recent work consisted of measurements of absorption of the alkali halides, NaF, NaBr, NaI, in the region 200 650 microns. A new absorption band of TiO Ba located at 51μ has been found. A new water (liquid state) band at 60μ has been found. Far IR spectra of $PO_4AH_5H_2$, quarts and silica, and boric acid have been obtained. Absorption and reflection spectra of some metallic films were measured. With polyethylene coated with aluminum a film of 25% transmission and 25% reflection has been made. This will be useful as a beam-splitter necessary for interferometric spectroscopy.

4.67

Pennsylvania State U., University Park.
MEASUREMENT OF BORON AND OTHER IMPURITIES IN SEMICONDUCTOR MATERIALS BY MASS SPECTROMETRY, L. Herzog. Project 5620(802A), Contract AF 19(604)-5538; CRRC, AFCRL.

The object of this research is the investigation of the parameters associated with a prototype solid-source mass spectrograph capable of detecting impurities in solid-state matrices at levels of one part per billion and less. This sensitivity is required for the determination of the level of purity of solid state semiconductor matrices. This study consists of: development of a tandem analyzer nuclide analysis system with an abundance sensitivity greater than one billion; development of a sputtering process ion source; an alternate radio-frequency spark type ion source; a tandem magnetic analyzer; electron-type ion source and electrostatic energy filter and its supply; and the testing and construction of an electronic multiplier detector.

4.68

Pennsylvania State U., University Park.
SPECTRA OF OXIDES OF NITROGEN, I. C. Hisatsune. Project 8603(804A), Contract AF 19(604)-7987; CRRC, AFCRL.

The research is directed toward the experimental study of the infrared bands of the oxides of nitrogen. The group performs experimental studies using low and medium resolution infrared spectrometers on the absorption bands of the oxides of nitrogen in the 1-30 micron region. The purpose is to determine the location and intensity of the infrared

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absorption bands of the various oxides of nitrogen and their dependence on pressure and temperature. The bands are identified as far as possible and used to deduce the molecular constants. Multitraversal cells, heated and cooled absorption cells and other related equipment are used.

4.69

Pennsylvania State U., University Park.
SPECTROSCOPIC INSTRUMENTATION, T. K. McCubbin. Project 8603(804A), Contract AF 19(604)-5458; CRZC, AFCRL.

The objective is the development of methods of doing high resolving power spectroscopy for the study of line widths and shapes of molecular spectra. Research in developing infrared multiple-beam interferometric techniques is also planned. Difficulties which arise when precise wavelength measurements are attempted have been overcome. Prof. McCubbin is confident of wavelength measurements to .005 cm^{-1}. Two bands of H_2O have been measured and agreement with Rank's highly accurate values is within $\pm$ .005 cm^{-1}.

4.70

Pennsylvania State U., University Park.
CRYSTAL IMPERFECTIONS AND SURFACE PROPERTIES OF HIGH MELTING METALS STUDIED BY FIELD ION MICROSCOPY AND FIELD EVAPORATION, E. W. Mueller. Project 9761(802A), Grant AF-AFOSR-62-96; SRPS, AFOSR.

Crystal imperfections of atomic dimensions in metal crystals, particularly tungsten, rhenium, and high melting metals, will be investigated using field ion microscopy. Imperfections will be created by α-radiation, and recovery will be studied. Fine structure of slip bands and fatigue, induced by a cycling applied field stress, will be studied in the microscope. The work function of tungsten will be accurately determined from field evaporation data, and the effects of alloying on field evaporation determined.

4.71

Philips Labs., Inc., Irvington-on-Hudson, N.Y.
X-RAY DETERMINATION OF PRECISION LATTICE PARAMETERS, W. Parrish. Project 9763(802A), Contract AF 49(638)-620; SRPS, AFOSR.

The need for a new approach in the X-ray determination of lattice parameters was shown vividly by the results of a recent international test of the accuracy of lattice parameter determinations. Fifteen of the most experienced X-ray analysts throughout the world under carefully controlled conditions cooperated in measuring the same homogeneous samples of three substances, using various existing techniques and methods they had developed. The spread of results was about 0.035% and even after the values which were furthest removed from the other were taken out, the spread was 0.014%. Prior published claims for precision were between 0.0001% and 0.00003%. It is obvious that such claims cannot be substantiated and that the problem requires careful study from a theoretical as well as experimental point of view. The results should be of the greatest interest in the solid state sciences where precision measurements are required for studies of crystal perfection, the role of impurities, strain and similar problems. In the field of general physics, there is now considerable doubt as to the precision of the X-ray determination of the Siegbahn-Avogadro number. It is hoped that this research will clarify these problems.

4.72

Physical Studies, Inc., Centerville, Ohio.
PRESSURE INDUCED EMISSION, R. G. Breene. Project 8603(804A), Contract AF 19(604)-8417; CRZC, AFCRL.

The theoretical calculation of the induced infrared emission of homonuclear molecules such as N_2 and O_2 at high pressures and temperatures such as exist in the shock wave of an aerodynamic body passing through the atmosphere.

4.73

Picker X-Ray Corp., Cleveland, Ohio.
LOW ENERGY X-RAYS, E. White. Project 7364(802A), Contract AF 33(616)-7177; ASRC, ASD.

Basic research on methods of studying X-ray spectra in the 15 to 50 Å region is being conducted. Techniques and equipment developed will be applied to the study of L spectra shifts and fine structure for such metals as iron, manganese, and titanium, and of K spectra of such elements as nitrogen, oxygen and carbon. An exhaustive literature search is nearly completed and designs have been formulated for instrumentation. Progress is noted in builtup monolayer analyzing devices.

4.74

Pittsburgh U., Pa.
INFRARED LINE WIDTHS, W. M. Benesch. Project 8603 (804A), Contract AF 19(604)-6138; CRZC, AFCRL.

The effort is directed toward a better understanding of the details of the line width of individual rotational absorption lines as a function of the vibration-rotational state of the molecule. Toward this end a vacuum spectrograph is being finished which has an unusual hydraulically operated grating wavelength drive system and also makes use of a Michelson-type interferometer to measure the angle of rotation

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of the grating. The study of line widths includes the use of various broadening gases. Also a program of observation of line widths of molecules in electrodeless discharges has been started.

4.75

Polaroid Corp., Waltham, Mass.
INFRARED BACKGROUNDS, R. C. Jones. Project 7670 (770A), Contract AF 19(604)-3903; CRZC, AFCRL.

The purpose of the work is to perform theoretical studies of infrared target detection problems utilising information theory with application to techniques of target discrimination and background suppression.

4.76

Polytechnic Inst. of Brooklyn, N. Y.
INFRARED SPECTRAL STUDY OF INTRAMOLECULAR AND INTERMOLECULAR FORCES, R. P. Bruman. Project 7364(802A), Contract AF 33(616)-6778; ASRC, ASD.

Intermolecular interactions and the results of these on infrared vibrational spectra are being investigated. The work is being conducted along two lines; weak interactions, such as those between tetrahedral molecules in the liquid phase, are being examined and strong interactions, such as hydrogen bonding, are receiving attention. In the spectrum of CF_4 in CCl_4 solution there appears to be some splitting of the normally degenerate vibrations of this tetrahedral molecule. This may be due to the appearance of hot bands and a further investigation of the vapor spectrum at low temperatures is being carried out. Hydrogen bonding is being studied through the use of dihydroxyanthraquinones. Since the bonding groups are fixed in space at positions which can be determined from a knowledge of bond angles and lengths, these molecules are well suited to a study of this type. Attempts are being made to purify 2,6-dihydroxyanthraquinone (anthraflavic acid).

4.77

Pomona Coll., Claremont, Calif.
PHYSICS OF SOFT X-RAYS, B. Henke. Project 9751 (801A), Contract AF 49(638)-394; SRPP, AFOSR.

Soft X-ray sources, monochromators and detectors have been constructed for studies in the wavelength region between conventional X-rays and the extreme ultraviolet. Improved sources combined with ellipsoidal reflecting monochromators are expected to improve microfocus techniques for improved measurements on the electronic structure of light-mass elements in radio- and radio-photoluminescent solids and in the anomalous dispersion region of thick and film targets. Further extension to mass and chemical composition determination for microsystems containing either inorganic or organic compounds and interpretation of photo- and auger-electron phenomena are also expected.

4.78

Providence Coll., R. I.
THEORETICAL STUDIES OF LINE SHAPES, E. K. Gora. Project 8603(804A), Contract AF 19(628)-282; CRZC, AFCRL.

Theoretical analysis of the generalization of the Boltzmann equation with applications to the study of line shapes. Detailed calculations of the spectral contour of the far infrared absorption spectrum of ozone and SO_2 have been carried out to permit comparison with experimental data.

4.79

Purdue U., Lafayette, Ind.
COORDINATION KINETIC CHROMATOGRAPHY, D. W. Margerum. Project 9763(802A), Contract AF 49(638)-60; SRC, AFOSR.

The feasibility of using coordination kinetics as a general tool for separation and analysis of metal ions will be determined, along with a study of the coordination reaction rates and the variables affecting them.

4.80

Rutgers U., New Brunswick, N. J.
NUCLEAR MAGNETIC RESONANCE INVESTIGATION OF THE PROPERTIES OF MATTER, H. C. Torrey, H. Y. Carr. Project 9760(802A), Contract AF 49(638)-755; SRPS, AFOSR.

The investigation will be concerned with such problems as: (1) dynamic polarization of nuclear spins at low temperatures and the attainment of extremely low temperatures; (2) a study of the Overhauser effect in liquids; (3) nuclear magnetic resonance studies of the solid, liquid, and gaseous states of monatomic systems; (4) use of nuclear magnetic resonance techniques in fundamental studies of self diffusion and liquid structure of water; (5) the application of steady-state free precession techniques to the measurement of nuclear spin relaxation times and self diffusion coefficients; (6) the use of intense rf pulses to eliminate the effect of the inhomogenity of magnetic fields on response width in nuclear magnetic resonance; and (7) development of a high Q filter.

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4.81

Southern Research Inst., Birmingham, Ala.
INFRARED SPECTRA OF SUBSTITUTED AROMATIC COMPOUNDS, W. Wilcox. Project 7364(802A), Contract AF 33(616)-5855; ASRC, ASD.

The objective of this work is to conduct a basic study of the infrared spectra from 2 - 35 microns of certain aromatic compounds to establish a better understanding as to the relationship between the wavelength and intensity of characteristic ring frequencies and the nature of the substituents bonded to the aromatic ring. Empirical correlations of the physical properties and specific frequencies of these molecules will be made to give information of value in determining the nature of the substituents bonded to an aromatic ring. Calculations of molecular constants will be made for a few molecules in order to test the correlations of frequency and group properties and to provide more information on what substitution does to the ring. This effort will be oriented toward more theoretical approaches to establish the feasibility of making reliable correlations of absorption spectra and other physical constants. Successful correlations of this type, would yield information on molecular structure and aid in predicting chemical reactivity of unknowns.

4.82

Stanford Research Inst., Menlo Park, Calif.
DESIGN PARAMETERS FOR AN INSTRUMENT FOR STUDY OF IONS WITH NANOSECOND LIFETIME, A. H. Samuel. Project 7023(802A), Contract AF 33(657)-8211; ARC, ARL.

The Contractor shall consider the theoretical feasibility of a mass spectrometer for the study of ion-molecule reactions occurring at or near atmospheric pressure. To determine actual design parameters for such an instrument, it is necessary to make design calculations of the dimensions of the pinhole gas leak necessary to produce a well defined ion beam; and calculations of the necessary energy dose rate to permit detection of ions by the mass spectrometer. The contractor shall also determine the effects of air currents, caused by cooling, on the collection of ions; and determine the effect of pressure variations (in the range 0.1 to 1 atmosphere) in the irradiated region in front of the pinhole, on gas flow and ion lifetime.

4.83

Stanford Research Inst., Menlo Park, Calif.
X-RAY FLUORESCENCE SPECTROSCOPY, S. Taimuty. Project 5621(802A), Contract AF 19(604)-8827; CERC, AFCRL.

The contract calls for an investigation of the X-ray fluorescence analysis with the objective to increase substantially the sensitivity of this method. It is expected that the results of this contract would make it possible to determine local changes of the impurity concentration in solid materials, such as, laser crystals (ruby, etc.).

4.84

Stanford U., Calif.
CHEMICAL APPLICATION OF NUCLEAR MAGNETIC RESONANCE, R. A. Ogg. Project 9760(802A), Contract AF 49(638)-286; SRC, AFOSR.

The research will apply techniques of high resolution nuclear magnetic resonance to obtain information about molecular structure of certain chemical substances and of the changes these undergo during reaction. This approach should permit detection and study of short-lived reaction intermediates. Prime emphasis will be given to inorganic compounds of nitrogen and boron.

4.85

Stanford U., Calif.
PARAMAGNETIC RESONANCE MAGNETISM AND THERMO PROPERTIES AT LOW TEMPERATURES, G. E. Pake. Project 9751(801A), Contract AF 49(638)-1056; SRPP, AFOSR.

The objective of this research is to develop methods of measuring electronic and nuclear spin lattice relaxation times at extremely low temperature and to analyze these data in terms of the exchange interactions, nuclei-electron interaction and dipolar interactions between pairs of electrons and pairs of nuclei. More careful studies of the Overhauser effect as a possible means of achieving nuclear alignment at low temperature will also be carried out. The studies of the physical laws governing atomic and molecular rotation and coupling of rotations is basic to the development of new materials and fuels and to the understanding of the apparently anomalous behavior of some of the well-known substances in excited states.

4.86

St. Louis U., Mo.
ELECTRONIC AND NUCLEAR PARAMAGNETISM AND ENERGY TRANSFER MECHANISMS, V. P. Jacobsmeyer. Project 8503(803A), Contract AF 30(602)-2204; RAWA, RADC.

This program is aimed at an understanding of spin coupling mechanisms in various solids at room temperature and low temperature. High nuclear spin polarization will be sought using Overhauser and Abragam effect. Efforts to date have been mainly concerned with instrumentation and design and choice of suitable samples. Suspensions of metallic

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particles, F, V and X centers are being investigated. Several resonance experiments have been performed concerning nuclei in solution via NMR techniques. X_2 and Cl_2 centers have been observed in several alkali halides at liquid nitrogen temperatures. Double resonance experiments have been performed so that the coupling mechanisms could be understood more thoroughly. Advances in the understanding of paramagnetic properties of various spin centers in solids may lead to maser type devices of use in r.f. and quite possibly to achievability of tunable four level masers operating at much higher microwave frequency than the pump.

4.87

Syracuse U., N. Y.
PRESSURE BROADENING IN THE FAR INFRARED, N. Ginsberg. Project 8603(802A), Contract AF 19(604)-2443; CRZC, AFCRL.

The purpose of the contract is to conduct studies of molecular line shape and widths in the far infrared particularly those molecules found in the atmosphere, of which H_2O is by far the most important. To this end a far infrared grating spectrometer has been built at Syracuse by Ginsburg and his co-workers. The instrument has only recently been brought into operation, and there are no completed studies as yet. The scope of the contract has recently been expanded to include studies of far infrared properties of crystals at low temperatures.

4.88

Syracuse U., N. Y.
PARAMAGNETIC RESONANCE IN SEMICONDUCTORS, A. Honig. Project 9763(802A), Contract AF 49(638)-966; SRPS, AFOSR.

Excited electronic states of impurities in pure solid matrices will be studied using paramagnetic resonance and infrared radiation techniques. A large variety of impurities including shallow and deep donors in silicon, and high energy radiation induced centers, should be subject to investigation in this manner. Conduction electron-bound electron exchange will be studied for "hot" electrons. Direct measurement of ionization energies for shallow donors will be made using spin resonance techniques. Solid state optical pumping studies will be initiated. These combined magnetic resonance and infrared radiation studies will play a very important role in understanding the behavior of impurities in solids, and should lay the groundwork for important applications such as high frequency generation and detection into the infrared region.

4.89

Tennessee U., Knoxville.
HIGH RESOLUTION STUDIES, A. H. Nielsen. Project 7670(770A), Contract AF 19(604)-7981; CRZC, AFCRL.

The research is primarily directed toward the high resolution spectral studies of molecules which are present in the flames of various fuels and oxidizers for example CO_2, CO and HF. They have recently made an intensive study of HF including the spectra of its dimer H_2F_2 and the pure rotational spectra to determine line position, shape and intensity. They are also completing the analysis of the some five-hundred lines that fall in the 4.3μ spectral region of CO_2.

4.90

Texas A. and M. Research Foundation, College Station.
STUDY OF LIQUIDS IN BINARY MIXTURES BY NUCLEAR MAGNETIC RESONANCE TECHNIQUES, M. Eisner. Project 9751(801A), Grant AF-AFOSR-62-151; SRPP, AFOSR.

This is an experimental program using nuclear magnetic resonance techniques to study the range of intermolecular forces between like molecules in liquids.

4.91

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
HIGH RESOLUTION MOLECULAR STUDIES, J. S. Garing. Project 8603(804A), Internal.

The effort involves the use of the high resolution double prism-grating spectrometer at CRZCL to obtain and analyze high resolution spectra of the vibration-rotation bands of various molecules. Certain improvements have been incorporated into the instrument particularly a much improved photometric accuracy which has been used for accurate band intensity measurements. An interferometer system for measuring the rotation of the grating together with a digital readout system will soon permit automatic accurate readout of the frequencies of the absorption lines. At present data have obtained primarily for the 9 and 9.6μ bands of ozone and computer programs are being worked out to help analyze these bands which are extremely complex. These studies will include other molecules of atmospheric interest.

4.92

Thermal Radiation Lab, CRZ, AFCRL, Bedford, Mass.
INFRARED VIBRATION-ROTATION BAND MEASUREMENTS, B. D. Schurin. Project 8603(804A), Internal.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
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CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZH- Sacramento Peak Observatory

The high resolution double-beam grating spectrophotometer at the Air Force Cambridge Research Laboratories is being used for measurements of atmospheric molecular band intensities. Auxiliary apparatus has been designed and constructed to facilitate the use of the spectrophotometer for such measurements. A commercial spectrometer (Beckmann IR-7) has been acquired to complement the high resolution instrument. It has been correspondingly modified to allow lower resolution measurements over a wider region of the spectrum. These data are needed to obtain radiation transfer properties of atmospheric molecules. Measurements have been completed for the fundamental band of nitric oxide and efforts are under way to extend the measurements to the overtones and to the other oxides of nitrogen.

4.93

Thermal Radiation Lab., CRZ, AFCRL.
INTERFEROMETRIC TECHNIQUES, G. A. Vanasse. Project 8603(804A), Internal.

The digital-tape readout system and computer programming for the large lamellar-grating type two-beam interferometer has been completed and work is in progress to obtain far infrared spectra for line broadening studies. New interferometric and analog data handling techniques are also being developed. Theoretical studies include improved methods of transforming the interferometric data to spectra.

4.94

Tufts U., Medford, Mass.
HIGH RESOLUTION INFRARED BAND INTENSITIES, M. K. Wilson. Project 8603(804A), Contract AF 19(604)-8033; CRZC, AFCRL.

This research involves the use of a high resolution spectrometer to measure the position and intensities of the infrared absorption bands of various molecules of atmospheric interest or that may occur in rocket exhausts. The experimental results will be used to calculate molecular structure parameters and to determine molecular force fields.

4.95

Utah State U., Logan.
INFRARED LUMINESCENCE PRODUCED IN GASES BY HEAVY ION BOMBARDMENT, D. J. Baker. Project 8658(804A), Contract AF 19(628)-251; CRZC, AFCRL.

Investigate and develop experimental techniques for determining the principal excitation mechanisms responsible for the emission of infrared radiation from atmospheric gases when they are bombarded by heavy ions, and determine quantitative data on the interaction cross sections and fluorescent efficiencies. Investigate the role of charge exchange (which may leave either of the two resulting "particles" excited) as a function of the energy and kind of particles which do the excitation. The energy of the exciting particles should range from a few kilovolts to at least 250 kilovolts. The excitation and energy loss processes are to be studied as a function of pressure (at least 10^{-5} atmospheres) and target gas composition.

4.96

Vienna U. (Austria).
POLAROGRAPHIC STUDIES IN CERTAIN NON AQUEOUS SYSTEMS, V. Gutmann. Project 7023(802A), Contract AF 61(052)-487; ARC, ARL.

Fundamental studies will be made on the polarography of substances in organic and inorganic polar solvents, for the purpose of determining the many parameters of oxidation-reduction phenomena. The theory of the "anion-effect" will be tested by half-wave potential measurements in these polar solvents. The polarographic behavior of traces of water in these solvents will be determined. Means will be determined for more accurate measurements of liquid junction potentials. Standard electrode potentials of a series of ions will be measured and established in the polar solvents found applicable for this purpose.

4.97

Warner and Swasey Research Corp., New York.
INFRARED MOLECULAR BAND MODELS AT HIGH TEMPERATURES AND VIBRATION-ROTATION LINE WIDTHS AND STRENGTHS, H. J. Babrov. Project 9768(803A), Contract AF 49 (638)-1127; SRPP, AFOSR.

This research concerns the measurement of the integrated absorption of molecular infrared bands and of lines within these bands, at temperatures up to 3500°K and possibly higher.. Measurements will be made under a variety of conditions of temperature, path length, and pressure of absorbing and broadening gases. The measured band absorption of simple molecules will be compared with that predicted on the basis of various theoretical models of a molecular band, with the object of establishing the limits of applicability of these models. It is also planned to calculate optical collision cross sections from the data on the line widths of simple molecules. These computations will aid in the study of the dependence of the optical collision cross sections on the rotational quantum number of the absorbing gas, on a nature of the broadening gas, and on the temperature.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARA- Hypersonics Research Lab
ARS- Solid State Physics Research Lab
ARM- Metallurgy & Ceramics Research Lab

AFD- Aeronautical Systems Division
AFRC- Directorate of Materials & Processes
AFRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAGR- Advanced Studies Office
RAE- Directorate of Engineering
RADA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEDR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESRH- Operational Applications Lab

4.98

Washington U., Seattle.
VIBRATIONAL AND VIBRATION-ROTATIONAL SPECTROSCOPY, D. F. Eggers. Project 9760(802A), Contract AF 49 (638)-797; SRC, AFOSR.

This is a study of vibrations and rotations of small molecules and calculation of atomic motions, forces, and energies, by means of infrared absorption spectra, using new measurements made possible by high resolution techniques, partial isotopic substitution and very low temperatures.

4.99

Washington U., Seattle.
NUCLEAR MAGNETIC RELAXATION TIMES, E. A. Vahling. Project 9760(802A), Contract AF 49(638)-92; SRPS, AFOSR.

The relaxation time T_1 of the protons in hydrogen-bonded ferroelectric crystals KH_2PO_4, KD_2PO_4, and KH_2AsO_4 is being experimentally determined by nuclear magnetic resonance techniques over a range of temperatures including the transition temperature. The results will be interpreted in terms of quadripolar coupling, lattice vibrations, and spin diffusion. Acoustic excitation of spin resonance will be attempted.

4.100

Washington U., St. Louis, Mo.
APPLICATION OF MAGNETIC RESONANCE TO SOLID STATE PHYSICS, J. Townsend. Project 9760(802A), Grant AF-AFOSR-62-320; SRPS, AFOSR.

Spin diffusion in ionic crystals is being studied by nuclear magnetic resonance (nmr) techniques in solids rotated mechanically at 8 Kcps to reduce dipolar broadening. The asymmetry in the rise and decay tissues of Overhauser polarization in metallic sodium and lithium will be determined.

4.101

Washington U., St. Louis, Mo.
PARAMAGNETIC RESONANCE ABSORPTION OF FREE RADICALS AND OTHER SUBSTANCES, R. E. Norberg. Project 9751 (801A), Contract AF 49(638)-464; SRPP, AFOSR.

This research studies the relationship between hyperfine spectral structure and the electronic spectra of free radicals and interprets the effects of excitation from inner shells and energy transitions. In addition to free radicals, intra-molecular electron migration is also considered extensively. Work involves both hydrocarbon and silicone equivalents along with substituted organics and atmospheric constituents.

4.102

Weismann Inst. of Science (Israel).
INFRARED ABSORPTION LINES, J. H. Jaffe. Project 8603(804A), Contract AF 61(052)-388; CRZC, AFCRL.

The large grating-spectrometer-hollow prism-refractometer at Weismann Institute is used for studies of the determination of line strengths and widths in molecular absorption spectra at normal and elevated temperatures, including by measurement of the optical dispersion (index of refraction), and of the determination of pressure induced shifts of individual lines at normal and elevated temperatures. Complementary theoretical studies are also being made.

4.103

Weismann Inst. of Science (Israel).
INFRARED DISPERSION OF GASES, J. H. Jaffe. Project 8603(804A), Contract AF 61(052)-57; CRZC, AFCRL.

This contract is concerned with experimental and theoretical studies of the infrared dispersion of gases in the neighborhood of infrared absorption bands. Apparatus has been designed and constructed which records dispersion curves automatically instead of on a point to point basis. The data is being interpreted to obtain values for the intensity and half widths of spectral lines. Primary interest is focused in the lithium fluoride region of approximately 1 to 7 microns. Studies have been made on gases with widely spaced lines such as HCl. As suitable techniques are developed the emphasis will shift to the atmospheric gases such as CO_2, H_2O, H_2O and CH_4.

See also: 1.44, 2.2, 2.15, 2.23, 2.58, 2.62, 2.76, 3.6, 3.16, 3.21, 3.27, 3.30, 3.57, 3.91, 3.128, 3.132, 6.2, 6.46, 6.84, 6.90, 6.103, 6.119, 7.1, 7.5, 7.7, 7.8, 7.17, 7.55-56, 7.64, 7.80, 7.103, 9.62, 11.5, 11.108, 12.39, 12.69, 12.118, 12.133, 14.59, 14.69, 14.104, 14.109, 16.141, 18.27, 20.14, 20.77, 22.4, 23.2, 23.11, 23.35.

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5. METALLURGY

Diffusion in Metals and Alloys; Electronic Structure of Metals and Alloys; Interstitial Effects in Metals; Mechanical Properties of Metals; Metallic Whiskers; Oxidation in Metals; Plastic Deformation in Metals.

5.1

Arizona U., Tucson.
IMPERFECTIONS IN METALS, C. T. Tomizuka. Project 9760(802A), Contract AF 49(638)-790; SRPS, AFOSR.

The specific studies shall include: (1) diffusion experiments in pure noble metals will be carried out using radioactive tracer techniques under hydrostatic pressure; (2) some diffusion experiments will be carried out, not as a function of pressure, but simply to obtain the activation energy to supplement item 1; (3) internal friction (anelastic) measurements will be conducted in alpha-brass type alloys, especially the possible isotope effect will be investigated; (4) some tracer diffusion experiments in alloys will be undertaken to supplement item 3; and (5) resistivity increase of quenched-in wires of noble metals will be measured as a function of hydrostatic pressure in which the quenching took place.

5.2

Armour Research Foundation, Chicago, Ill.
FACTORS GOVERNING YIELD EFFECTS IN METALS, W. Rostocker, P. R. V. Evans. Project 7024(802A), Contract AF 33(657)-7650; ARZ, ARL.

The contractor shall begin a two part research program on factors governing yield effects in metals. The first, using columbium as a base metal should arrive at a knowledge of the separate contributions made by interstitials to the proportionality constant in the lower yield stress-grain size relationship. The second, using metals of the three common crystal systems, is designed to obtain an understanding of the real significance of the proportionality constant. Both phases of this program are applicable to the internal work of the Metallurgy and Ceramics Branch on high purity iron in which the lower yield-grain size relationship is being used.

5.3

Battelle Memorial Inst., Columbus, Ohio.
EFFECTS OF INTERSTITIAL ELEMENTS ON THE INTERNAL FRICTION OF CHROMIUM, E. Maringer. Project 7024 (802A), Contract AF 33(616)-7993; ARZ, ARL.

Measurements of the internal friction and shear modulus of chromium are being made over the temperature range -180°C to +700°C after various heat treatments. Such measurements will also be made for iodide chromium to which interstitials (carbon, nitrogen, oxygen) have been purposely added so that their effects can be studied individually. The activation energy of stress-induced interstitial diffusion peaks is to be determined.

5.4

California Inst. of Tech., Pasadena.
PHYSICAL PROPERTIES OF METALS AND ALLOYS AT ELEVATED TEMPERATURES, P. Duwez. Project 9760(802A), Contract AF 49(638)-1034; SRPS, AFOSR.

Theoretical investigation to determine a relationship between the temperature dependence of atomic spacing and X-ray diffraction intensities on one hand, and specific heat, electrical conductivity and elastic constants on the other hand. X-ray diffraction study of the kinetics of transformation of metastable alloys obtained by quenching from the melt.

5.5

California U., Berkeley.
HEAT CAPACITY OF ALLOYS, Project 9760(802A), Contract AF 49(638)-83; SRPS, AFOSR.

The heat capacity of binary alloy systems and pure metals is being measured precisely over the temperature range from 400°K to 1500°K. Deviations from Kopp's law are being investigated. Samples are of single phase, high purity, and known composition. Materials such as iron, chromium, nickel, platinum, thallium, silver, palladium, and their alloys are being used.

5.6

California U., Berkeley.
ELECTRONIC STRUCTURE OF METALS, A. F. Kip. Project 9760(802A), Grant AF-AFOSR-62-127; SRPS, AFOSR.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAGR- Advanced Studies Office
RAS- Directorate of Engineering
RASA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AERR- Research Division
AFWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

Cyclotron resonance studies at 12, 8, and 4 mm wavelengths are being conducted on high purity, single crystals of such metals as aluminum, sodium, potassium, tin, and copper. These studies provide information about the Fermi surface of these materials, the effective masses of the electrons, and the relaxation times of the conduction electrons. The studies are being extended to 2 mm wavelengths and to the transition metals.

5.7

Cambridge U. (Gt. Brit.).
MECHANICAL PROPERTIES OF METAL CRYSTALS, P. B. Hirsch. Project 9760(802A), Contract AF 61(052)-98; SRPS, AFOSR.

The study of the mechanical properties of metal crystals containing particular distributions of dislocations in order to arrive at a better understanding of the various factors influencing the flow stress of metals. Investigations will be made first on face-centered cubic metals and alloys and then on hexagonal and body-centered cubic metals. In addition similar studies will be made on specimens irradiated with neutrons and after quenching treatments. Pure metals as well as metals with controlled amounts of impurities will be studied in both the single and polycrystalline form.

5.8

Cambridge U. (Gt. Brit.)
STRUCTURAL INVESTIGATION BY X-RAY DIFFRACTION METHODS OF TRANSITION METAL ALLOYS, W. H. Taylor. Project 9760(802A), Grant AF-EOAR-61-24; SRPS, AFOSR.

Contribution to the fundamental study of alloy chemistry, and, in particular, is providing information about the electron distribution in the alloys of the transition metals, iron, cobalt, nickel, copper, chromium, and manganese. Specific phases being studied at present include CoAl, Nb_3Al, dilute solutions of Mn, V, and Cr in Al, intermetallic compounds between V-Al, Fe-Al, etc. Determination of the actual electronic structure of these metals will provide a basis for understanding their magnetic and mechanical properties. The approach in this research consists of measurement of the absolute intensity of X-ray diffraction patterns from selected alloy structures.

5.9

Carnegie Inst. of Tech., Pittsburgh.
OPTICAL PROPERTIES OF METALS AND ALLOYS, W. R. Bitler. Project 9761(802A), Contract AF 49(638)-478; SRPS, AFOSR.

An attempt is being made to determine the electronic structure from reliable optical data; the coefficient of reflection of the metal; the absorption of light by thin films; and the rotation of the plane of polarization of magnetic metals, these being determined over a range of temperature down to liquid helium. Experiments will be conducted in vacuum to maintain a high degree of surface cleanliness and to study the effects of small amounts of gases on surface contamination.

5.10

Carnegie Inst. of Tech., Pittsburgh, Pa.
MECHANISM FOR EVAPORATION OF METAL CRYSTALS, J. P. Hirth, W. H. Robinson. Project 9761(802A), Contract AF 49(638)-551; SRPS, AFOSR.

This research is to determine quantitatively the evaporation rates from single crystal and polycrystal metal surfaces as a function of time, temperature, crystal orientation, and degree of crystal perfection. The results of the investigation will be compared with predictions of a theoretical treatment which is under continuing development. In addition, the theoretical kinetics of evaporation from crystals in equilibrium with atomic or molecular vapor phases will be derived. The method of investigation will include a study of thermal etching with the formation of etch pits at the sites of dislocations in the crystals. This aspect of the study will be correlated with X-ray studies to determine crystal perfection.

5.11

Carnegie Inst. of Tech., Pittsburgh, Pa.
NUCLEATION AND GROWTH OF METALS DEPOSITED FROM VAPOR AND OXIDATION OF ALLOYS, G. M. Pound, F. Maak. Project 9761(802A), Contract AF 18(600)-1572;SRPS,AFOSR.

This research is concerned with basic investigations on two important aspects of metal and alloy surfaces: (1) nucleation and growth in deposition of metals from vapor; and (2) oxidation of alloys. Nucleation, growth, and surface diffusion in deposition of metals from the vapor on various metallic substrates will be studied. A special Mueller field emission microscope has been developed for such studies and a fairly complete and quantitative elucidation of the adsorption and nucleation of silver on a clean tungsten surface achieved. This study will be extended to cover a range of substrate temperatures. Also, other systems, such as cesium on tungsten, gold on tantalum, and silver or gold on tungsten oxide layers will be studied. Finally, the work may be extended to systems of greater practical importance, e.g., titanium or niobium on tantalum, molybdenum or nickel. Further, a new and interesting field of oxidation, namely the passivation of alloys by thermal

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"prior" oxidation treatments will be studied. The systems which will be investigated are Cu-Be, Cu-Al, Cu-Si, Fe-Al and Fe-Cr.

5.12

Case Inst. of Tech., Cleveland, Ohio.
ELECTRONIC STRUCTURE OF METALS AND DILUTE ALLOYS, W. L. Gordon, T. G. Eck. Project 9760(802A), Contract AF 49(638)-621; SRPS, AFOSR.

De Haas - van Alphen measurements are being carried out in the magnesium crystals and in magnesium-silver alloy crystals. Cyclotron resonance measurements are being carried out in aluminum crystals cut sufficiently thin that the orbital motion of the electrons begin to be damped out.

5.13

Case Inst. of Tech., Cleveland, Ohio.
EFFECT OF INTERSTITIAL ALLOYING ELEMENTS ON THE MECHANICAL BEHAVIOR OF METALS, A. R. Troiano. Project 7021(802A), Contract AF 33(616)-6419; ARZ, ARL.

A number of critical experiments will be conducted which are designed to fill certain gaps in our knowledge of the behavior of interstitials in metals. These experiments include a determination of the possibility that hydrogen will cause strain aging in iron and its alloys, a determination of the possibility that hydrogen will cause the formation of a tetragonal iron martensite, and a determination of the strain energy involved in the solution of interstitials in a defect lattice. Currently, tests are being made to determine if carbon and nitrogen will produce embrittlement in ferrous alloys in an analogous way to hydrogen.

5.14

Central Institute for Industrial Research, Oslo (Norway).
OXIDATION CHARACTERISTICS OF TANTALUM AND TANTALUM ALLOYS AT HIGH TEMPERATURES, P. Kofstad. Project 7022(802A), Contract AF-EOAR-61-42; ARZ, ARL.

The oxidation characteristics of tantalum and tantalum alloys will be investigated under different conditions in order to evaluate the effect of temperature and gas pressure on the oxidation rate and oxidation rate laws. The formation of the oxide film will be monitored continuously by X-ray diffraction techniques, and the scales formed will be investigated using electron microscopy. The data obtained will be analyzed by applying current high temperature oxidation theories.

5.15

Chicago U., Ill.
EXCITED ELECTRONIC STATES IN SOLIDS USING SECONDARY EMISSION, J. Burns. Project 9760(802A), Grant AF-AFOSR-62-209; SRPS, AFOSR.

The work involves a program of experimental research on the electronic structure of excited states in solids, making use of the angular and energy distribution of secondary electron emission. The research will proceed according to the following schedule: (a) construct apparatus to measure the energy-angular distribution of secondary electrons; (b) obtain data in face-centered cubic metals such as Cu and Ni, body-centered cubic metals such as W and compounds such as MgO, KCl or NaCl; and (c) construct the energy-momentum surface of the excited electronic states of the above materials. No other experimental technique has yet been developed to obtain this information.

5.16

Clarkson Coll. of Tech., Potsdam, N. Y.
ELECTRICAL AND ELASTIC PROPERTIES OF METALLIC SINGLE CRYSTALS, M. C. Martin. Project 9760(802A), Grant AF-AFOSR-62-254; SRPS, AFOSR.

The purpose of this project is as follows: (1) to investigate the effect of plastic strain on the electrical resistivity of alpha-iron, beta-brass, nickel, and zinc single crystals; (2) to see whether or not the results fit the theoretical predictions on the number of defects created and length of dislocations formed by plastic strain by making use of the calculated values for the resistivity increase caused by one defect; (3) to investigate the effect of heat treatments on the change of electrical resistivity with plastic strain produced by mechanical loading; and (4) to investigate the effect of heat treatments on the elastic properties within the elastic limit of these single crystals.

5.17

Delaware U., Newark.
DIFFUSION IN CRYSTALS, C. E. Birchenall. Project 9760(802A), Grant AF-AFOSR-62-174; SRPS, AFOSR.

Volume self-diffusion studies, using radioactive techniques, will be carried out in cobalt and in cobalt-iron alloys near the magnetic transformation temperatures in applied magnetic fields. In addition, surface self-diffusion in iron, cation diffusion in spinel structures such as nickel ferrite and cation diffusion in Cr_2O_3-Fe_2O_3 solid solutions will be studied.

5.18

Denver U., Colo.
PRINCIPLES OF ALLOY FORMATION USING RARE EARTH METALS, J. F. Wachman. Project 7021(802A), Contract AF 33(616)-6787; ARZ, ARL.

A thorough study will be made of the principles of alloy formation using rare earth metals and being guided by a critical use of the Hume-Rothery rules. The rare earth elements were selected for this research since they effectively provide a means of interposing, between the elements lanthanum and hafnium, a series of sub-transition elements exhibiting a gentle gradation in properties, and whose properties are essentially a function of the atomic number. A suitable binary system (Nd-Pr) with the least number of variables will first be studied. The variables include electronic structure, crystal structure, atomic diameter, valency effects, electronegativity, mean Fermi energy and electron concentration. Using two or three property determinations as criteria, other rare earth binary alloys will be made in which the variables are introduced one by one and the alloys studied using the same criteria. The criteria will be solubility relationships in the alloy system, the approach to ideality in both the liquid and solid solutions, and possibly resistivity.

5.19

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
EFFECTS OF POINT DEFECTS ON THE MECHANICAL AND OTHER PROPERTIES OF CRYSTALLINE SUBSTANCES, H. L. Gegel. Project 7021(802A), Internal.

Aims of the program are the investigation of the effect of point defects in the crystal lattice of metals on the mechanical properties and the effect of an external electrical field on the transport of interstitial ions in metals. It has been shown that clusters of vacancies increase the yield strength of metals; it is of interest to study other properties such as the tensile yield stress and the transient creep. Quenched-in vacancies in the pure metals, Pt, Pd, Ir, etc., will be studied as a function of structure, temperature, and other pertinent variables. The effect of interstitials in metal wires of high purity will be studied by equilibration of the wire with gases, such as H_2, N_2, O_2, C, etc., at various temperatures under the influence of electric fields. By means of electrical resistivity measurements, volume changes, etc., the transport parameters will be measured.

5.20

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
INFLUENCE OF DEFECT STRUCTURE ON THE MECHANICAL PHYSICAL PROPERTIES OF FACE-CENTERED CUBIC METALS, H. L. Gegel. Project 7353(802A), Internal.

To investigate systematically the influence of point defects, stacking faults, and dislocation interactions on the mechanical and physical properties of pure metals and dilute binary alloys. A study of the stacking-fault probability and twinning frequency will help to categorize the width of the stacking faults, their energies, and will also give information as to the influence of certain alloying additions on the stacking fault energy. Pure metals and alloy wires will be quenched from temperatures close to their melting points to determine the energy of formation of point defects and subsequently aged to determine their energy of migration. Included in this work is the athermal nucleation of vacancy clusters and the clustering of solute atoms. Mechanical testing will be performed to study yield point phenomena, work hardening, and a possible ductile brittle transition. Dislocation interactions and nucleation phenomena will be investigated by an electron transmission technique.

5.21

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
SOLID STATE RESEARCH AND PROPERTIES OF MATTER, A. J. Herzog. Project 7021(802A), Internal.

The correlation of the structure and mechanical properties of fine, single crystal whiskers of iron and their growth conditions. Research on this extremely strong crystalline form of iron is essential to the development of stronger materials. The whiskers, grown under qualitatively controlled conditions, are subjected to microscopic investigation for the characterization of their surface and general morphology and to the measurement of their tensile strength. These observations are supported by contractual effort in order to investigate their surface with the electron microscope, their atomic arrangement with the field ion microscope, and their lattice with flash X-ray techniques. Growth conditions for the reduction of ferrous chloride have been found which produce whiskers having strengths up to 1500 Kg/mm^2.

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5.22

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
MECHANICAL PROPERTIES UNDER TRANSIENT TEMPERATURES, A. J. Herzog. Project 7353(802A), Internal.

The metallurgical as well as the mechanical properties of the metal at various depths from the surface will be investigated in order to gain an insight into the results of flash heating because it appears that with the time factor involved (1-3 seconds) the cross section will not be affected uniformly. In addition localized changes due to transformation of phases may occur which influence the results. An unusual behavior in aluminum and its alloys was noted in preliminary tests. The material changed its yield behavior after exposure to very short heating periods. The use of etch pit techniques and the electron microscope in these investigations encourage further work.

5.23

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
KINETICS AND MECHANISM OF WHISKER GROWTH, B. K. Morse. Project 7353(802A), Internal.

The purpose of this effort is to determine the nature of the growth process of the small single crystals known as whiskers. The approach to this problem is two-fold. First, studies will be made of growing whiskers to determine the effect of such parameters as temperature, pressure, partial pressures of the reactants, etc., on the observed growth rate, and to determine the variation of this rate as a function of time. Second, the chemical reaction, $FeCl_2 + H_2 \rightarrow Fe + 2HCl$, will be studied to determine the rate controlling process involved and the variation of reaction rate with the presence of known quantities of impurities such as iron, water vapor, oxygen, etc. These two sets of data having been acquired, a synthesis will be attempted in which the variables of the growth process are related to the variables of the chemical reaction.

5.24

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
KINETICS AND MECHANISMS OF WHISKER GROWTH, J. S. Taylor. Project 7023(802A), Internal.

A detailed investigation of the mechanism of growth of iron whiskers by the reduction of ferrous halide is being undertaken. It has become clear that definitive answers to the structural questions dependent upon growth conditions, for example nucleation, the role played by water vapor, trace impurities in the gases or salts, can be obtained only by a precisely controlled series of experiments. To this purpose equipment for the purification of gases, furnace, temperature recorders and controllers, and precise temperature measurement devices are being assembled or acquired.

5.25

Directorate of Research Analysis, SRAS, AFOSR, Washington, D. C.
INVESTIGATION IN MATERIALS, H. F. Borges. Project 6886(802A), Internal.

Development of uniform experimental techniques for the determination of the mechanical and deformational behavior of certain refractory metals, semi-metals, and inter-metallics. The study will include gross microscopic properties as well as manifestations due to microscopic behavior, in order to obtain a coherent unified picture of the particular metal under investigation. The AFOSR Solar Furnace will be used as the principal tool in this investigation.

5.26

Franklin Inst., Philadelphia, Pa.
DISLOCATIONS IN METALS BY TRANSMISSION ELECTRON MICROSCOPY, H. G. F. Wilsdorf. Project 7024(802A), Contract AF 33(616)-6995; ARZ, ARL.

A basic study of the motions and interactions of dislocations under unidirectional and reversed stress is being made using transmission electron microscopy techniques. Both tensile and fatigue specimens will be examined before and after deformation for dislocation movements and group, patterns, cross-slip, vacancy production, and interactions of these with themselves or the parent structure. These studies will encompass a wide range of stresses, strains, and strain rates and are directed toward increasing our general understanding of the mechanisms of deformation under alternating stress. The dislocation arrangements in an aluminum crystal for one tension and one compression strain of 0.3% are sparsely separated clusters. These dislocation arrangements are similar to those previously found in aluminum crystals deformed by small unidirectional strains.

5.27

Franklin Inst., Philadelphia, Pa.
PLASTIC DEFORMATION BY THE OBSERVATION OF SINGLE DISLOCATIONS, H. Wilsdorf. Project 9760(802A), Contract AF 49(638)-162; SRPS, AFOSR.

In this research program it is planned to study precipitation in dislocations (i) in an alloy whose composition is 69% Cu, 30% Zn, and 1% Cd, and (ii) in either aluminum with copper or silver as "impurity" components or 1-3% optimum conditions for obtaining small precipitates in polycrystalline samples and the correlation of the precipitation patterns with dislocations. Then single crystals will be produced and examined. In addition, experimental information on the following two problems will be sought (i) the creation of dislocations, and (ii) the difference of behavior of dislocations between quenched and room temperature annealed Al 1.5% Cu and alpha brass.

5.28

General Electric Co., Schenectady, N. Y.
DISPERSION HARDENING IN ALLOY SYSTEMS, V. A. Phillips. Project 7021(802A), Contract AF 33(616)-6406; ARZ, ARL.

A study of dispersion hardening in two phase alloy systems is being conducted in order to determine the effects of dispersed particles on the deformation behavior of metals and alloys. High resolution transmission electron microscopy is used on a series of alloys in which the precipitate gives slight, moderate, or extreme hardening. One such series is nickel-alumina, nickel-aluminum, and nickel-beryllium. It is hoped that it will be possible to determine whether dislocations pass through or around the particles during the deformation process. To aid in the interpretation of the observations made with the electron microscope, the deformation behavior of some of the alloys will be studied by some of the more conventional techniques, such as etch pit studies.

5.29

Hebrew U. (Israel).
SOLID STATE CHEMICAL REACTIONS, S. Patai. Project 7013(801A), Contract AF 61(052)-575; ARC, ARL.

The contractor shall extend his experimental investigation of heterogeneous oxidation reactions between solid oxidants and solid organic substrates to high melting polymers other than polydivinyl benzene and high melting organic compounds of known structure. The work shall involve various studies including kinetics of the reaction of the substrate-oxidant pairs selected for investigation; the influence of additive catalysts and inhibitors on the reaction rate; influence of physical factors on the reaction rate; influence of irradiation on reaction mechanism; labeled isotope studies to follow material transfer processes in the reacting system; and a complementary analysis to attempt to correlate the action of additives with their chemical and physical properties.

5.30

Illinois Inst. of Tech., Chicago.
CHEMICAL THERMODYNAMICS OF MATERIALS AT HIGH TEMPERATURES, P. G. Wahlbeck. Project 9762(802A), Contract AF 49(638)-346; SRPS, AFOSR.

The purpose of this work is to investigate the chemical thermodynamics of metals and alloys at high temperatures, that is, the strengths of the chemical bonds between atoms. Measurement at high temperature of the pressure of metal vapor or other constituent over selected alloys gives information about the energy required to break the bonds between one atom and its neighbors in the alloy. A number of metal-hydrogen systems are being studied, the metals being scandium, yttrium, vanadium, niobium, tantalum, thalium, gold, hafnium and their alloys. An intensive, careful study of these systems is of interest, because it is believed that the hydrogen going into solution in a metal will provide electrons which may be used by the metal for bond formation. Other systems being studied include gallium-indium and copper-silver-gold. The vapor pressure measurements are being supplemented with measurements of the thermoelectric power of the same alloys which will contribute to an understanding of the electronic bonding between atoms in alloys. In addition, such research should cast light on ways for the interconversion of electrical and thermal energy. Another aspect of alloy formation aside from the electronic aspects of bonding is being studied, the volume of mixing of atoms treated as hard spheres. Since theoretical treatment of this problem is very difficult, an experimental approach is used in which batches of glass beads of various radium ratios are mixed and the volume of the mixture is compared with the volumes of the constituents.

5.31

Illinois U., Urbana.
INTERACTION OF DISSOLVED INTERSTITIAL ATOMS WITH DISLOCATIONS, C. A. Wert. Project 7024(802A), Contract AF 33(616)-6175; ARZ, ARL.

The work under this contract is an exploratory research program to determine if amplitude independent relaxation effects are present in b.c.c. (body-centered cubic) metals containing interstitial solute atoms. Further, the effort will determine the possible efforts of various interstitial solutes on such factors as the deformation peaks in Fe and the normal interstitial peaks in other b.c.c. metals.

5.32

Illinois U., Urbana.
DIFFUSION AND PHASE CHANGES IN METALS, C. Wert.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRE- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astroservaillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

Project 9760(802A), Grant AF-AFOSR-62-192; SRPS, AFOSR.

This research is concerned with the development of new techniques for internal friction measurement. Current developments include very low temperature studies at frequencies of about one cycle per second, and a high frequency apparatus for use at 100KC. These techniques are being applied to studies of diffusion in solids at such low temperatures that other methods are useless. In addition, the method may be used to measure energy absorbed by dislocations as they are being driven through a crystal under the influence of stress. Current research is concerned with atom motion in iron near magnetic transitions, in Fe-V alloys, and in Mg-Cd alloys.

5.33

Johns Hopkins U., Baltimore, Md.
DESLIP IN ALUMINUM SINGLE BICRYSTALLINE SPECIMENS, R. B. Pond. Project 9761(802A), Contract AF 18(600)-1587; SRPS, AFOSR.

Techniques have been previously developed for investigating the plastic behavior of metals during deformation by utilizing optical interferometric principles. These techniques dramatically illustrate the velocities of propagation of edge dislocations as a function of strain rate and crystal orientation in high purity metal crystals. The current experiments are intended to determine the role that time could play in the deslipping of a crystal. It seems probable that reversing the stress field imposed on single crystals during the time interval before strain hardening may set in would require deslip as the easiest mode of deformation. Since the interferometric cinemicrographic techniques lend themselves to an investigation of this type, these experiments are being used to determine accurately whether or not there is any directional hardening developed on the active slip band of the single crystal or whether there is a delay in developing such hardening.

5.34

Manufacturing Labs., Inc., Boston, Mass.
DISLOCATION AND PLASTIC BEHAVIOR OF IRON SINGLE CYRSTALS; P. Fopiano. Project 7021(802A), Contract AF 33(616)-6348; ARL.

Studies of the effect of carbon on the growth of single crystals of vacuum melted iron, Armco iron, and silicon iron will be continued. Equipment designed at Manufacturing Laboratories is being used for investigations of: (1) rocking curve patterns for investigation of initial stages of plastic deformation; and (2) broadening of this rocking curve during subsequent deformation in the region of the lower yield point. Early stages of deformation based on dislocation velocities will be of principle interest. In particular, the strain regions associated with the upper and the lower yield points. Completion of this contract will help in the correlation of the change in crystallographic structure and mechanical behavior.

5.35

Massachusetts Inst. of Tech., Cambridge.
ROLE OF IMPERFECTIONS AND FINE STRUCTURES, M. Cohen. Project 7021(802A), Contract AF 33(616)-6873; ARZ, ARL.

A study is being made of the role of imperfections and fine structures produced by combinations of plastic deformation and phase transformations (particularly diffusionless reactions) on the enhancement in properties of metals and alloys. The principal experimental techniques are X-ray diffraction, and electron and optical microscopy for the quantitative determination of imperfections. The proper use of these methods will determine the presence of local lattice strains, the subgrain particle sizes and the number of stacking faults in the specimens before and after deformation. Static and dynamic (thermal) displacements of the atoms from the lattice points are obtained by measurement of diffraction line intensities. The materials to be studied include Ni, Fe-C, Fe-Ni-C, Cu-Zn and Cu-Al. Gold-nickel alloys are being studied to determine the effects of precipitation reactions in a system having complete mutual solid solubility.

5.36

McMaster U. (Canada).
OXIDATION OF METALS AND ALLOYS, W. W. Smeltzer. Project 9761(802A), Grant AF-AFOSR-61-108; SRPS, AFOSR.

The purpose of this research is to investigate the kinetics of metal and alloy oxidation. The kinetics will be studied as a function of oxygen pressures to determine reaction equations, i.e., linear, parabolic, or other. The rate of internal oxidation will be studied to evaluate diffusion processes of oxygen in the oxide surface and metal substrate. Studies will be centered on Zr, the transition elements and the Fe-Cr alloys. The alloys will be studied using various compositions.

5.37

Metallurgy and Ceramics Research Lab., ARZ, ARL. Dayton, Ohio.
SHORT RANGE STRUCTURE DISTORTIONS, H. J. Garrett. Project 7021(802A), Internal.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARR- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

AFD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRME- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

Diffuse scattering of X-rays is the result of two main additive, interdependent properties of crystalline materials. These are the static effects of random structural distortions and the dynamic effects of atomic thermal vibrations. A study of diffuse scattering, as a function of microstrain and temperature, will allow the separation of these effects and simultaneously provide for the evaluation of the several theories in this area. Aluminum has been chosen for this investigation because of the vast accumulation of other pertinent knowledge for this material.

5.38

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
INTERNAL PROTECTION FROM OXIDATION OF INTERNALLY OXIDIZABLE ALLOYS, R. A. Rapp. Project 7021(802A), Internal.

It has been shown that large drops in the oxygen partial pressure during oxidation of Ag-In alloys can cause the formation of a protective layer of In_2O_3 within the Ag matrix which protects the alloy from further oxidation. Since indium and oxygen have greatly differing activation energies for diffusion in Ag, oxidation in air of a Ag-In alloy (4.3 at. % In) with a rapidly increasing temperature should stop the advancing internal oxidation boundary and allow oxidation to continue at a fixed point within the Ag matrix, forming a compact In_2O_3 film in the matrix. Calculations predict that a rise in temperature from 450 to 650°C in 2 minutes should cause the formation of a 150 Å thick In_2O_3 layer, which should be protective against further oxidation. The protection of internally-oxidizable alloys with low contents of the less noble constituent could represent a commercially important process because of the relatively high cost of certain alloying elements. Apparatus is presently being constructed to check the validity of this theory and calculation.

5.39

North Dakota U., Grand Forks.
RESIDUAL STRESSES IN SILVER RESULTING FROM STRAIN DISTORTION AROUND IMPURITIES, Wahallen, J. A. Gjevre. Project 9760(802A), Grant AF-AFOSR-61-36; SRPS, AFOSR.

This research effort will be devoted to a systematic study of the effects of dilute alloying upon the elastic constants of silver. The investigation will be concerned with the study of several binary systems of the group V elements. Solute concentrations are expected to range from one to five percent. Single crystals of the alloys will be grown from the melt and elastic constants will be measured at constant temperature by the pulse echo method.

5.40

Northwestern U., Evanston, Ill.
PHASE TRANSFORMATIONS IN SOLIDS, M. E. Fine. Project 9760(802A), Contract AF 49(638)-524; SRPS, AFOSR.

Three areas of research on phase transformations in solids will be investigated: (1) the effect of introduced crystal imperfections on the kinetics of age-hardening and properties of the final age-hardened state in aluminum base alloys containing Ag, Cu, or Zn will be studied; (2) in Ni base Al and Ni base Ti alloys the kinetics of precipitation by measuring change in Curie temperature, the nature of precipitates using X-ray diffraction, and the strength and plasticity properties of age-hardened specimens will be determined; and (3) using large single crystals of gray tin grown by the Ewald-Tufte method the motion of the transformation interface when these transform to white tin will be studied, the orientation relations between parent and produce phases will be measured, and an attempt will be made to develop a model for the transformation mechanism.

5.41

Northwestern U., Evanston, Ill.
LOW TEMPERATURE CREEP DEFORMATION OF CRYSTALS, J. Weertman. Project 9760(802A), Contract AF 49(638)-1041; SRPS, AFOSR.

The occurrence of creep at such a low temperature is highly interesting on theoretical grounds. The creep motion of dislocation lines in this temperature region may be due to a quantum mechanical tunneling effect rather than thermal stress fluctuations. Unfortunately, the existing data are not good enough to prove that quantum mechanical tunneling does occur. The materials to be studied will include hexagonal metals such as cadmium, face-centered-cubic metals such as copper and aluminum, body-centered-cubic metals such as iron and mercury. Both single crystal and polycrystalline specimens will be used. Measurements of creep of the aforementioned materials will be made from approximately 1°K to room temperature.

5.42

Nuclear Metals, Inc., Cambridge, Mass.
GASES IN BERYLLIUM, J. P. Pemsler. Project 7367 (802A), Contract AF 33(616)-7665; ASRC, ASD.

The contractor will conduct research necessary to

establish the relationship between the metal beryllium and the elements oxygen, hydrogen and nitrogen when present in a wide range of concentrations and in various combinations. The rate of absorption of the gases at various pressures and temperatures by the metal shall be determined as well as the rate of diffusion throughout the material. The form in which each metal-gas combination exists shall be determined. The information derived from the above study will then be used to determine the conditions necessary to break down the metal-gas systems.

5.43

Nuclear Metals, Inc., Cambridge, Mass.
GASES IN METALS, J. P. Pemsler. Project 7364(802A), Contract AF 33(616)-6627; ASRC, ASD.

The purpose of this research is to develop methods and techniques to determine the physical and chemical state of a gaseous component and its distribution in a gas-metal system by determining the thermodynamic functions of the gas-metal system; namely combinations of the metals niobium or tantalum and the gases hydrogen, nitrogen, and oxygen, for gaseous concentrations from 10 parts per million to as much as 1% by weight at room temperatures and at about 100°C above the melting point of the liquid. The second phase of the program will study the gas metal system including the metal beryllium. The results will provide data for the development of methods to separate the gaseous component from the metal and to determine the total amount of gas present. The analytical data obtained will assist in correlating the chemical composition with the physical properties of the gas-metal system.

5.44

Ohio State U. Research Foundation, Columbus.
ETCH PIT INVESTIGATION OF IRON WHISKERS, F. H. Beck. Project 7353(802A), Contract AF 33(616)-8252; ASRC, ASD.

This work consists of the development of a suitable electrochemical method to determine the size and shape of etch pits as formed on small single iron crystals. Suitable mounting techniques will have to be developed for microscopic investigation of the etch pits formed. Upon development of these techniques, the shape of the etch pits will probably indicate the crystallographic orientation of the whiskers. The shape and position with respect to the crystal axis and the number of dislocations or etch pits in the whisker crystal will indicate the crystal perfection of the whisker.

5.45

Oxford U. (Gt. Brit.).
FREEZING AND MELTING TEMPERATURES OF IRON ALLOYS BeO/ThO_2, W. Hume-Rothery. Project 7021(802A), Contract AF 61(514)-1062; ARZ, ARL.

The constitution of various iron base alloys is being determined using very precise experimental conditions. The results are supplemented by X-ray and metallographic studies when these seem desirable. Special emphasis is being placed on the solidus-liquidus equilibrium. The aim of this research is to obtain accurate data for various binary and a few ternary iron base alloy systems for use in a theoretical treatment of alloying phenomena. The study of the iron-yttrium system has been held up until a suitable refractory to contain the molten alloys can be found. In the Ni-C-Fe system, determinations of the liquid-solid tie lines are being made using electron-probe microanalysis. The investigation of the iron-iridium system is almost complete. Work on the iron-technetium alloys is continuing. It is hoped to commence research on the iron-osmium system in the near future.

5.46

Pennsylvania State U., University Park.
EFFECTS OF TRIAXIAL STRESSES ON MECHANICAL PROPERTIES OF METALS UNDER HIGH PRESSURE, L. W. Hu. Project 9782(806A), Contract AF 49(638)-676; SRE, AFOSR.

This research consists of an experimental and theoretical investigation of the elastic and plastic behavior of metals under triaxial stresses created by subjecting specimens to hydrostatic pressures up to 200,000 p.s.i. with superimposed loading. The immediate research objectives are to develop testing techniques for conducting triaxial stress experiments and to subsequently investigate the effects of triaxial stress on elastic constants, plastic behavior and fracture properties of metals. Although the triaxial state of stress is not presently well understood, it is known that prediction of the desired information predicated on linear or biaxial stress theory is not valid. The use of hydrostatic pressure with superimposed loading appears to offer considerable promise for obtaining reliable data for triaxial stress studies.

5.47

Pennsylvania State U., University Park.
WHISKER TIP SURFACED WITH FIELD EMISSION MICROSCOPE TECHNIQUES, E. W. Muller. Project 7353 (802A), Contract AF 33(616)-6397; ASRC, ASD.

The contractor will develop techniques and equipment for the investigation of iron single crystal filaments ("whiskers"), and apply them to the study of iron whiskers provided by ASRCM. The program seeks to determine the nature of the internal

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ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARA- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARS- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMM- Electronics Technology Lab
RADC- Rome Air Development Center
RAKN- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RANA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEGR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESRR- Operational Applications Lab

structure of whiskers, in as-grown, worked, and annealed conditions. The data developed are expected to shed light on the growth mechanism of these filaments and on the source of their unusually high strength.

5.48

Pennsylvania U., Philadelphia.
DISLOCATION MOVEMENTS AND DISLOCATION ARRAYS, D. Wilsdorf. Project 9760(802A), Contract AF 49(638)-435; SRPS, AFOSR.

This investigation is undertaken to test the hypothesis that deformation bands are the boundaries between regions of the crystal which are bent in different directions because of the presence of a large surplus of edge dislocations of unlike kind. The specimens, single crystal Al, grown in slightly curved molds will be stretched and the location of deformation bands will give data which will provide the test of the hypothesis. The scope of the research program has been broadened to cover investigations which are now underway in which the expected distribution of dislocations, stresses and strains in deformation bands are undertaken from a theoretical standpoint. Observations of slip lines and deformation bands suggest the presence of easy sources of dislocations, which when blocked by obstacles, lead to dislocation pile-ups. Direct observations of dislocations by thin film techniques do not disclose such pile-ups nor do they show any dislocation structures which could be associated with slip bands or deformation bands in an unambiguous way. To resolve this contradiction it is proposed to investigate dislocation behavior on a coarser scale than found in thin film techniques by further developing Berg-Barrett or Schultz-X-ray techniques and to examine the influence of free surfaces on the formation of slip bands, deformation bands, and asterism.

5.49

Revere, Althea, Vineyard Haven, Mass.
REPLICATION TECHNIQUES FOR OBSERVING THE SURFACES AND CROSS-SECTIONS OF WHISKERS, A. Revere. Project 7023(802A), Contract AF 33(616)-6604; ASRC, ASD.

The surface and cross-sections of whiskers are now being observed with the electron microscope. The contractor has developed reliable replication techniques for the whiskers a micron in diameter but will continue to enhance these techniques. The main emphasis for this period of work will be placed on the electron microscope studies of 1-5 micron type whiskers. Observing the surface imperfections, notches, holes, elevations, areas where the whisker indicates a step deposition of material, screw or layer type growth, and any decoration of the whiskers surface caused by chemical, thermal or mechanical means. The electron-micrographs will be used in the correlation of light microscopy, X-ray and field emission microscopy. Electron microscopy will make a valuable contribution to the analysis and correlation of the physical structure and mechanical properties of high strength whiskers such that an understanding of the growth mechanism(s) of high strength filamentary single crystals can be forthcoming.

5.50

Rice U., Houston, Tex.
EFFECT OF VIBRATIONS ON LATTICE IMPERFECTIONS MOVEMENTS IN METALS, F. R. Brotzen. Project 9760 (802A), Contract AF 49(638)-78; SRPS, AFOSR.

It is the objective of the research herein to establish the mechanism of interaction between vibrations and imperfections. The study of the interaction is expected to yield valuable fundamental information concerning the role that lattice imperfections play in plastic deformation and diffusion processes. As vibrations seem to accelerate diffusion rates under certain conditions, it is conceivable that surface and other heat treatments could be improved eventually by appropriate application of vibrations. Vibrations in the sonic and ultrasonic ranges will be applied, so as to determine the influence of frequency upon the imperfections movements. A complete study will be made of the influence of vibrations upon the strength and ductility of certain metals.

5.51

Southwest Research Inst., San Antonio, Tex.
BASIC LAW OF METAL BEHAVIOR AT ELEVATED TEMPERATURES, E. Stowell. Project 7063(806A), Contract AF 33(616)-7981; AEM, ARL.

An experimental program is being conducted to establish a method of dealing with complex stress situations at elevated temperatures. Previous studies demonstrated that the Hencky stress and strain intensities are appropriate functions for combined loading in creep. Therefore, a set of careful measurements of steady creep under both simple and complex loading conditions will be made for the purpose of verifying a hypothetical relationship. Measurements will be made on a metallurgically stable aluminum alloy in the shape of thin-walled tubes which can be put under tension and twisted simultaneously, at elevated temperatures. Measurements will be made under various conditions to insure adequate coverage from pure tension to pure shear. Continuous strain records will be made to insure identification of a steady state.

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SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
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CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astroservaillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRE- Geophysics Research Directorate
CREA- Photochemistry Lab
CREC- Thermal Radiation Lab
CRED- Research Instrumentation Lab
CREO- Terrestrial Sciences Lab
CREM- Meteorological Research Lab
CREI- Ionospheric Physics Lab
CREH- Sacramento Peak Observatory

5.52

Stanford Research Inst., Menlo Park, Calif.
ELECTRON DEVICE MATERIALS TECHNOLOGY, L. Feinstein. Project 4619(760E), Contract AF 19(604)-7323; CRRC, AFCRL.

The object of this work is to conduct a basic study of metal-joining problems and to investigate the effect of diffusion on the behavior of metal joints. The joints to be studied are those formed by brazing two metals with a filler metal. It was decided to study the behavior of brazed molybdenum joints. The brazing metals used to date have been nickel (autectic with molybdenum formed at 1315°C) and an alloy consisting of 17.5 wt % nickel, balance gold with a melting point at 950°C. The strongest joints were those that were held at the liquidus temperature for two minutes with no subsequent heat treatment. It is anticipated that if the brazing alloys can be made sufficiently thin they can be diffused away from the joint, leaving a junction of the two base metals. This should provide a useful high-temperature joint.

5.53

Stanford U., Calif.
METALLURGICAL VARIABLES AFFECTING THE HIGH TEMPERATURE MODULUS OF ELASTICITY, O. D. Sherby. Project 7021(802A), Contract AF 33(616)-6789; ARZ, ARL.

Research is being conducted to determine the effects of preferred orientation, magnetic state (in the case of ferromagnetic alloys), and temperatures on the high temperature modulus of elasticity of metals and alloys. The Young's modulus is being measured by dynamic means over a range of frequencies at temperatures up to the melting point. The relationship between the crystal structure and the modulus of elasticity will be investigated also. In a few cases, modulus measurements will be made both on single crystal and on poly-crystal specimens of the same metal. Cu-Zn alloys are now being studied. The relationship between elastic modulus and degree of ordering in beta brass is being examined.

5.54

Technion Research and Development Foundation (Israel).
EFFECTS OF ORDER-DISORDER PHENOMENA ON THE STRENGTH PROPERTIES OF HIGH TEMPERATURE ALLOYS, P. S. Rudman. Project 7021(802A), Contract AF 61(052)-122; ARL, ARZ.

Metallic strength generally depends on metastable equilibria that relax rapidly at elevated temperatures. Order is an equilibrium state, and its strengthening properties can persist even at the higher temperatures. The strengthening mechanism of order-disorder phenomena are being investigated by simultaneous X-ray diffraction, metallographic, thermoelectric and mechanical property studies of Fe-Al and Fe-Ni-Al alloys. The problem of determining the orientation and/or structure of individual grains or parts of grains in coarse grained sheet alloys has been solved by the development of a selected area Laue back-reflection X-ray camera and analytical procedure. The crystallography of deformation, and of annealing and recovery of order after deformation of Fe-Al alloys with Fe-Al and Fe_3Al character order, is being investigated at the present time. This work will be closed out upon expiration of the present funding period.

See also: 7.4, 7.29, 15.3, 15.4, 15.13, 15.17, 15.41, 15.45, 15.55, 15.60, 15.64, 15.76

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARH- Hypersonics Research Lab
ARZ- Solid State Physics Research Lab
ARE- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMM- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAE- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SRR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
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ESRR- Operational Applications Lab

AFOSR- Air Force Office of Scientific Research
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6. SOLID STATE SCIENCES

Crystal Growth; Crystal Structures; Crystalline Transformation; Energy Band Structure; High-purity Solid-state Materials; Imperfections; Impurities; Organic Semi-conductors; p-n-Junctions; Surface Energy of Solids; Thin Films.

6.1

Advanced Studies Office, RACR, RADC, Rome, N. Y.
INDUCED DEFECTS IN CRYSTALLINE SOLIDS BY ESR, C. D. Mollenhauer. Project 8503(803A), Internal.

This is an experimental and analytical study of spin centers induced in crystalline substances by irradiation with high energy particles and X-rays. Of primary interest are the magnetic energy levels with long relaxation times. Multiple energy level schemes are sought.

6.2

Alabama U., University.
IRRADIATED SOLIDS AT LOW TEMPERATURE, W. G. Moulton. Project 9760(802A), Grant AF-AFOSR-61-43; SRPS, AFOSR.

The objective of this research is to investigate the nature of impurity centers or defects produced by the bombardment of solids with ionizing radiation and will consist of a search for new kinds of centers in various materials, their identification and determination of their structures. The initial efforts will be concentrated on a study of the centers produced in ferroelectric materials such as Rochelle salt and triglycine sulphate. Electron nuclear double resonance (ENDOR) techniques will be used to analyze such centers.

6.3

Armour Research Foundation, Chicago, Ill.
ORGANIC SEMICONDUCTORS, D. E. Laskowski, C. H. Sosnovsky. Project 9762(802A), Contract AF 49(638)-576; SRPS, AFOSR.

This investigation is concerned with a review of current research on organic semiconductors, a theoretical study of electron donors and acceptors, and the experimental study of addition compounds and polymers which may conduct by coupled oxidation-reduction processes. Pairs of compounds forming addition compounds being studied include aromatics with halogen molecules, nitroaromatics, and quinones. The polymer, polytributylin methacrylate with addition of iodine molecules is being examined.

6.4

Armour Research Foundation, Chicago, Ill.
NEUTRON DIFFRACTION STUDIES AT HIGH PRESSURES, L. Reiffel. Project 9763(802A), Contract AF 49(638)-1010; SRPS, AFOSR.

The purpose of this research is to establish the feasibility of obtaining neutron Laue patterns at high pressure and then to explore, in a preliminary way, the application of the technique to such problems as: (1) the study of various single crystals as a function of pressure; (2) an investigation of the metastable hexagonal structure with transforms to face-centered-cubic in cerium at high pressures; (3) a study of various magnetically active substances at high pressures; and (4) an investigation of pressure induced changes in the structure of hydrides or organic materials. It is not intended that exhaustive studies of any of the structure problems above will be undertaken in this first effort. The primary purpose is to clearly demonstrate the feasibility of the method and its general applicability.

6.5

Armour Research Foundation, Chicago, Ill.
PYROLYTIC DEPOSITION, F. Schossberger. Project 4150 (803A), Contract AF 33(657)-7823; ASRMM, ASD.

The objective of this effort is to investigate new methods and techniques for the preparation of new and complex types of thin films both singly and in combination with each other. Emphasis will be on reaction pyrolysis, i.e., that process which requires both the action of lattice forces of the substrate and a chemical reaction between the atoms of the single crystal and the atoms of the reacting vapors. Studies involving different substrate orientations will be pursued. Typical reactions to be studied are cadmium and AsH_3, Cd and H_2Se, and GaSb and $(CH_3)_2GaSbH_2$. Physical properties of a crystal will be determined while it is growing by using an X-ray diffraction adapter.

6.6

Armour Research Foundation, Chicago, Ill.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARH- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRME- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAE- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AERR- Research Division
AFWAL- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
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PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESWR- Operational Applications Lab

SOLID STATE PHENOMENA IN THIN FILMS FOR COMPOSITE MOLECULAR ELECTRONIC MATERIALS, F. Schossberger. Project 4150(803A), Contract AF 33(616)-6445; ASRMM, AFU.

The objective of this effort is to investigate new methods and techniques employed in the preparation of thin films both singly and in combination with each other, and the investigation of various physical and electronic properties associated with each combination film. Specific areas of study are the mechanisms involved in pyrolytically depositing adherent, continuous films of controlled thickness on a heated substrate; pyrolytically depositing and evaluating single crystal thin films under accurately reproducible conditions. Inorganic compounds, alloys and elements are to be considered. Techniques to be employed include epitaxial growth, topochemical methods and other suitable techniques. The interfacial effects of successive layers of thin film deposition will be determined.

6.7

Association des Amis du Laboratoire de Physique de l'Ecole Normale Superieure (ALPENS), Paris (France). RECOMBINATION RADIATIONS FROM SEMICONDUCTORS, P. Aigrain. Project 9760(802A), Contract AF 61(052)-370; SRPS, AFOSR.

The study of recombination radiations (electron-hole) emitted from the semiconductors germanium and silicon has produced much information concerning the recombination process and other phenomena. The method is complementary to the study of absorption and magneto-absorption from these materials. However, in many instances, recombination radiation techniques are potentially much more accurate than absorption techniques. This has made possible the refined observation of infrared emission of photon energy much smaller than gap energy from the recombination of hole-electron pairs in dislocated germanium and hence, a study of the mechanisms involved in the recombination process. A new model of the way dislocation produced recombination of hole electron pairs takes place in germanium has resulted. The purpose of this research is to further exploit these techniques to (1) study impurity induced radiations; (2) magneto-effects such as the Zeeman effect; and (3) observe and study unpinned dislocations in rather perfect crystals by their own infrared radiations.

6.8

AVCO Corp., Wilmington, Mass. DESIGN AND FABRICATE SPECIMEN CHAMBER, WITH CONTROLS, FOR X-RAY DIFFRACTION AT TEMPERATURES FROM 20°C to 2300°C, R. E. Dreikorn. Project 5621(802A), Contract AF 19(604)-8029; APCRL, CRRC.

Investigation of the high-temperature properties of certain selected materials.

6.9

Battelle Memorial Inst., Columbus, Ohio. DIFFUSION IN SOLIDS, A. F. Austin, F. J. Milford. Project 9761(802A), Grant AF-AFOSR-61-107; SRPS, AFOSR.

This program is based upon a combined experimental and theoretical effort directed toward three courses of investigation: (1) the investigation of a system where lattice diffusion is essentially independent of composition; (2) investigation of the range of validity of the approximations made in the mathematical solution by analysis of the experimental data; and (3) the investigation of surface diffusion and the applicability of present diffusion theories.

6.10

Battelle Memorial Inst., Columbus, Ohio. DEVELOPMENT AND APPLICATION OF METHODS FOR ANALYSES OF RESEARCH MATERIALS, W. M. Henry. Project 7022 (802A), Contract AF 33(657)-8108; ARZ, ARL.

This contract concerns the evaluation of existing, and the survey of new, compositional determination techniques, and research toward modification or extension of these, where necessary, to more useful limits of detection and accuracy. The contractor shall perform work on materials of interest to the Metallurgy and Ceramics Research Branch and could include starting, intermediate, and final products of high purity iron, high purity chromium, zirconia, pure titanium, nickel, metal-modified zirconia, nickel-palladium, iron-silicon, iron-chromium, and copper-nickel alloys or other materials as mutually agreed upon.

6.11

Battelle Memorial Inst., Columbus, Ohio. SEMICONDUCTING PROPERTIES OF RARE-EARTH METALS AND COMPOUNDS, R. C. Himes. Project 4150(803A), Contract AF 33(616)-7321; ASRM, ASD.

The rare earth metals and compounds form a potential new source of unique semiconducting materials. Techniques for controlling the purification of the rare earths are in progress. This is extremely difficult because of the high temperatures involved and because suitable containment materials must be empirically selected. Studies of selected selenides and tellurides of neodymium, gadolinium and of other compounds containing groups V and VI elements are progressing. Electrical and physical properties are being measured.

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6.12

Battelle Memorial Inst., Columbus, Ohio
EFFECTS OF VERY HIGH PRESSURE & TEMPERATURE ON SEMICONDUCTING & INSULATING MATERIALS, C. M. Schwartz. Project 9763(802A), Contract AF 49(638)-441; SRPS, AFOSR.

The research program will be directed towards obtaining fundamental knowledge of the structure and behavior of solids as well as gaining new insight into profitable areas of future research in new materials which may be synthesized in an environment utilizing high pressures and temperatures. In-situ measurements will be made of electrical conductivity and thermoelectric power of such solids as NiO, BeO, etc., having marked differences in zone structure.

6.13

Bristol U. (Gt. Brit.).
INVESTIGATION OF CRYSTAL IMPERFECTIONS BY X-RAY DIFFRACTION, A. R. Lang. Project 7021(802A), Contract AF 61(052)-449; ARZ, ARL.

This is a study of the origin, movement, and behavior of dislocations and other defects in single crystals of selected materials. The principal experimental techniques used shall be appropriate X-ray diffraction methods. Stereo-pair techniques shall be used when necessary. The configuration of the dislocations and their Burger's vectors shall be investigated in the predominant slip systems of quartz, sapphire, diamond and other similar substances for which this information is not currently available. The origin, motion, and multiplication of individual dislocations during the early stages of slip shall be studied in non-metallic crystals of sapphire, quartz and magnesium oxide and in crystals of suitable metals (aluminum is suggested as the initial metal). Research will be performed to determine the nature and origin of lattice defects, other than dislocations, which have been observed in previous studies of quartz and calcite.

6.14

Brown U., Providence, R. I.
RECRYSTALLIZATION OF DEFORMED SINGLE CRYSTALS, C. Albaum. Project 9760(802A), Contract AF 49(638)-479; SRPS, AFOSR.

The complexity of the phenomena makes it difficult to design experiments which yield clear and reproducible results. The work involves investigation of two fundamental features of recrystallization that have been experimentally established relatively recently. One of these is the dependence of the rate of recrystallization upon impurities and whether these impurities are precipitated or in solution. The other feature is concerned with the orientation of the recrystallized grains relative to the deformed matrix. In this field complete'y different results have been obtained by two independent groups of workers and it seems important to determine whether or not this can be related to differences of the state of impurities (solution or precipated). The recovery of growth rate after both continuous isothermal heating and after repeatedly interrupted heating will be studied. Investigation of the connection between dislocation structure in the deformed specimen and the rate of growth of the new crystals is part of the program.

6.15

Brown U., Providence, R. I.
MECHANICAL PROPERTIES OF CARBIDE MONOCRYSTALS, J. J. Gilman. Project 9763(802A), Grant AF-AFOSR-61-97; SRPS, AFOSR.

This program will investigate the physical properties of several carbides, borides, and nitrides. Initially large, high quality single crystals of tungsten carbide will be grown. Next it will be necessary to learn how to prepare strain-free surfaces on the crystals, how to observe dislocations in them, and how to measure some of their anisotropic physical properties such as their elastic constants. After these preliminary studies, it will be possible to measure the parameters that limit the strength of WC.

6.16

California U., Berkeley.
ELECTRONIC STRUCTURE OF SEMICONDUCTOR AND METAL CRYSTALS, A. F. Kip. Project 9760(802A), Contract AF 49(638)-600; SRPS, AFOSR.

The principal object of the research under this contract is to determine the energy band and impurity level structure of solids, with particular emphasis on semiconductors. It is planned to exploit further the newly developed techniques for studying cyclotron resonance in metals and to extend the method to new metals and new semiconducting crystals. Such studies will add new detail to our knowledge of conduction processes. Low temperature studies of solids will be extended to higher microwave frequencies and to infrared wavelength regions which have been neglected so far.

6.17

California U., Riverside.
TRANSPORT PROCESSES IN TRANSITION METAL COMPOUNDS, R. L. Wild. Project 9760(802A), Grant AF-AFOSR-61-70; SRPS, AFOSR.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARA- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAE- Directorate of Engineering
RAWA- Advanced Development Lab
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AEDC- Arnold Engineering Development Center
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Single crystals of compounds of the type RX, where R is a transition metal of the first long period and X is a non-metal in the sixth column, will be prepared and zone-refined. Spectrochemical and X-ray diffraction analysis will be made. The low temperature optical absorption spectra over the range of photon energies from 0.5 to 5 ev., the photoconductivity as a function of wavelength and temperature in the range of 10°K to 78°K, the photoconductive Hall effect, and the dielectric constant at low and high frequencies will be experimentally determined. Interpretation of the experimental results will be directed towards a coherent treatment of transport processes in the ionic crystals and towards a possible breakdown of the conventional band theory.

6.18

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
MEASUREMENT OF SURFACE FREE ENERGY OF SOLIDS, P. M. Williamson. Project 7022(802A), Internal.

The free energies of solid surfaces are to be determined by microcreep effects in fibers. Sample fibers at high temperatures will be subjected to constant strain rates and the tensile forces thus generated will be observed. The use of constant strain rates should produce experimental data that are consistent with absolute rate theory. Desirable consistency is not obtained with microcreep data observed with time-wise constant forces and variable strain rates. The constant strain rate approach requires a sensitive apparatus subject to precise controls. Hence, the first phase of the work is that of the design and construction of this novel apparatus.

6.19

Chemistry Research Branch, ARC, ARL, Dayton, Ohio.
MIGRATION OF ORGANIC FILMS ON METAL SURFACES, P. M. Williamson. Project 7022(802A), Internal.

Migration of thin films over specially prepared metal surfaces will be studied. Migration phenomena may, if exploited, constitute a research method for obtaining fundamental information about surfaces. This possibility is indicated by the fact that the energy of activation for surface migration is always a small, though casewise variable, fraction of the energy of activation for desorption. Migration may, therefore, be sensitively affected by surface characteristics such as fine scale roughness. The Kelvin contact potential method will be used as an observational tool to follow the migration process.

6.20

Chicago U., Ill.
DIFFUSION IN SOLIDS AND LIQUIDS AT HIGH PRESSURES, H. H. Hachtrieb. Project 9760(802A), Grant AF-AFOSR-62-231; SRPS, AFOSR.

The research is an experimental study of the effects of hydrostatic pressure on the kinetics of diffusion in selected crystalline solids and in various liquids. These will include (1) anisotropic metals such as tin, zinc, cadmium, and gallium; (2) dislocation-free germanium; (3) alpha-silver sulfide; and (4) selected pure metals, alloys, and salts in the molten state. The purpose of the research on solids is to obtain information on the volume and shape of excited lattice imperfections in solids of low symmetry and in a typical substance having the diamond-structure. The aim of the studies on liquids is to determine the volume of activation for diffusion in a variety of liquids of differing coordination number and intermolecular potential, with which to test contending theories of structure.

6.21

Cincinnati U. Research Foundation, Ohio.
MEASUREMENT OF THE THERMOPHYSICAL PROPERTIES OF MATERIALS IN THE TEMPERATURE RANGE 1000°-3000°C, M. Hoch. Project 7367(802A), Contract AF 33(616)-7123; ASRC, ASD.

The contractor shall continue to investigate the feasibility of utilizing an induction heating technique for the measurement of the thermophysical properties of solid materials and determination of the specific heat, thermal conductivity, and thermal expansion of selected materials in the temperature range 1000°-3000°C. The materials, for which the thermophysical properties are to be determined, shall be selected from the following group: vanadium, niobium, zirconium diboride, tungsten, pyrolytic graphite, aluminum oxide, and zirconium oxide.

6.22

Clevite Research Center, Cleveland, Ohio.
NEW HI-TEMP SEMICONDUCTING MATERIALS, L. Shiozawa. Project 7885(802A), Contract AF 33(616)-6865; AEX, ARL.

This work is designed to add to current knowledge on growth and properties of II-VI semiconductor compounds, using the Reynolds-Greene growth technique as developed in the Aeronautical Research Laboratory and used in several other laboratories. The work will include purification by controlled sublimation, determination of impurity concentrations by radioactive tracer techniques, and final evaluation of the purity by measurement of low temperature mobilities. Both n- and p-types of CdS, CdSe, and ZnTe have been grown and will be the subject of study. Doping with Ag, Au, P and As will be used for special studies.

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CRFG- Terrestrial Sciences Lab
CRFH- Meteorological Research Lab
CRFI- Ionospheric Physics Lab
CRFR- Sacramento Peak Observatory

6.23

Columbia U., New York.
BASIC PROBLEMS IN DISLOCATION THEORY, J. H. Weiner. Project 9763(802A), Contract AF 49(638)-909; SRPS, AFOSR.

The purpose of this research is to analytically examine some of the models employed in dislocation theory in an attempt to ascertain directions in which they may be made more realistic and effective. These investigations will include: (1) the determination of the width of a dislocation (i.e., the width of the zone along the slip plane in which substantial misalignment exists); (2) the calculation of the critical shear stress required to move a dislocation from an equilibrium position; (3) the determination of the acceleration and velocity of a dislocation when, from a position of equilibrium, it is subjected to a prescribed shear stress above the critical value; and (4) the application of the principles of classical thermodynamics to a continuum with continuously distributed dislocations, and the determination of the form of the stress-strain relations they indicate.

6.24

Cornell U., Ithaca, N. Y.
X-RAY STUDIES OF SOLIDS, L. Parratt. Project 9760 (802A), Contract AF 49(638)-402; SRPS, AFOSR.

This research is for the purpose of (1) obtaining quantitative information on the electronic structures and density of states in solids; (2) developing a new quantitative method of studying impurity type states in solids; (3) extending the present inadequate one electron approximations to a theory of impurity perturbations involving a self-consistent many electron model.

6.25

Cornell U., Ithaca, N. Y.
NEW SOLID STATE DEFECT STRUCTURES, M. J. Sienko. Project 9762(802A), Contract AF 49(638)-191; SRPS, AFOSR.

This is a study of non-stoichiometric compounds, specifically the tungsten bronzes. New defect structures are being synthesized based on dissolving various metals in transition metal oxides such as WO_3, V_2O_5 and Sc_2O_3. The structure and properties of the materials prepared are being investigated in an attempt to understand and explain: (1) the correlation between electric and magnetic properties of non-stoichiometric materials and their chemical compositions and structures; (2) how the effective mass of the charge carriers changes with composition in the non-stoichiometric ternary oxides; and (3) how the thermoelectric power of the non-stoichiometric ter ry oxides depends on composition.

6.26

Cornell U., Ithaca, N. Y.
EFFECT OF CRYSTAL IMPERFECTIONS UPON ELECTRICAL PROPERTIES OF SEMICONDUCTING COMPOUNDS, C. W. Spencer. Project 9760(802A), Contract AF 49(638)-480; SRPS, AFOSR.

This research is concerned with an experimental program designed to find the relationship between crystalline imperfections and electrical properties. The research has two phases, preparation of specimens near the transition from p-type to n-type material and determination of the electrical behavior of the specimens during annealing at high temperatures. Information gained in the annealing process will aid in determining the source and nature of the crystalline imperfections.

6.27

Corning Glass Works, Corning, N. Y.
MECHANISM OF SINGLE CRYSTAL GROWTH IN HIGH TEMPERATURE SYSTEMS, J. A. Marley. Project 5621(802A), Contract AF 19(604)-8447; CRRC, AFCRL.

The determination of the influence of environmental factors during growth on the mechanism and kinetics of growth, on structural perfection, and on the physical, electrical, optical, and chemical properties of single crystals of SnO and SnO_2. The nature and extent of these influences will be established from a consideration of the careful and complete record of the environment of the growing crystals, including the temperature, thermal gradient, oxygen pressure, water-vapor pressure, etc., and of the structural perfection, optical, spectral, electrical, and chemical properties of the grown crystals.

6.28

Delaware U., Newark.
HEAT CONTENTS OF IONIC CRYSTALS, R. H. Wood. Project 9750(801A), Grant AF-AFOSR-62-247; SRPP, AFOSR.

This program tackles the problem of improved methods of evaluating the energy content of ionic crystals by computation.

6.29

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
SURFACE CONDITION OF AN ELECTRODEPOSITED SUBSTRATE, B. K. Morse. Project 7353(802A), Internal.

In the study of the effect of surface effect upon mechanical properties, many films are prepared by

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electrolytic deposition. Unanswered is the question of the effect of interstitial hydrogen in the films arising from the cathodic process. Hydrogen could penetrate these films during their formation and in an interstitial position might be responsible for the strengthening effect. To this purpose it is proposed to eliminate the questions of intermetallic bonding by plating a metal ion on the same substrate in the form of a wire as a function both of pH and anion. The question, then, of the effect of hydrogen on the strength could be resolved.

6.30

Directorate of Research Analysis, SRAS, AFOSR, Washington, D. C.
FORMATION OF RUBY IN A SOLAR FURNACE, G. Hughes. Project 6886(802A), Internal.

Rubies of large size and specified purity are required in lasers to produce monochromatic light of high intensity. It is proposed to use the solar furnace with auxiliary equipment to melt and cool aluminum oxide in an endeavor to produce rubies with the proper qualities for use in lasers. To date such an approach has not been attempted.

6.31

Eagle-Picher Co., Miami, Okla.
PURIFICATION AND GROWTH OF II-VI SINGLE CRYSTALS, W. E. Madcalf. Project 7885(802A), Contract AF 33 (616)-7127; ARX, ARL.

The contractor will investigate the growth from the melt, of crystals of group II-VI compounds that show promise for solar conversion, with special emphasis on zinc sulfide, cadmium sulfide, selenium, zinc selenide and cadmium selenide. Studies will be made on techniques for purification of these compounds. The work presently being performed will be continued, i.e., the purification of cadmium, sulfur and zinc and studies of techniques for reacting them to obtain ultimate purity in the compound and the detailed analysis of the remaining impurities. The feasibility of producing high purity cadmium oxide single crystals will also be investigated.

6.32

Eagle-Picher Co., Miami, Okla.
PURIFICATION OF CADMIUM SULFIDE CRYSTALS, W. Metcalf. Project 7885(802A), Contract AF 33(616)-6203; ARX, ARL.

Effective semiconductor research depends on progress toward greatly improved semiconductor materials. The research called for in this contract is designed to improve the purity, and the lattice perfection of cadmium sulfide and other II-VI compound semiconductor crystals by orders of magnitude. This is being accomplished by ultra purification of the raw materials using zone refining and distillation, and growth of crystals from the vapor or from a melt. Since there is no known direct method for determining either the amount of impurity or the number of defects for crystals this near perfection, use will be made of the very semiconductor properties which require this high degree of perfection. A principal technique is to create a barrier layer, measure the photovoltaic properties of this layer, and infer the kinds and numbers of impurity atoms and defects by studying a series of crystals made under slightly different experimental conditions.

6.33

Ecole Normale Superieure, Paris (France).
ANALYSIS OF IMPURITIES IN SEMICONDUCTORS, M. Balkanski. Project 9763(802A), Contract AF 61(052)-572; SRPS, AFOSR.

A series of qualitative and quantitative analyses by means of spectroscopy and magnetic resonance of impurities contained in Group III-V and II-VI compounds. Examples: gallium arsenide; and cadmium sulfide. The impurities are of two groups: neutral impurities which do not give free carriers and electrically active impurities which accept or give up free charge carriers. To be considered are the neutral impurities because their study is more of a specific problem in infrared spectroscopy.

6.34

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
INTERACTIONS OF MICROWAVE PHONONS WITH SOLID STATE MATERIALS, T. A. Olson. Project 5635(803A), Internal.

This work is directed toward investigating the interaction of hypersonic waves (microwave phonons) with solid state materials. Three types of interactions are suitable for probing the structure and properties of materials (such as the spin wave-phonon coupling in YIG which can be used to determine the exchange-energy constant); those interactions which may be suitable for altering the electrical properties of materials (such as the phonon modulation of carriers in semi- and super-conductors); and those phonon-material interactions (such as the nonreciprocal acoustic properties of magnetic crystals) which can be used for the control of hypersonic waves and hence may be applicable to the development of microwave acoustic devices.

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CRI- Geophysics Research Directorate
CRIA- Photochemistry Lab
CRIC- Thermal Radiation Lab
CRIE- Research Instrumentation Lab
CRIO- Terrestrial Sciences Lab
CRIM- Meteorological Research Lab
CRIT- Ionospheric Physics Lab
CRIR- Sacramento Peak Observatory

6.35

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
ETCHING STUDIES ON THE STRUCTURE OF SAPPHIRE, W. J. Alford. Project 5621(802A), Internal.

The objective of this research is to provide a relatively quick evaluation for line and planar imperfections by chemical etch techniques in crystals used as host lattices for laser and maser materials. Emphasis is on Al_2O_3 because several new methods are being developed by CRRC to grow Al_2O_3 with superior structural perfection.

6.36

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
ORGANIC SEMICONDUCTING COMPOUNDS, A. F. Armington. Project 5620(802A), Internal.

The object of this effort is the investigation of organic compounds for use as semiconducting materials. The properties of these compounds will be studied on a laboratory scale. Experimental investigations will be initiated beginning with the organic dyes. The melting point, energy gap, change of energy gap with temperature, intrinsic resistivity, mobility and lifetime of such dyes as cymathrene, indanthrene (black) indanthrone, indantrazine, falvanthrone, isoviolanthrene, pyranthrone, pyranthrene, ovalene, isodibenzanthrone, anthracene, naphthacene, anthranthrene, methylene blue, coronene, and other such compounds will be determined as the first step. In addition, the physical chemistry of these compounds (vapor pressure, decomposition temperature, lattice parameters) will be studied. The importance of purity and defect structure on the semiconducting properties of these compounds will also be investigated.

6.37

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
PURIFICATION OF ELECTRONIC MATERIALS, A. Armington. Project 4608(760E), Internal.

The object of this effort is the preparation and purification of materials of in-house interest to units and sections within the Electronic Material Sciences Laboratory. The materials of interest are of the solid state type with application to semiconductor, magnetic, and allied fields.

6.38

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
DIFFUSION STUDY, I. Berman. Project 4608(760E), Internal.

Diffusion studies on Si are being carried out using various diffusants such as P, B, Li, etc. The experiments are done with emphasis on deep diffusion and large doping concentration. One objective of this study is to provide degenerate materials for fabrication of tunnel diodes. Impurity interaction and oxide masked technique are being studied. We are also investigating techniques to fabricate an abrupt p-n junction by diffusion.

6.39

Electronic Material Sciences Lab., CRR, AFCRL.
SINGLE CRYSTAL GROWTH FROM THE VAPOR, M. S. Brooks. Project 5620(802A), Internal.

Perform experimentally a detailed study of the factors which affect the growth rate of highly physically and chemically perfect massive single crystals from the vapor. Two such studies are (1) growth of single crystals of low melting metals (e.g., Cd, Zn, Mg) from polycrystalline masses and/or melts via vapor transport and (2) growth of high melting elements (e.g., Si) by decomposition of a halide of these elements (e.g., SiI_4). The aims are to observe optimum experimental conditions, correlate with existing theories, modify or formulate new theories and establish basic principles applicable to a wide variety of crystal growth problems.

6.40

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
EPITAXIAL GROWN JUNCTIONS, R. F. Cornelissen. Project 5621(802A), Internal.

In view of the progress being made throughout the country in the epitaxial growth of semiconductors, new device designs have become feasible. A design for a unique field effect device has been conceived in the laboratory and the successful reduction to practice will be in large part dependent upon good VI characteristics in the epitaxial formed junctions. Variations in the basic closed tube disproportionation reaction of Ge and iodine have and are being made to determine effects on electrical characteristics. Junctions formed by a straight reduction technique will also be evaluated. The experimental set up for this technique is in process of construction as are duplicate set ups for making silicon p-n junctions.

6.41

Electronic Material Sciences Lab., CRR, AFCRL,

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARL- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRME- Electronics Technology Lab
RADC- Rome Air Development Center
RASW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESWR- Operational Applications Lab

Bedford, Mass.
X-RAY STRUCTURE INVESTIGATIONS, E. R. Czerlinsky. Project 5621(802A), Internal.

One part of the X-ray investigations is performed in supporting in-house efforts for which specific information on materials have to be established, such as lattice constants, orientation of crystals, analysis of samples, and identification of solid phases. The essential part of the research program is concerned with the determination of the oxygen positions in different structures, such as garnets and sapphires. This work yielded valuable results in the past year, and the data obtained are of significance for theoretical studies on energy levels and anisotropy in magnetic materials.

6.42

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
SOLUTION GROWTH OF SINGLE CRYSTALS, M. A. DiPietro. Project 5621(802A), Internal.

The objective of this research is to substantially improve the capability for growth of single crystals of a wide variety of materials from aqueous solutions and to study the growth mechanisms of this type of crystals. While many crystals have been grown from solution by CRRC in the past, this is a new effort starting with the design and construction of apparatus.

6.43

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
GARNET STRUCTURE MATERIALS, C. O. Dugger. Project 5621(802A), Internal.

The objective of this effort is the study and investigation of rare earth iron garnets, especially on the problem associated with the growth of single crystals of these materials. A large number of different rare earth iron garnets have been grown at high temperatures within the range of 1500°C to 1600°C. Emphasis has been on lutetium iron garnet. At these temperatures, under an air atmosphere, objectionable problems exist, e.g., the phase changes of iron oxide and non-equilibrium conditions due to a viscous melt. The non-equilibrium state greatly restricts the quality of the crystals. Current research has centered around the investigation of fluxes which give promise of permitting the growth of garnet structure materials by the Czochralski method.

6.44

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
OXYGEN COORDINATES IN GARNETS, F. K. Euler. Project 5621(802A), Internal.

The objective of this research is to determine more precisely the exact oxygen coordinates in rare earth iron garnets. This information is essential to the basic understanding of ferrimagnetic materials and for investigation of paramagnetic resonance spectra of the rare earth ions.

6.45

Electronic Material Sciences Lab., CRR, AFCRL. Bedford, Mass.
CRYSTAL GROWTH STUDIES, W. G. Field. Project 5621 (802A), Internal.

This effort emphasizes theoretical and experimental investigations of techniques for the growth of single crystals, and studies relating to the growth mechanism and perfection of single crystals. This work has resulted in the development of a crystal growing method based upon the dissocation and subsequent recombination of a polyatomic gas. It is hoped that this method will be applicable to the growth of certain high temperature ceramic materials. An induction coupled plasma torch was also placed in operation during the past year. A program is now under way to study the chemical and structural perfection of single crystal diamond. The laser amplifier to be built at this Directorate will provide an excellent means for evaluating the perfection of optical crystals. The basic growth phenomena in silicon has also been investigated.

6.46

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
ULTRA HIGH PRESSURE RESEARCH, W. G. Field. Project 5621(802A), Internal.

This effort emphasizes theoretical and experimental investigations in the field of ultra high pressure research. Of major interest at the present are the areas of diamond crystal growth, temperature gradient problems, temperature measurements, and selected problems in the study of silicate systems. A 600-ton tetrahedral anvil press was designed and constructed. This press has been in operation for a period of approximately one year. Research on diamonds is aimed at producing high quality semi-conducting diamond for device application. Techniques for X-ray diffraction and microwave spectroscopy are also being studied.

6.47

Electronic Material Sciences Lab., CRR, AFCRL,

Bedford, Mass.
PROPERTIES OF WIDE BAND SEMICONDUCTORS, A. D. Johnson. Project 5621(802A), Internal.

The objective of this new investigation is to gain a deeper understanding of the defect levels in the energy gaps of wide band semiconductors. Particular emphasis is on the group IV semiconductors, carbon in diamond form and silicon carbide. Literature investigations have been made. A variety of measurement techniques are being developed for optical and electrical measurements on small single crystal samples.

6.48

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
GROWTH OF SEMICONDUCTOR CRYSTALS, B. Lichter, L. J. Smiltens. Project 5621(802A), Internal.

This effort emphasizes both theoretical and experimental investigations related to the growth of single crystals of semiconductor materials. Materials which are being considered include silicon, diamond, silicon carbide, and magnesium stannide. Work on silicon includes a study of the growth mechanism from the melt and the effect of Peltier cooling at a solid-liquid interface. A large vapor furnace is under construction and will be utilized for the growth of large high quality silicon carbide crystals. The growth of single crystal diamond is being carried out in the ultra high pressure tetrahedral anvil press. The objective of this research is to grow large semiconducting high purity diamond in the laboratory. Magnesium stannide single crystals are being grown by the Bridgman Stockbarger technique. The effect of crystalline stoichiometry is being investigated.

6.49

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
APPLICATIONS OF SEMICONDUCTOR TECHNIQUES TO DIAMOND, J. E. Ludman. Project 5621(802A), Internal.

Diamonds have been successfully made at AFCRL during the past year, and it is hoped that some crystals with controlled dopants will be available in the near future. In acticipation of this, an investigation of contacts to diamonds has been initiated. Low resistance ohmic contacts are necessary for the proper evaluation of the electrical properties of any crystals that become available, and it is possible that device possibilities of doped diamonds may be realized during this investigation.

6.50

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
ULTRA HIGH PRESSURE RESEARCH, R. A. MacMillan. Project 5621(802A), Internal.

The objective of this effort is the study of the growth of single crystals under various conditions of pressure and temperature.

6.51

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
GROWTH OF OPTICAL CRYSTALS, G. Oshesky. Project 5621(802A), Internal.

It is the purpose of this work to grow single crystals of various materials which are important for the laser program. A special annealing furnace has been developed to anneal ruby single crystals in order to remove all strains. These crystals will be utilized in the laser amplifier being built at AFCRL. Special optical polishing techniques have been developed for processing these crystals. Single crystals of doped fluorite will be grown in the near future.

6.52

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
GROWTH OF SINGLE CRYSTALS BY THE VERNEUIL TECHNIQUE, G. Oshesky. Project 5621(802A), Internal.

Crystals of willemite (Zn_2SiO_4) and calcium spinel ($CaAl_2O_4$) for laser studies, are currently being investigated. A new method for growing NiO crystals has produced successful boules but the crystals have not yet been evaluated. A new Verneuil furnace, incorporating many advances and changes resulting from extensive experience with this technique, is in the design stage.

6.53

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
MAGNETIC MATERIALS CRYSTAL GROWTH, C. A. Pitha. Project 5621(802A), Internal.

Controlled amounts of nickel, cobalt, iron, manganese, chromium, vanadium, titanium, platinum, and palladium have been introduced into Al_2O_3 "host" lattices. Also, single crystals of garnet-structured rare earth iron oxides have been prepared in which the rare earths have been lutetium, ytterbium, thulium, terbium,

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AEDR- Research Division
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SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
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holmium, dysprosium, erbium, gadolinium, europium, samarium, and yttrium. In the immediate future, the effect of transition element "guest" atoms in spinel-structured hosts and of the rare earths on non-ferric garnet structured compounds will be considered.

6.54

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
STRUCTURAL PERFECTION AND ELECTRONIC SPECTRA OF SINGLE CRYSTALS, C. Pitha. Project 5621(802A), Internal.

The objective of this new effort is to utilize electronic spectra for the evaluation of influences of structural imperfections, particularly in the case of transition metal ions as "guests" in host lattices of alpha Al_2O_3 where the "guest" concentration is less than one percent. Electronic spectra are sensitive indicators of many types of imperfections on an atomic scale.

6.55

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
THIN SILICON FILMS BY VAPOR PHASE EPITAXIAL GROWTH, J. Rohan. Project 5621(802A), Internal.

The objective of this research is to understand and control the basic mechanisms of crystal growth by chemical decomposition techniques to provide the necessary background both for growing crystals and for fabricating device structures by epitaxial methods. The more immediate practical aspects of the work deal with the preparation of precisely controlled junctions on silicon substrates for the fabrication of new devices conceived in this laboratory.

6.56

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
GROWTH OF SILICON CARBIDE CRYSTALS, J. Smiltens. Project 5621(802A), Internal.

The objective of this research is to grow silicon carbide crystals at least 1000 times as large and 1000 times purer than those currently available. The theoretical approach has been completed. The furnace, which is unique in design, construction, and test, is nearing completion. The first crystals will be grown in the next report period.

6.57

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
SOLUTION GROWTH OF SILICON P-N JUNCTIONS, A. C. Yang. Project 4608(760E), Internal.

The object of this series of experiments is to attempt to grow narrow, abrupt Si-p-n junctions. The junctions that are made with diffusion techniques or grown for the melt usually give a broad, compensated region because of the fast diffusion of impurities at high temperatures. The junctions can be grown at much lower temperatures using solution growth techniques. Solubility of Si in Sn is temperature dependent. By varying the doping concentrations and temperature, a series of p-n junctions can be fabricated. This will enable us to investigate both the growth phenomena and the electrical characteristics of such junctions.

6.58

Electronics Technology Lab., ASRNE, ASD, Dayton, Ohio.
PHYSICS OF THIN FILMS, C. R. Barnes. Project 4150 (803A), Internal.

Based upon previous in-house research on silicon nitride, titanium nitride, titanium sesqui-oxide, cadmium sulfide and thin films of metals, oxides, nitrides, sulfides, antimonides, arsenides, borides, tellurides, selenides, and phosphides, research is progressing on pyrolytic techniques for depositing thin films of dielectrics, metals and semiconductors. Considerable success has been experienced by utilizing the pyrolytic method for depositing dielectrics. New work indicates boron nitride, silicon dioxide, and tungsten films may be very promising. Work will continue using new research tools such as the X-ray diffraction adaptor camera and the spectrophotometer.

6.59

Electronics Technology Lab., ASRNE, ASD, Dayton, Ohio.
PREPARATION AND MEASUREMENT TECHNIQUES, J. M. Blasingame. Project 4150(803A), Internal.

The objective of this program of basic research is twofold: (1) to prepare various solid state electronic materials by evaporation in ultra-high vacuum while attempting to control their physical properties by heat treatment and epitaxy; (2) to study techniques for measurement of various phenomena, such as electroluminescence, photoconduction, and electron transport in these films. Specifically, experiments are currently being conducted on the following: the preparation and characterization of single crystal, electroluminescent zinc sulfide on calcium fluoride substrates; the study of the emission spectrum of electroluminescent boron nitride thin films to determine its band structure and activation energies; and the study of tunnel emission and electron transport phenomena

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SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRE- Geophysics Research Directorate
CREA- Photochemistry Lab
CREC- Thermal Radiation Lab
CREE- Research Instrumentation Lab
CREG- Terrestrial Sciences Lab
CREM- Meteorological Research Lab
CREI- Ionospheric Physics Lab
CRER- Sacramento Peak Observatory

in thin films of metals and insulators, such as aluminum-aluminum oxide, silicon-silicon dioxide, and silicon-silicon nitride. Electron diffraction pictures of thin films of zinc sulfide grown on calcium fluoride in preliminary experiments in a 10^{-5}mm Hg vacuum indicate small areas of single crystals. More accurate control of the substrate temperature by an automatic programmer which has been recently constructed and placed in operation together with the use of a new specially designed ultra-high vacuum system should greatly improve these results in the near future.

6.60

General Dynamics Corp., Rochester, N. Y.
THIN FILM MEASUREMENT TECHNIQUES, Drumheller. Project 4150(803A), Contract AF 33(657)-8753; ASRME, ASD.

The objective of this basic research program is to investigate new techniques for measuring various physical properties of thin films of solid state electronic materials.

6.61

General Electric Co., Schenectady, N. Y.
METAL THIN FILM FORMATION AND STRUCTURE, C. Neugebauer. Project 5621(802A), Contract AF 19(604)-5566; CRRC, AFCRL.

The endeavor, in this study, is to establish the nature and magnitude of the influence of a number of experimental factors on the properties of films of reactive and unreactive metals.

6.62

General Mills, Inc., Minneapolis, Minn.
SURFACE ENERGY STATES OF SINGLE CRYSTAL METALS BY FRICTION PROBE, A. A. Anderson. Project 7022(802A), Contract AF 33(657)-8038; ARC, ARL.

The program to be performed by the contractor will consist of an investigation of the surface energy of extremely clean single crystal metals as a function of the type of space lattice and of crystallographic orientation. The initial study will include three common types of single crystal lattice structures; namely, body-centered cubic, face-centered cubic, and close packed hexagonal as represented by iron, copper and titanium. A more compact version of the friction probe than currently used will be constructed as well as the new ion bombardment system. Most of the necessary parts will come from the present apparatus.

6.63

General Mills, Inc., Minneapolis, Minn.
ELECTRICAL CHARACTERISTICS OF GRAIN BOUNDARIES IN SEMICONDUCTORS, R. K. Mueller. Project 9761(802A), Contract AF 49(638)-628; SRPS, AFOSR.

This work is an investigation of the electronic properties of grain boundaries, particularly very low angle grain boundaries which may be regarded as a "picket fence" of edge dislocations. The material for study in Dr. Mueller's past work has been germanium, and he is now extending this to other semiconductor materials. Specifically the research is concerned with (1) preparation of InSb of highest purity; (2) preparation of precisely oriented bycrystals in n- and p- type material (tilt boundaries, twist boundaries, and coherent twin boundaries); (3) X-ray study of these grain boundaries; (4) study of their electrical and optical properties; and (5) theoretical studies and interpretation of experimental results.

6.64

General Physics Research Lab., ARP, ARL, Dayton, Ohio.
SPHALERITE-WURTZITE TRANSITION IN ZINC SULFIDE CRYSTALS, S. J. Czyzak, B. A. Kulp, D. C. Reynolds. Project 7112(802A), Internal.

The transformation of synthetic zinc sulfide crystals from sphalerite to wurtzite structure and vice versa in being studied experimentally by employing X-ray diffraction techniques. This transition is believed to occur at 1020°C. The general procedure in this study is to examine single crystals of zinc sulfide at room temperature and at various other higher temperatures. By these various X-ray techniques, the structure of the crystal will be examined.

6.65

General Telephone Labs., Bayside, N. Y.
IMPERFECTION STUDIES IN SEMICONDUCTOR CRYSTALS, G. H. Schwuttke. Project 5621(802A), Contract AF 19 (604)-7313; CRRC, AFCRL.

The work under this contract is concerned with the development of X-ray diffraction microscopy methods such as X-ray extinction and anomalous transmission and their application to the study of imperfection in semiconductor crystals. The work will be conducted in three phases. Phase one will be concerned with X-ray extinction; phase two with anomalous absorption; and phase three with the correlation of the results obtained by both methods. Detailed investigations will include the examination of segregation effects, cluster formation and precipitation in Si, Ge, III-V compounds and other materials of interest.

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6.66

Georgia Inst. of Tech., Atlanta.
VACUUM EVAPORATED AND CATHODE SPUTTERED THIN FILMS, R. B. Belser. Project 4150(803A), Contract AF 33 (616)-6379; ASRM, ASD.

Research is being conducted on vacuum evaporated and cathode sputtered thin films for the purpose of determining the effect of various experimental parameters on the films. Studies in progress include flash evaporation of indium antimonide onto cleaved NaCl substrates maintained at selected temperatures; epitaxial growth of silver on MgO substrates; gold films sputtered onto MgO and NaCl substrates; and examinations of rare earth metals such as dysprosium and thulium. Structure analysis of this film is continuing.

6.67

Georgia Inst. of Tech., Atlanta.
VARIOUS PHENOMENA FOR THE PERFORMANCE OF CIRCUIT FUNCTIONS, E. J. Scheibner. Project 4150(803A), Contract AF 33(616)-6028; ASRME, ASD.

The objective of this program is to gain a more fundamental understanding of the theoretical basis for the various physical phenomena in solid state, electronic materials which are of interest in molecular electronics. Specific problem areas which are being studied are: (1) the theory and taxonomy of physical phenomena in solids; (2) the interaction of phenomena in composite layers of thin films; (3) techniques for the preparation of thin films and measurement of phenomena in ultra-high vacuum; and (4) derivation of equivalent circuit models and transfer functions for certain selected phenomena.

6.68

Georgia Inst. of Tech., Atlanta.
MECHANISM OF THE PHASE TRANSITIONS IN QUARTZ, R. A. Young. Project 9760(802A), Contract AF 49(638)-624; SRPS, AFOSR.

A definitive study by X-ray means, of the mechanism of the alpha to beta transition and the reverse reaction in quartz will be made. The approach involves the temperature dependence of the intensities of diffracted X-rays. These data will be used to determine the changes in the thermal vibrations and positional parameters of the individual atoms as the temperature is gradually varied through the phase transition point. Detailed electron density maps prepared from data obtained at different specimen temperatures are expected to constitute an important means of data analysis.

6.69

Hebrew U. (Israel).
DOUBLE X-RAY REFLECTIONS OF SINGLE CRYSTALS, B. S. Fraenkel. Project 9763(802A), Contract AF 61(052)-222; SRPS, AFOSR.

Using an integrating photometer, the intensity of double X-ray reflections in diamond like crystals will be measured. The variation of intensity of double X-ray reflections with wavelength relative to the intensity of allowed reflections will be investigated. Intensity of double and forbidden reflections as a function of temperature, impurities, and other parameters will be determined in diamond, silicon, and germanium. The wavelength to which double reflections are particularly sensitive will be determined and reflection intensity formulas will be developed for perfect and mosaic structures. The existence and intensity of double X-ray reflections in anthracene and other organic crystals will be studied as a function of temperature, tension and other parameters.

6.70

Illinois Inst. of Tech., Chicago.
DISTRIBUTION OF ELECTRONS AND IMPERFECTIONS IN CRYSTALS, L. V. Azaroff. Project 9760(802A), Grant AF-AFOSR-62-71; SRPS, AFOSR.

Although tremendous strides in elucidating crystalline properties have been made by using approximate methods, it is becoming clear that the next major advance will be possible only if means for measuring absolute integrated reflecting powers are available for all crystals, irrespective of their size. This research is to devise a procedure whereby this can be done. Using this method the electron distribution, transfer, and bonding in alloys and intermediate compounds, systems such as aluminum and silicon in manganese, iron, cobalt and nickel will be studied.

6.71

Illinois Inst. of Tech., Chicago.
STRUCTURE STUDIES OF IMPERFECTIONS IN CRYSTALS, L. V. Azaroff. Project 9763(802A), Contract AF 49(638)-425; SRPS, AFOSR.

This is a study of the structure of imperfections in crystals using X-rays. This technique will reveal the electron density distribution in crystals around imperfections. The distribution will be compared with theoretical calculations carried out with considerable care.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
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CRRE- Control Sciences Lab
CRI- Geophysics Research Directorate
CRIA- Photochemistry Lab
CRIC- Thermal Radiation Lab
CRIE- Research Instrumentation Lab
CRIG- Terrestrial Sciences Lab
CRIM- Meteorological Research Lab
CRIX- Ionospheric Physics Lab
CRIR- Sacramento Peak Observatory

6.72

Illinois U., Urbana.
ELECTRONIC STRUCTURE OF IONIC CRYSTALS, F. C. Brown. Project 9760(802A), Grant AF-AFOSR-62-215; SRPS, AFOSR.

The band structure and electronic defect structure of ionic crystals, such as the silver and thallium halides, will be experimentally investigated using the techniques of high-resolution optical absorption measurements at liquid helium temperatures; of transient, photoconductive Hall effect and magnetoresistance measurements; and of electron spin resonance measurements at 4 mm wavelengths.

6.73

Illinois U., Urbana.
SOLID STATE PHASE TRANSFORMATIONS, T. A. Read, Wayman. Project 9760(802A), Contract AF 49(638)-420; SRPS, AFOSR.

This research is concerned with experimental and theoretical research in the crystallographic features of diffusionless phase changes in metals. The objectives are to account for the diversity of habit planes and orientation relationships observed in martensite formation. In particular, the role played by crystal imperfections in the formation of martensite plates is being studied. Various materials displaying the martensitic transformation will be investigated to determine the effect of composition and defect, structure, point and line imperfections, on the crystallographic features of the transformation. Studies will also be initiated to determine whether or not critical dislocation densities or arrangements are nucleating agents for the reaction.

6.74

Illinois U., Urbana.
DISLOCATIONS IN SOLIDS, R. M. Thomson. Project 9760 (802A), Grant AF-AFOSR-62-179; SRPS, AFOSR.

The work involves a combination theoretical and experimental study of the properties of dislocations in the following areas: (1) diffusion along dislocation lines in ionic crystals; (2) the mobility of dislocations in germanium and silicon; (3) dislocation climb mechanism; (4) the formation of F-centers by dislocations; (5) the movement of dislocations at sonic speeds; and (6) electronic structure of dislocations in covalent crystals.

6.75

John Carroll U., University Heights, Ohio.
MAGNETO-ACOUSTIC ABSORPTION IN SOLIDS, J. Trivisonno, E. F. Carome. Project 9760(802A), Grant AF-AFOSR-62-224; SRPS, AFOSR.

Magneto-acoustic absorption measurements on single crystals of magnesium and potassium will be made at liquid helium temperatures. The results of such measurements, when combined with different experimental techniques of other researchers, will be used in determining the Fermi surface of these materials.

6.76

Johns Hopkins U., Baltimore, Md.
VIBRATIONAL AND ROTATIONAL ENERGY LEVELS, J. B. Newman. Project 4150(803A), Contract AF 33(616)-6457; ASRMM, ASD.

The objective of this work is to determine the possibility of finding an electrically coupled discrete energy level in a solid. Such a material will open new areas of quantum resonant electronics with greatly increased performance possibilities. The detection of an anomalous dielectric absorption in thallium nitrate has encouraged further investigation. Larger samples of the material will be tested when they become available. Crystals of beta-quinol clathrate are also being grown for testing. Theoretical studies of frozen gases have been completed and experimentation is progressing.

6.77

Kansas State Coll., Manhattan.
PREPARATION AND ELECTRONIC EVALUATION OF SINGLE CRYSTAL SEMICONDUCTOR FILMS, E. B. Dale. Project 5621(802A), Contract AF 19(604)-7218; CRRC, ARCRL.

The objective of this research is to produce and evaluate thin monocrystalline films of germanium and indium antimonide. Currently, the group is investigating the effect of deposition variables on the structure and properties of InSb films prepared by vacuum evaporation of bulk InSb.

6.78

Kansas State Coll., Manhattan.
CRYSTALLOGRAPHY OF SOLID NITROGEN OXIDES, R. D. Dragsdorf. Project 9760(802A), Grant AF-AFOSR-61-24; SRC, AFOSR.

This is an X-ray diffraction study of $N_2H_2O_4$, N_2O_4 and N_2O_3 to determine their crystal structure and molecular geometry. A further object is correlation between their NN and NO distances and various bond angles.

6.79

Kulite Semi-Conductor Prods., Inc., Ridgefield, N.J.
FABRICATION OF ABRUPT, NARROW P-N JUNCTIONS BY DIFFUSION

AFL- Aeronautical Research Laboratories
- AFC- Chemistry Research Lab
- AFF- Fluid Dynamics Facilities Lab
- AFP- General Physics Research Lab
- AFR- Plasma Physics Research Lab
- AFM- Applied Mathematics Research Lab
- AFT- Thermomechanics Research Lab
- AFA- Hypersonics Research Lab
- AFX- Solid State Physics Research Lab
- AFZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
- ASRC- Directorate of Materials & Processes
- ASRMM- Electronics Technology Lab

RADC- Rome Air Development Center
- RAEM- Intelligence & Electronic Warfare Div.
- RAOR- Advanced Studies Office
- RAS- Directorate of Engineering
- RAWA- Advanced Development Lab
- RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
- AERR- Research Division

AFSWC- Air Force Special Weapons Center
- SWR- Research Directorate

AMRL- 6570th Aerospace Medical Research Laboratories

APGC- Air Proving Ground Center
- PGBR- Ballistics Directorate

ESD- Electronics Systems Division
- ESWR- Operational Applications Lab

TECHNIQUES, A. Kurtz. Project 4608(760E), Contract AF 19(604)-7328; CRRC, AFCRL.

The research objectives include the investigation and development of techniques for the fabrication of abrupt, narrow p-n junctions in semiconductor materials by diffusion techniques. These junctions are made either by the diffusion of two oppositely doped adjacent layers or by a combination of a diffused layer and an alloying process. Attention has been concentrated on preparing junctions in silicon which exhibit quantum mechanical tunneling effects. Work is in progress to study the effects of diffusion parameters on junctions formed by alloying aluminum-boron into previously "n" diffused crystals.

6.80

Madrid U. (Spain).
SOLID STATE THERMODYNAMICS AND CRYSTAL ANALYSIS, J. L. Amoros, M. L. Canut. Project 9763(802A), Contract AF 61(052)-193; SRPS, AFOSR.

The main objectives of the proposed research program are twofold. The first is the determination of the thermal expansion of single crystals and its analysis as a function of the crystal structure and dynamics. The experimental work will mainly be extended to the low temperatures range, where the influence of creation of imperfections and the presence of diffusion will be minimum and where a correlation with the theory of crystal dynamics can be done in simpler manner. The second is to study the behavior of single crystals under thermal strain and to correlate it with crystal structure and crystal perfection. The production of imperfections in such crystals under thermal gradient will be studied via X-ray reflection (Barth's and divergent beam methods) and optical as well as electron microscopy.

6.81

Mellon Inst. of Industrial Research, Pittsburgh, Pa.
SOLID STATE STUDIES ON RARE GAS SOLID SOLUTIONS, H. P. Klug. Project 9760(802A), Contract AF 49(638)-575; SRPS, AFOSR.

Rare gas atoms most nearly of all elements approach the uncomplicated characteristics ascribed to atoms in simple theories of solids. Therefore, a study of the crystals of these rare gases both pure and mixed should provide valuable information about some of the basic assumptions of solid state theories. An X-ray diffraction examination to test for adherence to Vegard's law and the presence of ordering of binary mixtures is planned. At the same time a thermodynamic investigation will provide further information on the energy of formation of crystals of these elements. A special X-ray spectrogoniometer cryostat will be constructed during the first half of this program.

6.82

Melpar, Inc., Falls Church, Va.
GROWTH AND ORIENTATION OF ALKALI HALIDE BICRYSTALS, M. Fuschillo. Project 7022(802A), Contract AF 33 (657)-8228; ARZ, ARL.

This is a study of the effect of orientation on the growth of a grain boundary in simple crystal structures by growing bicrystals. These studies will be conducted using materials such as NaCl or LiF (for f.c.c. structure) and CsCl (for b.c.c. structure) to take advantage of their low melting points and the extensive information available concerning their growth from the molten state. Initially, the bicrystals will be grown with the orientation of the boundary deviating only slightly (10° or less) from a normal crystallographic plane (either the 100, 110, or 111) and will include only one deviation, either tilt or twist. As growth techniques are developed, greater and more complicated misorientations shall be attempted. The bicrystals grown will be evaluated by visual observation of the perfection of the boundary, X-ray determination of its orientation, and other feasible techniques.

6.83

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
MECHANISM OF DECARBURIZATION, R. A. Rapp. Project 7021(802A), Internal.

The rate at which carbon is removed from pure Fe-C alloys which are heated in CO-CO_2 or H_2-H_2O mixtures is probably controlled by the diffusion of C. At temperatures between 723° and 910°C decarburization from the outer surface causes the nucleation of the αBCC phase as a case around a γFCC core. As decarburization proceeds, the α case grows at the expense of the γ core, at a rate which is determined by the rate of removal of the carbon. Assuming that decarburization is a diffusion-controlled process, i.e., that equilibrium carbon concentrations exist at the α/γ interface and that the outer surface equilibrates with the gas phase, the rate of growth of the α case has been calculated by solution of diffusion equations. If experimentally determined growth rates of the α case agree with those calculated, then decarburization is certainly diffusion controlled.

6.84

Metallurgy and Ceramics Research Lab., ARZ, ARL. Dayton, Ohio.
INTERACTIONS OF IMPURITIES AND DISLOCATIONS IN SINGLE

AFOSR- Air Force Office of Scientific Research
- SRA- Directorate of Research Analysis
- SRC- Directorate of Chemical Sciences
- SRE- Directorate of Engineering Sciences
- SRI- Directorate of Information Sciences
- SRL- Directorate of Life Sciences
- SRM- Directorate of Mathematical Sciences
- SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
- CRR- Electronic Research Directorate
  - CRRB- Computer & Mathematical Sciences Lab
  - CRRC- Electronic Material Sciences Lab
  - CRRD- Electromagnetic Radiation Lab
  - CRRI- Astrosurveillance Sciences Lab
  - CRRK- Propagation Sciences Lab
  - CRRS- Communications Sciences Lab
  - CRRZ- Control Sciences Lab
- CRE- Geophysics Research Directorate
  - CREA- Photochemistry Lab
  - CREC- Thermal Radiation Lab
  - CREE- Research Instrumentation Lab
  - CREG- Terrestrial Sciences Lab
  - CREH- Meteorological Research Lab
  - CREI- Ionospheric Physics Lab
  - CRER- Sacramento Peak Observatory

CRYSTALS, N. M. Tallan. Project 7021(802A), Internal.

The presence of impurities, including hydrogen, in the vicinity of dislocations in real crystals may have a pronounced influence on the physical properties of these materials. This possibility will be investigated using single crystals, when possible, of Al, Mg, and Zr oxides, and the techniques of solid state physics. A model has been proposed for the special case of hydrogen in sapphire based on electrostatic considerations and the results of earlier studies of the dielectric loss in sapphire. The results of magnetic resonance studies of sapphire will be used for its evaluation. It is anticipated that future study of hydrogen in sapphire will include diffusion experiments and mass spectrometric analyses of the gases evolved upon heating. These studies and the electrical conductivity and dielectric loss studies will be extended to other materials to determine the generality of the proposed interactions in ionic crystals.

6.85

Michigan Coll. of Mining and Tech., Houghton.
DEFECT BEHAVIOR IN PLASTICALLY DEFORMED SEMICONDUCTORS, L. A. Haldt. Project 9760(802A), Grant AF-AFOSR-62-290; SRPS, AFOSR.

The purpose of the proposed research is to obtain new information concerning the behavior of defects during plastic deformation and the relation of this behavior to observed plastic properties. The experimental program will be 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 precipated along the dislocation lines, will be measured in order 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 effect of an impurity precipitated along dislocation lines upon dislocation motion.

6.86

Michigan State U., East Lansing.
TRANSPORT PROPERTIES OF SOLIDS, F. G. Blatt. Project 9763(802A), Contract AF 49(638)-70; SRPS, AFOSR.

The purpose of this research is to investigate some problems in an effort to further advance the theory of transport properties of solids. The investigation will include: (a) a study of the influence of impurities of various kinds on transport in metals; (b) a study of the relaxation times and relaxation mechanisms in solids as observed under a variety of experimental conditions; (c) an extension of the method of partial waves for calculating scattering cross sections; (d) the study of multi-phonon processes of "hot carriers"; and (e) the comparison of the collision time from dc conductivity and cyclotron resonance.

6.87

Michigan State U., East Lansing.
INTERACTION OF ELECTROMAGNETIC RADIATION WITH THE CRYSTAL LATTICE, D. J. Montgomery. Project 9760 (802A), Grant AF-AFOSR-62-37; SRPS, AFOSR.

The photon-phonon interaction in ionic and homopolar crystals will be studied using the techniques of infrared absorption in transmission through thin films. Variables include isotopic mass, isotopic composition, and temperature. Current studies of LiH and LiF in the wavelength range from 18 to 35 microns will be extended to include the heavier alkali halides at longer wavelengths.

6.88

Michigan U., Ann Arbor.
ELECTROMAGNETIC RADIATION IN CRYSTAL DEFECT CENTERS, C. Kikuchi. Project 9763(802A), Contract AF 49(638)-987; SRPS, AFOSR.

The purpose of this investigation is to obtain definitive information about interactions of electron spin with nuclear spins, electron spins with phonons, and determine their effects upon the mutual interactions of electromagnetic radiations at crystal defect centers. The unpaired electrons associated with the paramagnetic ions, are like microscopic electric and magnetic probes, and as such can be used for the submicroscopic examination of crystal defects. Such defect centers, due to chemical impurities or otherwise, can play a significant role in bringing about the interaction of electromagnetic radiations of different frequencies.

6.89

Mineralagisk - Geologisk Museum (Norway).
RELATIONSHIP BETWEEN MAGNETIC AND PHYSICAL PROPERTIES OF SULFIDES AND THEIR CRYSTAL STRUCTURE AND CHEMICAL COMPOSITION, H. Haraldsen. Project 7021(802A), Contract AF 61(052)-178; ARL, ARL.

A study into the structural and thermodynamic relationship of sulfides of synthetic and natural origin is being conducted to develop the theory of semiconductors and ferromagnetism. The experimental methods include the use of a high temperature X-ray camera to make accurate determinations of the crystal structure over a range of temperatures, and the

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ARH- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
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RAS- Directorate of Engineering
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AEDC- Arnold Engineering Development Center
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measurement of selected magnetic, electrical, and optical properties. The current work is principally concerned with the X-ray studies of the vanadium sulfides to determine the recurring phases, and to characterize these phases by composition and crystallographic properties. The study of the magnetic properties and heat capacities of selected phases as functions of temperature is continuing. The work on uranium disulfide and uranium trisulfide is being brought to a conclusion. As the remaining time permits, this investigation will be extended to studies of selected selenides and tellurides of uranium.

6.90

Minnesota U., Minneapolis.
ELECTRON SPIN RESONANCE STUDIES OF SOLID DEFECTS, J. E. Wertz. Project 9760(802A), Grant AF-AFOSR-62-54; SRPS, AFOSR.

The purpose of this work is: (1) to identify the defects giving rise to electron spin resonance lines presently observed but unassigned; (2) to seek evidence for centers presumed to occur but not experimentally established; (3) to relate optical absorption, luminescence properties and electrical conductivity of MgO samples to defects identified by electron spin resonance; and (4) to observe electron spin resonance of defects from helium temperatures up to the point where vacancies are mobile and electronic conductivity is appreciable.

6.91

Motorola, Inc., Phoenix, Ariz.
NON-DENDRITIC RIBBON CRYSTAL GROWTH, R. Pellen. Project 5621(802A), Contract AF 19(604)-8351; CERC, AFCRL.

This work will investigate theory and techniques for making thin single crystal sheets in a normal Czochralski process with the expectation of high quality associated with this process. This will start with a study of the correlation between crystal shape and meniscus shape at the liquid solid interface using germanium as the semiconductor, and will involve a mathematical analysis of the steady state equilibrium at the growth interface. Techniques for controlling the meniscus shape will be investigated and, if found feasible and if a correlation with final crystal shape is uncovered, thin single crystals will be grown. The properties of such crystals will, of course, be evaluated and a complete theory governing such growth will be fully developed.

6.92

Nevada U., Reno.
FIELD EMISSION STUDIES OF SURFACE MIGRATION OF REFRACTORY METALS, P. C. Bettler, G. Barnes. Project 9761(802A), Grant AF-AFOSR-62-297; SRPS, AFOSR.

The work will be directed toward the experimental study of the mechanisms of surface migration of a metal on its own crystal lattice by field emission methods. It will include the measurement of the activation energy for surface migration for metals of different crystal structures with particular attention to the activation energy of certain crystal planes of low Miller indices. The work will also include measurements of the surface tension (structure free energy) in the solid phase of refractory metals and a study of the variation of surface tension with temperature, with a view towards refinement of existing theories of the surface tension of solids.

6.93

New Hampshire U., Durham.
TRANSPORT PROPERTIES OF TITANIUM DIOXIDE, S. R. Butler. Project 9760(802A), Grant AF-AFOSR-61-49; SRPS, AFOSR.

This program of research will study the influence of lattice defects on the transport properties (electrical conductivity, thermoelectric power and Hall effect) of TiO_2. Lattice defects will be introduced by controlled gas phase interaction with the crystals during heat treatment at high temperature. It is hoped that a single unified theory of the transport properties of the transition metal oxides can then be developed.

6.94

New York U., N. Y.
PREPARATION OF ULTRA-PURE MATERIALS BY MEANS OF SPECIFIC HYDRIDE REACTIONS, W. Brenner. Project 5620(802A), Contract AF 19(604)-4124; CERC, AFCRL.

The objective of this research is the preparation of selected elements from Groups II, III, IV and V of the periodic table via the formation and subsequent decomposition of specific hydrides, and having the lowest impurity levels possible by this technique. Experimentation has concentrated on synthesis of high purity tin , barium and gallium. The conditions leading to the preparation of stannane have been explored in considerable detail. Spectroscopically pure tin has been obtained from thermal decomposition of stannane. Stoichiometric barium hydride has been prepared and its decomposition is under study. The reaction of gallium chloride with lithium hydride has resulted in gallium metal with quite promising purity characteristics. Methods for the analysis of trace impurities in gallium are being explored. Future investigation will concentrate

on the larger scale preparation of gallium and tin with improved purity and the synthesis of hyper-pure barium.

6.95

North Carolina U., Chapel Hill.
IMPERFECTIONS IN IONIC CRYSTALLINE SOLIDS, L. M. Slifkin. Project 9760(802A), Contract AF 49(638)-865; SRPS, AFOSR.

Study of: (1) the interactions of impurity atoms with dislocations by means of strain-aging experiments on doped crystals, exposed crystals, and crystals loaded during part of the strain-aging anneal; (2) the effects of various annealing and cooling procedures on the low-temperature ionic conductivity, the electrical conductivity and charge displacement produced during plastic deformation as a function of crystal orientation and temperature; (3) a means of obtaining the internally-grown silver whiskers free of the AgCl matrix in order to study their physical properties and to observe their cross-sectional shape via electron microscopy; and (4) the possibility of detection of heavy primary cosmic rays using large single crystals of AgCl.

6.96

Northwestern U., Evanston, Ill.
EFFECT OF SOLUTE-IMPERFECTION INTERACTIONS UPON PLASTICITY AND FRACTURE, J. O. Brittain. Project 9761 (802A), Contract AF 49(638)-780; SRPS, AFOSR.

The objectives of this research are to make a systematic study of (1) grain boundary cohesion and (2) solute-imperfection interactions in metals. These are distinctly related objectives since grain boundaries are composed of imperfections and experience has shown that small additions of foreign elements profoundly affect the mechanical behavior of materials at both elevated and low temperatures. The research on grain boundary cohesion is being carried out through a study of the role of solute elements upon the grain boundary migration, relaxation and fracture over a range of temperatures. The study of solute imperfection interactions is being accomplished by means of strain-aging and internal friction studies on iron and steel. Further aims of the research are to study yielding of materials that deform in a heterogeneous manner in the transition from elastic to plastic deformation, the relation of yielding to the initiation and/or propagation of a crack, and the study of strain aging at elevated temperatures of high-temperature materials.

6.97

Northwestern U., Evanston, Ill.
CHEMICAL PHYSICS OF NON-METALLIC CRYSTALS, M. E. Fine. Project 9763(802A), Grant AF-AFOSR-61-76; SRPS, AFOSR.

There exists now an extensive technology based on the unique physical behavior of certain crystals (e.g., semiconductors) brought about by the controlled addition of small amounts of impurities and imperfections called "point defects." This technology is supported by a large scientific activity on the effects of point defects on the physical properties of crystals. The activity has been carried forward largely by solid state physicists and it has led to frequent scientific conferences on the physical aspects of point defects. However, there is also a more chemical aspect to the subject of point defects in crystals which is very important. It is described as follows: (a) principles underlying the incorporation of point defects in crystals; (b) energetics of point defects in crystals, including the energetics of their mutual interaction; (c) structure of point defects and its characterization.

6.98

Notre Dame U., South Bend, Ind.
SINGLE CRYSTAL EMITTERS, E. A. Coomes. Project 6694 (750F), Contract AF 19(604)-8434; CRZA, AFCRL.

This program is divided in terms of short-range and long-range objectives. In the latter category, initial implementation of the program is concerned with the development of techniques for the production of refractory metallic single crystals in wire and rod forms. Ultimately, it is intended that the program scope will cover a theoretical and experimental investigation of electron emission, optical activity and surface equilibrium for single crystal emitters.

6.99

Ohio State U. Research Foundation, Columbus.
STRUCTURE CHANGES AND RELEVANT PHYSICAL AND CHEMICAL PROPERTIES ATTENDANT TO CERTAIN CHANGES OF STATE, P. M. Harris. Project 9760(802A), Contract AF 49 (638)-397; SRPS, AFOSR.

The research presently being covered includes: (a) structure investigations primarily of inorganic structures by X-ray and neutron diffraction methods. Past work on crystals having hydrated ions is to be continued. A continuation of previous work on inorganic crystals exhibiting first and second order transformations is contemplated; (b) the variation of the dielectric constant as a function of temperature will be investigated where these measurements would appear to clarify the mechanism of first and second order transformations; (c) the components of the thermal vibration tensor for the atoms of certain crystals

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of interest will be evaluated from X-ray (or neutron) diffraction data using an IBM-704 computer; (d) in connection with the IBM-704 computations, an attempt will be made to evaluate the electronic field, E, as a function of position from values of the charge density in the cell.

6.100

Ohio State U. Research Foundation, Columbus.
BEHAVIOR OF SOLIDS IN ALTERNATING AND CONSTANT MAGNETIC FIELDS, J. Korringa. Project 9760(802A), Contract AF 49(638)-264; SRPS, AFOSR.

Theoretical research in solid state physics, using the techniques of mathematical physics, is being conducted with emphasis in the following areas: (1) perturbation and spin wave approach to antiferromagnetism; (2) the electronic structure and relaxation processes for the electron spin of an F-center; (3) the energy band theory of random alloys; and (4) the theory of screw-type spin structures.

6.101

Ohio State U., Columbus.
ELECTRICAL PROPERTIES OF HIGH-PURITY BORON, M. O. Thurston. Project 9760(802A), Contract AF 49(638)-424; SRPS, AFOSR.

The objectives of the research are: first to produce boron crystals having the greatest possible purity, size, and crystalline perfection; second, to measure the physical and electrical characteristics of these crystals; and third, to study the effects of the addition of carefully controlled impurities. Recent rapid advances in the development of semiconductor devices such as transistors, rectifiers, and masers make it increasingly important to study the characteristics of a wide range of semiconducting elements and compounds. Although a tremendous amount of work has been done on the properties of silicon, germanium, various intermetallic compounds, and certain oxides, other semiconductors of potential importance have not been adequately investigated. For example, different sources give values of resistivity for boron ranging from 10^3 to 10^{18} ohm. Similarly, the intrinsic energy gap is given by different authors as 0.5, 1.0, 1.25, 1.55 and 2.0 ev. Carrier mobilities measured in samples of moderate purity have differed by a factor of ten but are believed to be low. There is not at present any agreement even on the crystalline structure of boron or its melting point. Qualitatively, the present knowledge of boron indicates that it is a semiconductor of very high resistivity at room temperature and low resistivity at temperatures of 600-800°C.

6.102

Paris U. (France).
DISLOCATIONS IN METALS BY X-RAY DIFFRACTION, A. Guinier. Project 9763(802A), Contract AF 61(052)-310; SRPS, AFOSR.

Defects in the structure of crystal have pronounced effects on the physical properties and behavior of materials. The precise measurement location and extent of such defects is made difficult by the very small size of these lattice imperfections. To provide experimental proof of theoretical predictions that dislocations in metals will have an effect on the diffraction of X-rays would offer a new method for obtaining precise information on the position of the atoms around dislocations. Measurements will be made of the diffuse scattering of X-rays by the distorted part of the lattice around a dislocation and of the variation of the reflecting power of a crystal in a Bragg reflection.

6.103

Pavia U. (Italy).
LOCALIZED EXCITONS IN ALKALI HALIDE CRYSTALS, G. Chiarotti. Project 9760(802A), Contract AF 61(052)-423; SRPS, AFOSR.

Using the techniques of vacuum ultraviolet and visible spectroscopy, the growth of the α band (negative ion vacancy) in NaCl and KCl under the action of low momentum X-rays at temperatures between 4 and 80°K will be studied. In addition, theoretical calculations of the various proposed mechanisms of vacancy production will be undertaken.

6.104

Pennsylvania State U., University Park.
X-RAY DIFFRACTION DETERMINATION OF LATTICE CONSTANTS OF PURE ZnS AND CdS AT TEMPERATURES DOWN TO LIQUID HELIUM, H. A. McKinstry. Project 7885(802A), Contract AF 33(616)-8038; ARX, ARL.

The lattice constants of pure platelet and bulk zinc sulfide and cadmium sulfide crystals, produced in ARL, are to be measured at 298, 195, 77, 20 and 4.20°K, to determine whether there is a measurable change of the constants with temperature. These measurements are needed in the interpretation of optical and electrical measurements made in the ARL in-house research on compound semiconductors.

6.105

Pennsylvania State U., University Park.

AFOSR- Air Force Office of Scientific Research
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CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

PREPARATION OF PHYSICAL MEASUREMENTS AND COLLATION OF PROPERTIES AND STRUCTURES OF CRYSTALS, R. Pepinsky. Project 9762(802A), Grant AF-AFOSR-62-367; SRPS, AFOSR.

This program involves research in crystallogenesis, with emphasis on new methods of preparation of organic semiconductors of the intermolecular-complex electron-transfer type, and for growth of materials for measurements of Fitzgerald audiomechanical resonance in solids. Since both semiconducting and resonance behaviors depend on crystal defects, particular attention will be paid to methods for control and measurement of purity and imperfection concentrations. Also, work will be undertaken to collect, correlate, and interpret in the light of modern techniques and procedures all available significant information on the physical and chemical properties of crystals.

6.106

Pennsylvania U., Philadelphia, Pa.
FORMATION AND ANNEALING OF POINT DEFECTS IN GERMANIUM, J. N. Hobstetter. Project 9760(802A), Contract AF 49(638)-626; SRPS, AFOSR.

Specifically the research will include: (a) a study of the relative numbers of defects introduced by quenching as functions of quenching temperature so as to find directly the energies of formation of vacancies and interstitials in germanium. Subsequent annealing studies will then reveal the fate of these defects as they combine with each other, or with dislocations of known densities, or are trapped at defects in the structure. Similar studies will be made of defects introduced during plastic extension of germanium. These will reveal dislocation motion at various temperatures as well as on annealing when widely disparate numbers of vacancies and interstitials are present.

6.107

Pennsylvania U., Philadelphia.
CRYSTAL CHEMISTRY OF METALLIC COMPOUNDS, E. Parthe. Project 9763(802A), Contract AF 49(638)-1027; SRPS, AFOSR.

It is the intention of this study first to investigate the formation and crystal structure of certain groups of compounds experimentally. Secondly, the data will be correlated and rules will be derived which will allow the prediction of the formation and properties of still other compounds as yet uninvestigated. Research will be directed toward the solution of the following four separate but related problems: (1) crystal structures of silicides, germanides, stannides, plumbides, etc.; (2) crystal chemistry of yttrium and scandium compounds; (3) the possibility of forming ternary rhenium carbides; (4) the calculation of three-dimensional Madelung constants.

6.108

Pittsburgh U., Pa.
MAGNETIC AND STRUCTURE PROPERTIES OF SOLIDS AND SOLUTIONS, F. Keffer, C. Dean, J. Anderson. Project 9760(802A), Contract AF 49(638)-323; SRPS, AFOSR.

The electronic energy levels of X- and UV- irradiated color centers in quartz and potassium azide are being studied by paramagnetic resonance techniques at 3 and 1 cm wavelengths. Structure analysis of molecules such as chlorine-substituted benzene are being performed using the combined techniques of X-ray diffraction and nuclear quadrupole resonance. In addition, theoretical studies of magnetic properties include: (1) right-angled superexchange via the Slater mechanism; (2) Moriya spin-coupling in β-MnS; (3) magnetic anisotropy constants in iron and nickel; (4) paramagnetic resonance line width just above the transition temperature; and (5) the specific heat anomaly of $CuCl_2 \cdot 2H_2O$.

6.109

Polytechnic Inst. of Brooklyn, N. Y.
INTERACTION OF HIGH FREQUENCY SOUND WAVES AND ELECTRONS, T. Kjeldaas. Project 9763(802A), Grant AF-AFOSR-62-258; SRPS, AFOSR.

The extent to which measurements of the attenuation of ultrasonic sound waves can yield information about the following will be examined theoretically: (a) the electronic energy band structure and electronic relaxation times as a function of position on the Fermi surface; (b) the relationship between electron-phonon interaction in the superconducting and the normal state; and (c) the relevancy of models used in the theory of ferromagnetism.

6.110

Pontificia Universidade Catolica du Rio de Janerio (Brasil).
CHARGE STORAGE AND IRRADIATION EFFECTS IN SOLID DIELECTRICS, H. Gross. Project 9763(802A), Grant AF-AFOSR-60-6; SRPS, AFOSR.

A range of electrostatic phenomena will be studied in solid dielectrics with attention being directed to such topics as: (1) the properties of electrets; (2) storage of charge accumulated from electron bombardment; (3) charge storage after gamma irradiation; and (4) radiation induced conductivity of dielectrics. The first of these, study of electrets, will receive most attention. These are the electrostatic equivalent of the magnet. That is, they remain electrically

polarized for decades without loss, the polarization intensity being limited only by the dielectric breakdown of air, about 10,000 volts per centimeter.

6.111

Queens Laboratories, Inc., Edison, N. J.
ORIENTATION OF SINGLE CRYSTALS, T. Smyth. Project 7022(802A), Contract AF 33(616)-8279; ARZ, ARL.

Research is being done to develop a satisfactory method of depositing electrodes on ionic crystals of definite specified orientation. The electrode must be of a material (such as platinum) which is suited to electrical measurements and which does not readily diffuse into the crystal. The electrode configuration will be the three-terminal type so that the bulk, and not the surface, properties can be measured. The width of guard ring will be 3-5 times the thickness of the crystal and it will be separated from the center electrode by a distance 1/3 - 1/5 the thickness of the crystal. Since the cut crystals will be approximately 0.020 inch thick, the electrode deposition process must be closely controlled. Attempts are being made initially to deposit these electrodes on the (100) and (111) faces of NaCl single crystals and perpendicular and parallel to the principal axis of MgO and Al_2O_3.

6.112

Radio Corp. of America, Princeton, N. J.
STUDY OF NEGATIVE MASS CARRIER PHENOMENA EMPHASIZING ESPECIALLY CYCLOTRON RESONANCE TECHNIQUES, C. Dousmanis. Project 4608(760E), Contract AF 19(604)-5479; CERC, AFCRL.

To investigate negative mass carrier phenomena in semiconductors, and the feasibility of using these effects for amplifiers and other devices at microwave and mm-wave frequencies. The negative-mass emissive cyclotron resonance in Ge, reported earlier at 4.2°K, has been observed (as before with circular microwaves) at temperatures as low as 1.4°K. The emission, relative to the absorption spectra, has shown no significant change in the range of 1.4° to 4.2°K. This shows that it arises from high-energy carriers that are far from equilibrium with lattice temperature. The resonances provide a very sensitive method of determining the temperature dependence of collision time and lifetime of optically excited carriers.

6.113

Radio Corp. of America, Princeton, N. J.
TWO-CARRIER INJECTION ELECTROLUMINESCENCE, A. Fischer. Project 5621(802A), Contract AF 19(604)-8018; CERC, AFCRL.

Improve crystal growing techniques under high pressure to obtain large, electroluminescent, single crystals of high purity and crystalline perfection, and determine techniques for bulk doping, either during growth or by post-diffusion so as to yield efficient luminescence from single crystals. Specific tasks will include but not be limited to the following: design and construction of pressure type crystal growing furnace; grow 1/2-in. diameter crystals of ZnSe, ZnSCdS, CdSe and mixtures thereof; determine effects of various dopants on the electroluminescent properties of above crystals as well as GaP; and determine mobilities and lifetimes of carriers, recombination kinetics, injection characteristics, etc., both theoretically and experimentally.

6.114

Radio Corp. of America, Princeton, N. J.
FUNDAMENTAL LIMITATIONS DETERMINING THE ULTIMATE SIZE OF MICROSTRUCTURES, J. T. Wallmark, A. G. Reeves. Project 5632(803A), Contract AF 19(604)-8040; CERB, AFCRL.

This effort is an investigation of fundamental limitations determining the ultimate size of microstructures. Consisting of an analysis of semiconducting structures to identify the fundamental physical phenomena, such as the statistical distribution of impurities in semiconductors, cosmic radiation and temperature, that set limitations on ultimate dimensions. The results of this analysis will be extended to structures using other than semiconducting properties and the implications of such limitations for extended multi-element structures embodying concepts such as redundancy and adaptive networks will be explored. Some theoretical and experimental work will be undertaken on physical techniques that have a direct bearing on the ultimate size of microstructures using non-linear phenomena.

6.115

Radio Corp. of America, Princeton, N. J.
HIGH TEMPERATURE SEMICONDUCTOR RESEARCH, L. R. Weisberg. Project 4608(760E), Contract AF 19(604)-6152; CERC, AFCRL.

The research objectives are to investigate the preparation, properties, and new device fabrication of III-V compound semiconductors with large energy band gaps, especially GaAs and GaP.

6.116

Raytheon Mfg. Co., Waltham, Mass.
CHEMISTRY AND SINGLE CRYSTAL GROWTH OF MAGNETIC OXIDES, H. J. Van Hook. Project 4608(760E), Contract AF 19(604)-5511; CERC, AFCRL.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
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SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRE- Electronic Research Directorate
CREB- Computer & Mathematical Sciences Lab
CREC- Electronic Material Sciences Lab
CRED- Electromagnetic Radiation Lab
CREI- Astroelectronics Sciences Lab
CREP- Propagation Sciences Lab
CRES- Communications Sciences Lab
CRET- Control Sciences Lab
CRO- Geophysics Research Directorate
CROA- Photochemistry Lab
CROC- Thermal Radiation Lab
CROE- Research Instrumentation Lab
CROO- Terrestrial Sciences Lab
CROR- Meteorological Research Lab
CROI- Ionospheric Physics Lab
CROM- Sacramento Peak Observatory

The objective of these studies is to provide the necessary data on the high temperature chemistry in oxide systems of interest so that predictions can be made as to the optimum conditions for synthesizing both polycrystalline and single crystal materials of known compositions.

16.117

RCA Labs. Div., Radio Corp. of America, Princeton, N. J.
CRYSTAL FIELD THEORY AND LIGAND FIELD THEORY, D. S. McClure. Project 5621(802A), Contract AF 19(604)-5541; CRRC, AFCRL.

The objective of this research is to provide a better understanding of the factors which determine the energy level schemes of transition metal ions in crystals. Both experimental and theoretical approaches are being used. Crystal field theory is successful in explaining the energy levels as long as the parameters of the theory are considered to be empirical. Exploration is beginning on the simple approximations such as M.O. theory and the non-orthogonality corrections to crystal field theory. It is also planned to extend the experimental work to other crystals, and already spectra of several pure transition metal halides have been determined. These will extend the parameter ranges and increase the probability of finding empirical correlations.

6.118

RIAS, Inc., Baltimore, Md.
PROPERTIES OF CONDUCTION ELECTRONS IN IONIC CRYSTALS, D. Kahn. Project 9760(802A), Contract AF 49(638)-1017; SRPS, AFOSR.

This research effort consists of four topics: (1) an investigation of the excitation of electrons from F-centers in colored alkali halides crystals into the conduction band; (2) the transport properties of electrons in the conduction bands (polaron mass, polaron mobility, trapping times); (3) space charge build up in alkali halides (interior potentials and electrode effects; and (4) problems in other fields arising from these investigations.

6.119

Rochester U., N. Y.
ELECTRONIC PROPERTIES OF SOLIDS, D. L. Dexter, R. S. Knox. Project 9760(802A), Grant AF-AFOSR-62-145; SRPS, AFOSR.

Energy band calculations using the tight-binding approximation of the solid rare gases in the pure state and with dilute substitutional impurities of heavier rare gas atoms will be continued; theoretical studies of the hot electron problem and pair creation in ionic crystals will be undertaken; the Pekar theory of the F-center will be studied; and the other theoretical studies related to luminescence and color centers will be undertaken. In addition, vacuum ultraviolet spectroscopy of the systems solid argon, neon-argon, and argon-hydrogen will be continued.

6.120

Shockley Transistor Corp., Mountain View, Calif.
THIN COMPOSITIONAL LAYERS IN SILICON, A. Goetzberger. Project 4608(760E), Contract AF 19(604)-5524; CRRC, AFCRL.

Research objectives for this program include the determination of the factors influencing the electrical characteristics and techniques of producing very thin layer junctions in silicon. A second part of the work has as its objective the study of diffusion and characteristics of junctions produced by such diffusion at, along, or adjacent to grain boundaries in silicon.

6.121

Solid State Materials Corp., East Natick, Mass.
GROWTH OF OPTICAL CRYSTALS, J. F. Wenckus. Project 5621(802A), Contract AF 19(604)-8846; CRRC, AFCRL.

The research called for in this contract is the growth of single crystals for utilization in optical and laser research. Various systems will be studied to determine those most suitable for these applications. The background information necessary to determine the best conditions and method for growth will then be obtained. Single crystals of the chosen materials will be grown and turned over to AFCRL for evaluation.

6.122

Solid State Physics Research Lab., AEX, ARL, Dayton, Ohio.
GROWTH OF COMPOUND SEMICONDUCTOR CRYSTALS, L. C. Greene. Project 7885(802A), Internal.

Crystals of outstanding quality are being grown for use in all in-house work and they are also loaned to other leading solid state researchers. Four furnaces for growing crystals of different compounds by vapor diffusion are in operation, and two others are planned for the near future. A special furnace is being prepared for operation in which isotopes will be used to study the growing process. Growth of crystals from a melt, and growth by the Frerichs' method, involving chemical reaction of the vapor are planned for the near future.

ARL- Aeronautical Research Laboratories
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ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARH- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRER- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAE- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEDR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESRH- Operational Applications Lab

6.123

Solid State Physics Research Lab., AEX, ARL, Dayton, Ohio.
CADMIUM SULFIDE USING ELECTRON BOMBARDMENT, B. A. Kulp. Project 7885(802A), Internal.

The present effort is designed to provide information on the energy band structure of cadmium sulfide, utilizing electron bombardment to make tailored changes in the defect structures, and measurements of physical properties before and after the bombardment for identification of property changes with specific defects. Heavy emphasis is placed on fluorescence radiation; in particular, spectral lines at 8500 Å, and at 1.05 microns have been under investigation. A number of treatments, including heat treatment and X-ray bombardment, have provided strong evidence that the 8500 Å band is associated with copper impurity atoms. The search for an explanation of the 1.05 micron band is still in progress.

6.124

Solid State Physics Research Lab., AEX, ARL, Dayton, Ohio.
OPTICAL AND ELECTRICAL PROPERTIES OF SEMICONDUCTOR MATERIALS UNDER HIGH-HYDROSTATIC PRESSURES, W. B. Lauterbach. Project 7885(802A), Internal.

This research is designed to elucidate the details of the energy band structures of crystals. As a result of research on critical problems associated with high pressure measurements, especially optical, experimental systems were developed, and development reported in the literature.

6.125

Solid State Physics Research Lab., AEX; ARL, Dayton, Ohio.
STRUCTURE AND PROPERTIES OF CADMIUM SULFIDE AND OTHER COMPOUND SEMICONDUCTORS, D. C. Reynolds. Project 7885 (802A), Internal.

Work has been started on the electron paramagnetic resonance of CdS. New equipment for use in this work has been developed which is capable of detecting something less than 10^{12} electron spins and can be operated from 100°C down to liquid helium temperature without dismantling. The measurements of samples gave a preliminary indication of a resonance not previously reported.

6.126

Southern Research Inst., Birmingham, Ala.
DIFFUSIVITY OF IRON IN MOLTEN SILICATES, E. B. Diamukos. Project 9760(802A), Contract AF 49(638)-523; SRC, AFOSR.

This research is concerned with studying the self-diffusion of radioactive iron in molten silicates and determining from the results whether iron in these solutions possesses an ionic or covalent structure.

6.127

Southwest Research Inst., San Antonio, Tex.
EFFECTS OF MAGNETIC FIELDS ON THE STRUCTURE OF SOLIDS, J. F. Funnell. Project 6886(802A), Contract AF 29 (600)-2778; SRAS, AFOSR.

The objective of this experimental study is to influence and/or control the nuclei forming in a cooling melt such that preferred orientation of the crystals is achieved on solidification.

6.128

Stanford Research Inst., Menlo Park, Calif.
DYNAMIC COMPRESSION OF SOLIDS, G. E. Duvall. Project 9760(802A), Contract AF 49(638)-625; SRPS, AFOSR.

Thermodynamic properties of solids at pressures as high as one million atmospheres will be determined using shaped charge explosives to produce the high pressures. The effect of first and second order phase transitions in condensed materials on shock wave propagation and the equation of state of materials such as invar, aluminum, and the noble metals will be determined. The effects of dislocation density on the shock transition in nonmetals, and the relation between conductivity of insulators under shock and the generation of dislocations in the shock transition will be studied.

6.129

Stanford Research Inst., Menlo Park, Calif.
CRYSTAL GROWTH PROCESSES, W. J. Fredericks. Project 9762(802A), Contract AF 49(638)-999; SRPS, AFOSR.

This effort concerns two aspects of crystal growth and the problems of fundamental importance to the growth process. One aspect of this study is an investigation of the applicability of the ideas developed in the field of hydrothermal synthesis to non-aqueous systems. A second aspect of emphasis is research on the growth of ionic crystals from melts. The initial effort in this program will be on the alkali halides.

6.130

Stanford Research Inst., Menlo Park, Calif.
SOLID-STATE ELECTROLYTES, W. J. Fredericks. Project 5620(802A), Contract AF 19(604)-7231; CRRC, AFCRL.

The object of this work is to develop the concept of

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CRRI- Astrosurveillance Sciences Lab
CRRL- Propagation Sciences Lab
CRRR- Communications Sciences Lab
CRRS- Control Sciences Lab
CRE- Geophysics Research Directorate
CREA- Photochemistry Lab
CREC- Thermal Radiation Lab
CREE- Research Instrumentation Lab
CRES- Terrestrial Sciences Lab
CREM- Meteorological Research Lab
CREI- Ionospheric Physics Lab
CREM- Sacramento Peak Observatory

solid state electrolytes including all phenomena in solids in which there are interactions between chemical defects and between chemical and physical defects. Emphasis will be placed on ion-pairing reactions in semiconductors, interactions of solutes to form donor and/or acceptor complexes, the temperature stability of these complexes, and the kinetics and mechanism of solute precipitation arising from solid state interactions. An extensive literature survey is being compiled on McBee Keysort Cards, extending from January 1946 to March 1961 at present, covering a wide variety of semiconductors and insulators and an attempt is being made to interpret the collected data and information in terms of solid state electrolyte theory. An experimental program, largely directed by the results of the literature survey, is being conducted to extend the present knowledge of solid state electrolyte behavior.

6.131

Stanford Research Inst., Menlo Park, Calif.
GROWTH AND EVALUATION OF BORON SUBOXIDE SINGLE CRYSTALS, F. A. Halden. Project 7022(802A), Contract AF 33(616)-7967; ARZ, ARL.

Single crystals of the boron suboxide B_6O are necessary to unequivocally establish its existence, to determine its crystallographic structure and to investigate its properties. This research is planned to learn how to grow the necessary single crystals and to study their properties. The growth of B_6O will be investigated using such methods as growth from the melt, from vapor and from solutions.

6.132

Stanford U., Calif.
BEHAVIOR OF GRAIN BOUNDARIES IN ALUMINUM BICRYSTALS AT HIGH TEMPERATURE, R. A. Huggins. Project 9761 (802A), Contract AF 18(603)-66; SRPS, AFOSR.

The purpose of this research is to study the effect of solute elements upon the kinematics of grain boundary shear in metals at high temperatures. A number of phenomena occur during the deformation of metals including the movement of individual dislocations, subgrain movement, grain boundary sliding, and boundary migration. Further, the relative magnitudes of these phenomena have been shown to depend upon several variables, including temperature and strain rate. Much of the previous work on grain boundary behavior has been done on polycrystalline materials in which boundary movements are accompanied and complicated by other deformation phenomena. For this reason, the current program is concerned with the effect of solute content on grain boundary shear in simple bicrystals, utilizing high purity aluminum and aluminum alloys.

6.133

Syracuse U., N. Y.
THEORETICAL STUDIES OF VIBRATION SPECTRA AND EFFECT OF SURFACES ON LATTICE VIBRATIONS, H. Kaplan. Project 9760(802A), Contract AF 49(638)-642; SRPS, AFOSR.

Theoretical analysis of the vibration spectra of crystals with the zinc blende, Wurtzite, and quartz structures, using experimentally-determined parameters, will be continued. Intensity of the infrared absorptions will be studied and the nature of the chemical binding considered. The effect of crystallite surfaces in carbon samples on thermal conductivity will be incorporated in a complete treatment of the thermal conductivity of carbons.

6.134

University of Southern California, Los Angeles.
SPECTRA OF CRYSTALS, D. A. Dows. Project 9760(802A), Grant AF-AFOSR-62-165; SRC, AFOSR.

This project is a study of the splittings and shifts in the infrared absorption bands of crystals, theoretical studies of the intermolecular forces in crystals and the relationship between crystal compressibilities and gas transport properties.

6.135

University of Southern California, Los Angeles.
SOLID STATE PHYSICS USING DISPERSION RELATION TECHNIQUES, P. E. Kraus. Project 7885(802A), Contract AF 33(616)-7781; AEX, ARL.

A new mathematical technique has been reported which can, in principle, use information obtained from the bottom of the conduction band in a semiconductor and the top of its valence band to derive information pertaining to the forbidden region between them. This technique for the one dimensional case was worked out and will appear in the Physical Review. Under this contract, the scientist who developed this new approach is to attempt to extend the procedure to two, and three dimensions. If successful, this may provide a basis for relating tunneling probabilities to common experimental properties of semiconductors and to use dispersion relation methods to investigate the effects of impurities and dislocations.

6.136

Virginia Inst. for Scientific Research, Richmond, Va.
GROWTH AND PERFECTION OF SINGLE CRYSTALS OF THE RARE EARTHS AND ALKALI METALS, J. F. Kirn. Project 9762 (802A), Grant AF-AFOSR-61-41; SRPS, AFOSR.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
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ARP- General Physics Research Lab
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ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARY- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEM- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAE- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESRR- Operational Applications Lab

Large single crystals of the rare earths and alkali metals will be prepared by crystallisation on a seed. The objective is to obtain crystals of high purity and known perfection for use in physical and chemical studies. Emphasis will be placed on reducing to a minimum the pick-up of impurities from the container walls and analyzing the perfection of the crystals by X-ray and optical microscope techniques.

6.137

Wentworth Inst., Boston, Mass.
PREPARATION, PURIFICATION, AND EVALUATION OF INORGANIC ELECTRONIC MATERIALS, M. J. Devin. Project 5620 (802A), Contract AF 19(604)-8503; CRRC, AFCRL.

The objective of this contract is to investigate those techniques, procedures, and equipment that will provide the optimum conditions for obtaining ultra-pure, inorganic electronic materials. The purity of materials will be evaluated by comparing the purity of the purified materials with the highest grade of materials commercially available. This investigation will provide information on the best method of purification of many inorganic electronic materials and will focus attention on those purification techniques which may have general applicability.

6.138

Westinghouse Electric Corp., Pittsburgh, Pa.
CRYSTAL GROWTH MECHANISMS, R. L. Langini, A. I. Bennett. Project 9761(802A), Contract AF 49(638)-599; SRPS, AFOSR.

Crystal growth is a process wherein an ordered atomic lattice structure is extended by accretion of atoms from an adjacent liquid or vapor phase. In many cases the details of the accretive mechanisms and their dependence on experimental conditions are poorly understood. It would therefore seem appropriate to look for a crystal growth system which from an experimental standpoint is easy to work with, and on which results of controlled reproducibility can be obtained; one might propose a thorough investigation of such a system, with the hope that the results might be applied to cases which are experimentally much less tractable, and which application might lead to an understanding which would be difficult to obtain by direct experimentation on the latter cases. The study of such a system is the objective of this research. The research falls into three overlapping phases: First, the effects of seed geometry and structure, temperature distribution and time variation, growth rate, cooling after solidification, and other pertinent growth variables will be investigated to further expand the range of validity of the present theory of this type of growth. Second, research will be directed toward determining the distribution of impurities both within the grown crystal and within the melt. This will involve measurement of the electrical properties. And finally, theoretical considerations will be made of such things as the effects of the liquid on the rate and direction of growth of the crystal and the preferred stacking of atoms through a double bond mechanism.

6.139

Westinghouse Electric Corp., Washington, D. C.
BASIC RESEARCH ON CRYSTALLOGENICS, W. A. Tiller. Project 9762(802A), Contract AF 49(638)-1029; SRPS, AFOSR.

The contractor will conduct basic research in the general area of crystallogenics and shall as required conduct research in the following sub-areas: (a) atomic kinetics and atomic morphology at the solid-liquid interface; (b) macroscopic interface morphology; (c) fluid flow control; (d) crystal nucleation and epitaxy; (e) crystal imperfections; and (f) phase equilibria and growth variables.

6.140

Wilkes Coll., Wilkes-Barre, Pa.
INTERNAL FRICTION IN NON-METALLICS, D. P. Datwiler. Project 7021(802A), Contract AF 33(616)-8050; AEZ, AEL.

The study of internal friction in metals has added significantly to present knowledge of the defect structure of metals and has assisted in the interpretation of defect controlled mechanisms. Considerably less work has been done on internal friction in non-metallic solids and far less has been learned about them. This has been largely due to the inherent difficulties involved in studying these materials: their bonding and defect structures are very different from metals and less is known about them, they are much more difficult to purify, etc. As a result, much more sophisticated measurement techniques are required for their study. This investigation will develop a free decay apparatus possessing a sensitivity for Q^{-1} measurements at least as low as 1×10^{-5}. Using this apparatus, a survey will be made of the internal friction characteristics of a considerable group of oxide and halide single crystals. The internal friction will be measured over a wide temperature range (at least -200° to 700°C) in the frequency range 10 Kc to 1 Mc. From the results of this survey, a small number of crystals will be selected for detailed study of mechanical losses involving interstitials and point or line defects.

6.141

Wisconsin U., Madison.

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CROT- Ionospheric Physics Lab
CROU- Sacramento Peak Observatory

ENERGY LEVELS IN SEMICONDUCTOR MATERIALS THROUGH CYCLOTRON RESONANCE, D. L. Dexter. Project 7885 (802A), Contract AF 33(616)-6111; ARX, ARL.

This contract utilizes research in microwave conductivity and cyclotron resonance to study the band structure of group II-VI semiconducting compounds. It involves work on (1) the effect of a magnetic field on the microwave conductivity, (2) the effect on microwave photoconductivity of the wavelength of the exciting light quanta and (3) on the character and anisotropy of cyclotron resonance.

6.142

Yale U., New Haven, Conn.
OPTICAL ABSORPTION EDGE OF INSULATING CRYSTALS AT LOW TEMPERATURES, R. G. Wheeler. Project 9760(802A), Contract AF 18(600)-850, AF 49(638)-503; SRPS, AFOSR.

The problem with which this research is concerned is the investigation of excited electronic states of insulating crystals. It is now becoming quite clear, as evidenced by the work on CdS, that optical techniques when properly interpreted allow a determination of the electronic band structures of some insulating materials. The investigation will proceed along the following general lines: (1) group theoretical analysis of the group of the wave vector applicable to the particular space group to which the insulating crystal belongs; (2) optical reflection and absorption interpreted in light of group theoretical selection rules; (3) observation of line spectra near the absorption edge interpreted in light of possible exciton states as predicted from the group theory; (4) magnetic optical effects, Zeeman splitting of exciton lines and the observation of the Landau levels associated with the valence and conduction bands; and (5) further magnetic measurements, such as susceptibility which offers the possibility of eliminating the ambiguities on the location within the zone of the band extrema. The group theoretical selection rules ofttimes, when compared with experiment, are not able to establish definitely the location of the band extrema. Susceptibility sometimes can determine the number of equivalent extrema, thus usually eliminating the ambiguity determined only from selection rules.

6.143

Yale U., New Haven, Conn.
OPTICAL PROPERTIES OF INSULATING CRYSTALS AT LOW TEMPERATURES, R. G. Wheeler. Project 9760(802A), Grant AF-AFOSR-62-186; SRPS, AFOSR.

The band structure in wurtzite crystals, CdS will be determined by observation and interpretation of the magneto-optical effects on the exciton spectra. Magneto-optical experiments will be performed on selected antiferromagnetic crystals to gain further information on the nature of the correlation forces in these crystals.

See also: 1.20, 2.1, 2.4, 2.20, 2.21, 2.25-27, 2.34, 2.36, 2.39-40, 2.46-47, 2.54, 2.58, 2.61, 2.68, 2.70, 2.72, 2.77, 3.33, 3.120, 3.134, 4.7, 4.28, 4.35, 4.48, 4.51, 4.70, 4.88, 5.7, 5.9, 5.10, 5.18-19, 5.21, 5.23, 5.27, 5.31, 5.33-35, 5.40, 5.44, 5.47, 5.50, 5.53, 7.14, 7.26, 7.29, 7.32-34, 7.40, 8.67, 9.31, 9.37-38, 9.40, 9.44, 9.47, 9.55-56, 9.66, 9.70-71, 9.75, 9.80, 10.10, 10.19, 10.24, 10.28, 11.20, 11.28, 11.47, 11.108, 11.120, 12.133, 14.11, 14.79, 15.3, 15.29, 15.44, 15.49, 15.63, 15.69, 15.84, 19.83, 23.16, 23.36, 23.39, 23.55, 23.104, 23.118, 24.55

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- CRRK- Propagation Sciences Lab
- CRRS- Communications Sciences Lab
- CRRZ- Control Sciences Lab

CRP- Geophysics Research Directorate
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- CRPC- Thermal Radiation Lab
- CRPE- Research Instrumentation Lab
- CRPG- Terrestrial Sciences Lab
- CRPH- Meteorological Research Lab
- CRPI- Ionospheric Physics Lab
- CRPR- Sacramento Peak Observatory

7. EXPERIMENTAL NUCLEAR PHYSICS, PARTICLES, AND COSMIC RADIATION

Cosmic Radiation; Particles (Nuclear Physics); Nuclear Energy Levels; Nuclear Reactions; Nuclear States; Nuclear Structure; Radioactive Isotopes; Spin Systems; Radiation Chemistry; Radiation Effects on Solids; Biological Effects of Radiation.

7.1

Advanced Development Lab., RAUA, RADC, Rome, N. Y.
INDUCED DEFECTS IN CRYSTALLINE SOLIDS BY ESR, R. A. Serway. Project 8503(803A), Internal.

This is an experimental and analytical study of spin centers induced in crystalline substances by irradiation with high energy particles and X-rays. Of primary interest are the magnetic energy levels with long relaxation times. Multiple energy level schemes are sought. Instrumentation for this work is completed and a large amount of data has been obtained of an unirradiated natural $CaCO_3$ crystal at room temperatures, and at several crystalline axis orientations. The spectrum observed was due to Mn^{++} ions in $CaCO_3$, and 30 lines were well resolved at 0-90°. However, of prime interest are the five additional narrow EPR lines which occur in an irradiated sample of $CaCO_3$. The observed line widths are about .2 gauss and their origin is still unexplained.

7.2

Advanced Development Lab., RAUA, RADC, Rome, N.Y.
SPIN COUPLING INVESTIGATION, R. A. Serway. Project 8503(803A), Internal.

The feasibility of obtaining oscillation and amplification of rf energy using stimulated emission of a proton spin system has been demonstrated. An analytical study has been made of the effects of laminar liquid flow in a tube on the measured values of relaxation time of a nuclear spin system. This treatment brings out the necessity for consideration of the type of liquid flow involved when making steady state measurements of nuclear polarization and relaxation time. The experimental work concerning laminar flow effects on these measurements has been completed and agrees with predicted results.

7.3

American Oil Co., New York, N. Y.
THERMAL AND NUCLEAR EFFECTS, J. D. McCollum. Project 7021(802A), Contract AF 33(616)-8247; ASRC, ASD.

This contract is for experimental and theoretical investigation of the thermal and radiolytic effects on selected organic compounds using an Air Force/contractor developed apparatus which measures the concentration of triplet state intermediates formed by irradiation. The objective of the program is to gain information on the nature of radiolytically formed transient species, the mechanisms by which such species are formed and the resultant fate of the species or subspecies. The combined effects of thermal and radiolytic action are to be determined in the hope of clarifying the significance of thermal effects on radiolysis products.

7.4

Arkansas U., Fayetteville.
ATOMIC SPECTROSCOPIC INVESTIGATION OF NUCLEAR PROPERTIES, R. Hughes. Project 9767(803A), Contract AF 49(638)-547; SRPP, AFOSR.

High-stability spectrographic equipment will be constructed for the measurement of weak spectral lines of stable isotopes of light and medium weight atoms. Isotopic shifts in even-even and even-odd neutron-proton isotopic neighbors will be analyzed for particle effects, spectral shifts, and binding energy shifts. This will permit formulation of stability criteria and excitation levels of elements important as primary radiation and as high temperature alloy materials.

7.5

Arkansas U., Fayetteville.
ION BEAM STUDIES, R. Hughes. Project 7661(770A), Contract AF 19(604)-4966; CRZI, AFCRL.

This work is the study of proton impact on atmospheric gases in the range 100 to 400 Kev. The discharge is observed spectroscopically.

7.6

Arkansas U., Fayetteville.
OPTICAL POLARIZATION BY ELECTRON IMPACT, R. H. Hughes. Project 9767(803A), Grant AF-AFOSR-62-159; SRPP, AFOSR.

A high-precision spectrographic study will be made of the variation in the polarized light emitted from atoms excited into spectral emission by electron impact at various discrete energies. The work will be extended to the detection of excited states of positronium from Lyman-Alpha radiation and to the determination of atomic lifetimes by spatial distribution of radiation intensity in crossed electric and magnetic fields.

7.7

Armour Research Foundation, Chicago, Ill.
STRUCTURE OF DEFECT CLUSTERS IN SOLIDS, R. H. Bragg. Project 9763(802A), Contract AF 49(638)-829; SRPS, AFOSR.

The contractor will undertake a theoretical and computational analysis to be used for relating measurements of small angle scattering of X-rays in solids to the sizes and shapes of particles in the solids; and apply this analysis to the study of particles in the solids, principaliy defect clusters produced by nuclear irradiation. This investigation will be centered around study of neutron damage in lithium fluoride crystals. The mechanism whereby the point imperfections resulting from irradiation are able to condense to form cavities and precipitates of impurity atoms will be considered.

7.8

Armour Research Foundation, Chicago, Ill
CHEMICAL REACTIONS OF SECONDARY ELECTRONS, P. Y. Feng. Project 9763(802A), Contract AF 49(638)-1104; SRC, AFOSR.

Little attention has heretofore been paid to the role of secondary electrons in studies aimed at understanding the interaction of radiation and molecular species. The investigator proposes to uncover information regarding the relative role of low and high energy electrons in radiation chemistry. Simple systems such as acetylene and halocarbons will be studied and the techniques used will include radioactive carbon and tritium combined with gas chromatography, conventional and time-of-flight mass spectrometry.

7.9

Armour Research Foundation, Chicago, Ill.
RADIATION-INDUCED CROSS FLUORINATION, P. Y. Feng. Project 9762(802A), Contract AF 18(603)-121; AFOSR, SRC.

This is a study of the thoretical significance of the radiation chemistry of fluorocompounds. It concerns the possible synthesis of organofluorocarbons, by means of cross-fluorination of aromatic materials. This involves the treatment with ionizing radiation of a mixture of simple, easily available fluorocarbons and an organic compound of desired structure. It is also an experimental investigation of the relative importance of the various possible mechanisms (radical, ion molecule, and molecular) of radiation induced reactions and to gather detailed information concerning the radical processes in such reactions.

7.10

Batelle Memorial Inst., Columbus, Ohio.
RADIATION EFFECTS RESEARCH ON SEMICONDUCTING MATERIALS, R. F. Willardson. Project 7885(802A), Contract AF 33 (616)-8064; AEK, ARL.

The present work consists of experimental studies of the energy levels, and of the mechanism of optical absorption, of electron-irradiated gallium arsenide, and also annealing studies of this material. It also includes studies of the annealing of fast neutron damage in p-type gallium arsenide and in indium phosphide, and of the disordered regions produced in gallium arsenide. Theoretical work also will be performed on the effect of radiation damage on the transport properties of these materials, and on the relation between the energy lost by a fast atom moving in a solid and the potential distribution describing the propulsion of colliding atoms.

7.11

California U., Berkeley.
TIME VARIATIONS OF COSMIC RADIATION AT HIGH ALTITUDE IN POLAR REGIONS, R. R. Brown. Project 9774(804A), Grant AF-AFOSR-62-422; SRPM, AFOSR.

This research will make use of high altitude balloons, aircraft or sounding rockets to determine the type, intensity and spectra of the radiation at high latitudes and high altitudes. This will be done both during the active and the quiescent sun in order to establish the differences which may exist at these times. In addition, an attempt will be made to determine if electrons observed are due to "dumping" from the radiation belts which could be instigated by solar activity and if gammas and neutrons are primary or if they are produced within the atmosphere by proton interactions. These studies will also result in a better knowledge of the relationship of solar activity, magnetic storms and communications blackout.

7.12

Biomedical Lab., MIM, AMRL, Dayton, Ohio.
MECHANISMS OF NUTRIENT UTILIZATION, E. G. Sander. Project 7163(805A), Internal.

The objectives of this research are to examine the mechanisms by which nutrient utilization is altered

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SRE- Directorate of Engineering Sciences
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SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRE- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRO- Geophysics Research Directorate
CROA- Photochemistry Lab
CROC- Thermal Radiation Lab
CRRE- Research Instrumentation Lab
CROG- Terrestrial Sciences Lab
CROM- Meteorological Research Lab
CROI- Ionospheric Physics Lab
CROR- Sacramento Peak Observatory

by radiation and to examine techniques by which man can be protected from the hazards of continuous or acute radiation either by alteration of the dietary regime or by administration of chemo-protective compounds.

7.13

Biomedical Lab., MRM, AMRC, Dayton, Ohio.
CELLULAR EFFECTS OF IONIZING SPACE RADIATION ON THE VISUAL SYSTEM, L. R. Loper. Project 7163(805A), Internal.

The objective of this effort is to conduct a literature survey of the cellular effects of ionizing space radiation on the visual system. An attempt is being made to determine cellular changes that are induced by different levels of ionizing radiation. The information gained from this effort will be used in evaluating protection techniques and/or devices against ionizing space radiation on the visual system.

7.14

Brown U., Providence, R. I.
SURFACE PROPERTIES OF SILICON AND OTHER SEMICONDUCTOR SURFACES, H. E. Farnsworth, J. A. Dillon. Project 5620(802A), Contract AF 19(604)-5986; CRRC, AFCRL.

Research on the physical, electrical, and chemical properties of semiconductor surfaces and particularly on the effects of chemical and physical defects on these properties will be performed to obtain a better understanding of surface phenomena. This research will directly support an internal program concerned with the effects of nuclear irradiation on the properties of electronic materials. In this research, ion-bombardment and subsequent annealing in ultra high vacuum are used to prepare reproducible surfaces. Interactions of such surfaces with various gaseous species will be observed using a low energy diffraction apparatus. Work on electron microscopy will be directed toward the analysis of defects introduced into surfaces by ion-bombardment and nuclear irradiations. Work function and photoelectric photoelectric properties of various surfaces will be measured and correlated with the electron diffraction and electron microscopy data to obtain information concerning the properties of defects.

7.15

California U., Berkeley.
ATOMIC AND MOLECULAR BEAM RESEARCH, H. A. Shugart. Project 9768(803A), Grant AF-AFOSR 62-346; SRFP, AFOSR.

Continuation of measurements on atomic and nuclear properties of radioactive isotopes including nuclear spins, electron angular moments, magnetic moments, quadrupole moments and hyperfine structure constants.

7.16

California U., Los Angeles.
CHEMICAL EFFECTS OF RADIATION, W. F. Libby. Project 9760(802A), Contract AF 49(638)-901; SRC, AFOSR.

The project involves several phases in the chemistry of materials, such as the effects of atomic radiation on matter dealing with hot atom chemistry and radiation chemistry particularly ion-molecule reactions. The role of the chemical bond in the cooling of neutrons to thermal energies below room temperatures will be investigated. Both theoretical and experimental work will be done on the chemistry of gas-solid and liquid-solid reactions involved with metals. The kinetics and thermodynamics of the chemical properties of matter at very high temperatures and pressures will be investigated as well as the development of techniques associated with measuring slow reactions using a radioactive reactant and other low-level counting means.

7.17

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
RADIATION CHEMISTRY OF HYDROCARBONS, J. H. Futrell. Project 7023(802A), Internal.

Experiments to measure quantitatively the initial radiolysis products are under way in hydrocarbon systems in an attempt to delineate the limits of applicability of newly developed mechanisms for gas phase radiation chemistry. Gas chromatography and vacuum techniques are being developed to measure the trace amounts of products formed at very low dose.

7.18

Chicago U., Ill.
RADIATION DAMAGE TO ORGANIC MATERIALS, W. G. Brown. Project 7023(802A), Contract AF 33(616)-3875; ARC, ARL.

Experimental studies are being conducted on the interaction of high energy nuclear radiation with several classes of organic materials. The following specific systems are being investigated. The gamma ray induced reaction of nitric oxide with the lower alcohols is being studied in an effort to establish the intermediates of reaction in the radiolysis of alcohols to produce aldehydes and/or glycols. To this same end, deuterium and tritium tracers are also being used. The radiolysis of aryl ketones and aliphatic cyclic ketones is being studied in an effort to further correlate radiation sensitivity with molecular structure.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
AED- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMM- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

7.19

Chicago U., Ill.
NUCLEONIC COMPONENT, J. A. Simpson. Project 8600 (804A), Contract AF 19(604)-4554; CRZI, AFCRL.

The study of cosmic ray intensity as a function of time and space for the determination of the mechanisms operative in space which cause the observed intensity changes and the relation of these changes to other geophysical parameters. This work includes (a) pile monitor observations at selected sites with an extension of the method so as to improve the precision of the intensity-time data by an order of magnitude; (b) solar geomagnetic cosmic ray and other relationships to be derived from the data of the cosmic ray-neutron intensity observations; (c) exploration of methods developed in the laboratory for prediction of solar active regions, particularly those which tend to increase geomagnetic and/or cosmic ray activity; (d) the study of the relationship between solar flares, magnetic disturbances and cosmic ray intensity variations; (e) high altitude neutron monitoring balloon flights to measure neutron component.

7.20

Chicago U., Ill.
COSMIC AND SOLAR RADIATION STUDIES AND THEIR ASTROPHYSICAL CONSEQUENCES, J. A. Simpson. Project 9774 (804A), Grant AF-AFOSR-62-23; SRPM, AFOSR.

A search is being made for the origin and nature of the modulating mechanism which controls the variations of the low energy cosmic radiation. In particular, the phenomena associated with solar flares is being studied as a means of forecasting the environment along the sun-earth line as a function of time. The data are collected at a network of stations on the earth's surface and by means of high altitude equipment during solar active periods. In addition to the experimental research, theoretical work is being done on the environment, the plasma, near the sun to try to determine the origin of cosmic rays and how solar activity affects this. The composition and spectrum of the low energy components is being determined through a study of the proton to alpha ratio in the primary beam. The primary gammas in the 0.5 to 20 Mev range are being studied.

7.21

Chicago U., Ill.
NUCLEAR EMULSION STUDIES OF THE PROPERTIES OF HYPERNUCLEI, V. L. Telegdi. Project 9750(801A), Grant AF-AFOSR-62-358; SRPM, AFOSR.

The investigation by nuclear emulsion techniques of phenomena induced by beams from high energy accelerators. The production, decay, lifetime, binding energy and other properties of hypernuclei will be studied. The associated production and interaction of neutral particles with other charged strange particles will be investigated.

7.22

Chicago U., Illinois.
QUASI-ELASTIC PROTON-PROTON SCATTERING IN LIGHT NUCLEI, H. Tyren. Project 9751(801A), Contract AF 49(638)-958; SRPM, AFOSR.

A double magnetic spectrometer is used to analyse protons scattered quasi-elastically from light nuclei, e.g., carbon. Quasi-elastic scattering in this case is a process in which the incident proton transfers some of its momentum to a nucleon (not the whole nucleus). The struck nucleon is ejected from the nucleus and the incident proton is scattered away from the direction of the incident beam. From a consideration of the energies and momenta of the incident and emergent particles the binding energy of a nucleon can be obtained.

7.23

Columbia U., New York.
PROPERTIES OF RADIOACTIVE ATOMS BY OPTICAL ORIENTATION, R. Novick. Project 9768(803A), Grant AF-AFOSR-62-65; SRPP, AFOSR.

Optical orientation techniques are used as a method to give a preferential orientation to the nuclear angular momentum vector. The method will be applied to the determination of nuclear properties of alkaline earth and copper isotopes, with emphasis upon those with very short half lives. Measurements will be made of spins, magnetic, and electric quadrupole moments. The work will aid in the understanding of fundamental energy-producing and energy-absorption mechanisms in nuclear processes.

7.24

Columbia U., New York.
PROPERTIES OF ATOMIC IONS, R. Novick. Project 9751 (801A), Contract AF 49(638)-996; SRPP, AFOSR.

Direct measurements of cross sections and lifetimes of metastable ions including helium, lithium and the noble gases. The principal measurements of the experimental portion of this research will be conducted on a 10-meter long ion beam spectrometer.

7.25

Dartmouth Coll., Hanover, N. H.
PHOTOELECTRIC CROSS SECTIONS OF ENERGIES ABOVE 1 MEV, F. Titus. Project 9751(801A), Contract AF 49(638)-634; SRPM, AFOSR.

AFOSR- Air Force Office of Scientific Research
- SRA- Directorate of Research Analysis
- SRC- Directorate of Chemical Sciences
- SRE- Directorate of Engineering Sciences
- SRI- Directorate of Information Sciences
- SRL- Directorate of Life Sciences
- SRM- Directorate of Mathematical Sciences
- SRP- Directorate of Physical Sciences

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  - CRRI- Astrosurveillance Sciences Lab
  - CRRK- Propagation Sciences Lab
  - CRRS- Communications Sciences Lab
  - CRRZ- Control Sciences Lab
- CRE- Geophysics Research Directorate
  - CREA- Photochemistry Lab
  - CREC- Thermal Radiation Lab
  - CREE- Research Instrumentation Lab
  - CRES- Terrestrial Sciences Lab
  - CREM- Meteorological Research Lab
  - CREI- Ionospheric Physics Lab
  - CRER- Sacramento Peak Observatory

This research, which is nearing completion, has been directed at direct determination of photoelectric effect cross section in the energy region above 1 Mev. This is in the energy region where Compton effect and pair production are becoming serious competitors for the method of annihilation of gammas. The results will be important toward identifying which one of the several conflicting theoretical calculations of photoelectric cross section at high energies is most nearly correct. It is probable that the research will also have practical value in calculating shielding parameters.

7.26

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
RADIATION EFFECTS ON TRIPLY BONDED COMPOUNDS, L. A. Harrah. Project 7367(802A), Internal.

The radiation chemistry of simple molecules containing the triple bond will be studied with particular emphasis on the identity and structure of the highly excited, transient species formed under irradiation. The reactions and reaction kinetics leading from these species to the final products of irradiation will be studied with the aid of the time of flight mass spectrometer and the electron paramagnetic resonance spectrometer. Simultaneously with these studies, an investigation of the Co^{60} gamma radiolysis of these materials in the gaseous and liquid phases will be undertaken to determine the nature of the final stable species formed at various pressures and temperatures.

7.27

Durham U. (Gt. Brit.).
MUON COMPONENT, A. W. Wolfendale. Project 8600(804A), Contract AF 61(052)-27; CRZI, AFCRL.

The study of the variation with respect to time and direction of the muon component of cosmic radiation received at sea level. Information will be sought on the relationship between variation of atmospheric parameters and cosmic radiation, and on the origin of cosmic radiation. Measurements are conducted by means of a cosmic ray spectrograph with a solid iron electromagnet as the deflecting element, and with automatic electronic recording of direction and moments of individual muons for high counting rate and high momemts resolution.

7.28

Ecole Normale Superieure, Paris (France).
RADIATION INDUCED DEFECTS IN SEMICONDUCTORS FROM THE POINT OF VIEW OF ANNEALING TO UNDERSTAND DEFECT STRUCTURE, P. Baruch. Project 5620(802A), Contract AF 61 (052)-543; CRRC, AFCRL.

The defect structure of irradiated germanium and silicon will be investigated by a study of annealing kinetics, drift mobility experiments, and stored energy measurements.

7.29

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
LOW TEMPERATURE ELECTRON BOMBARDMENT STUDIES OF CRYSTALLINE MATERIALS, E. A. Burke. Project 5620 (802A), Internal.

The ability of energetic radiations to displace atoms in crystalline solids is the cause of most of the persistent radiation effects observed in electronic materials. This work involves studies of the threshold energy for the onset of damage, the average threshold energy for atomic displacement, and the recovery behavior of the damage. Electrons are employed for irradiations because they produce the simplest type of damage, namely Frenkel pairs.

7.30

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
SURFACES BOMBARDED WITH IONS, H. DeAngelis. Project 5620(802A), Internal.

This work is directed toward a study of surfaces bombarded with ions. A simple arc discharge - target assembly provides monoergic ions with energies up to 1500 volts. Bombardment with radioactive krypton is used to establish the conditions necessary to achieve uniform surface bombardment, to estimate the number of the bombarding atoms trapped, and to determine the rate of evaporation of the trapped atoms during annealing. Various electronic materials, particularly semiconductor materials, will be studied. The effect of ion bombardment on chemical and electrical properties of semoconductor surfaces will be investigated. Ion bombardment will also be used in nuclear irradiation studies. In this case etch pits resulting from ion bombardment of nuclear irradiated specimens may reveal "displacement spike" regions.

7.31

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
FAST NEUTRON DAMAGE, L. F. Lowe. Project 5620(802A), Internal.

Present studies are directed toward a realistic intercomparison using the same sample for both electron and neutron irradiation within the AFCRL positive-ion facility. The same physical property will be measured, namely electrical resistivity, and using the same measuring apparatus. Fast neutron irradiation data

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ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARY- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMH- Electronics Technology Lab

RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESER- Operational Applications Lab

per se will be used to study effects such as the energy dependence of displacement spikes, and the dependence of defect production on atomic number.

7.32

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
RADIATION INDUCED COLORATION OF INSULATOR PLASTICS, B. Manning. Project 5620(802A), Internal.

Carefully deoxygenated styrene containing a small percentage of 1, 4 diphenyl butadiene will, after thermal polymerization turn blue under beta ray bombardment. If completely polymerized and not as carefully deoxygenated the same plastic material is a scintillation plastic having a high emission half-life in the order of 10-80 seconds. The coloration in the plastic under study has a decay half-time of 37 minutes. The absorption spectrum of this colored plastic disappears and the fluorescence light emitted is a spectrometrically nearly identical with the light emitted during the normal scintillation process. The "frozen" scintillation process appears to be a step in the degradation of incident radiation energy to heat, light, and molecular rearrangement. This phenomenon may lead to an explanation of the details of the energy conversion process, and will be further investigated. A study has been made of the thermoluminescence of sapphire and doped alumina"s such as ruby. The thermoluminescence spectra and intensity have been related to radiation dose on the one hand and purity and quantity of dopant on the other.

7.33

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
RADIATION DAMAGE AND SPECTROMETRY, B. Manning. Project 5620(802A), Internal.

The number of damage sites, their location and distribution are a function of the type and energy of the incident radiation. The electronic effects produced by radiation are related to these same physical changes. Therefore, it becomes important to know the energy distribution of incident radiation. The accuracy to which this energy distribution is known will limit the accuracy to which cause and effect relationships can be determined. While the radiation machines available are almost monoergic, they do in practice have a finite distribution of energies which are a function of the physical makeup of the target and as well as the accelerator portion of the machines. The method of detecting and measuring this energy distribution would vary with the physical set up and with the radiation used. Principally, solid state detectors such as thin junction diodes will be used. These will be calibrated against radioactive sources fabricated as thin films to prevent degradation of radiation. A second detector will be Li^6I doped with Europium. Scintillation crystals of the organic and inorganic type maintained at liquid nitrogen temperatures will be tested.

7.34

Electronic Technology Lab., ASRME, ASD, Dayton, Ohio.
SOLID STATE SURFACE PHENOMENA IN GAS DISCHARGES, E. B. Henschke. Project 4152(803A), Internal.

Sputtering rates and threshold energies of a variety of metals bombarded by noble gas ions have been determined. Experiments are being performed to verify the theoretically derived relationship between threshold energy and the square of the collision radii. Sputtering rates and threshold energies are being determined for polycrystalline and single crystal materials bombarded with particles arriving at different angles of incidence. Theoretical studies concerning the shape of the yield curve at below, and near, threshold energies.

7.35

Emmanuel Coll., Boston, Mass.
COSMIC RAY DATA EVALUATION, M. P. Hagan. Project 8600(804A), Contract AF 19(604)-6107: CRZI, AFCRL.

The analysis of photographic emulsions exposed to cosmic and Van Allen radiation and high altitudes and the attainment therefrom of detail information in regard to the presence of star producing events, heavy primaries, ionising radiation and other nuclear events. The evaluation of cosmic radiation data attained in space for spectral distribution, magnetic effect. and other solar and geophysical parameters of interest.

7.36

Florida State U., Tallahassee.
LOW ENERGY (1-10 MEV PROTONS) RESEARCH USING A TANDEM VAN DE GRAAFF ACCELERATOR, C. M. Tenmer. Project 9750(801A), Grant AF-AFOSR-62-423; SRPH, AFOSR.

A tandem Van de Graaff accelerator is used to provide protons, alpha particles, and heavy ions with energies up to 13, 20 and 35 Mev, respectively. These will be used for elastic and inelastic scattering experiments and for angular correlation experiments involving one or two outgoing particles and one or two outgoing gamma rays. (He^3, p) reactions depositing deuterons in nuclei will also be studied.

7.37

Franklin Inst., Philadelphia, Pa.
PROPERTIES OF MEDIUM WEIGHT NUCLEI, D. M. Van Patter.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
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CRRD- Electromagnetic Radiation Lab
CRRI- Astroservaillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
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CRE- Geophysics Research Directorate
CRRA- Photochemistry Lab
CRRC- Thermal Radiation Lab
CRRE- Research Instrumentation Lab
CRRG- Terrestrial Sciences Lab
CRRM- Meteorological Research Lab
CRRI- Ionospheric Physics Lab
CRRM- Sacramento Peak Observatory

Project 9751(801A), Grant AF-AFOSR-62-217; SRPM, AFOSR.

Precise determination of nuclear disintegration energies are made using a magnetic spectrometer for charged particles in conjunction with a Van de Graaff accelerator. Attention is focused on the medium and heavy weight nuclei. Excitation curves for inelastic proton scattering will be observed where appropriate. Measurement of gamma rays and their transition probabilities from inelastic proton scattering will be performed.

7.38

Franklin Inst., Philadelphia, Pa.
HIGH ENERGY PHYSICS INVESTIGATIONS USING NUCLEAR EMULSIONS, D. F. Davis. Project 9751(801A), Contract AF 49(638)-1023; SRPM, AFOSR.

A stack of Ilford G-5 nuclear emulsion was exposed to a beam of neutral K-mesons of momentum 1.3 Gev/c at the Brookhaven National Laboratory Cosmotron. The plates are being scanned for events which will give the nuclear cross section and permit further study of the interactions of the K^{o} meson. The experiment will also serve as a source of high energy hyperons, hyperfragments and possibly cascade particles.

7.39

General Dynamics Corp., San Diego, Calif.
RANGE OF RECOIL ATOMS, V. Lint. Project 7885(802A), Contract AF 33(616)-6795; AMX, ARL.

Measurements are made of the ranges of recoil atoms displaced from Cu, Ag and Au, and from other selected solids, by high energy γ rays produced in a 35 Mev linear accelerator; the ranges are measured as functions of the recoil energy in a lattice of the parent metal, or in a dilute alloy of this metal. Attention will be given to the (γ,n), (γ,p),(γ,d), and (γ,α) reactions. A measurement may be undertaken of the fraction of atoms that have recoiled out of a foil bombarded for a prolonged period in a reactor with a fast neutron spectrum.

7.40

General Electric Co., Schenectady, N. Y.
ELECTRON BOMBARDMENT STUDIES OF THE FUNDAMENTAL ASPECTS OF RADIATION EFFECTS IN METALS, R. M. Walker. Project 5620(802A), Contract AF 19(604)-5557; CRRC, AFCRL.

The work to date has included a literature survey on radiation damage thresholds, a study of the production and recovery of radiation in a number of metals heretofore not studied, and a study of the effects of crystal imperfections and temperature on the production and recovery of radiation damage in copper. These studies resulted in the determination of radiation damage thresholds and point-defect resistivities for Cu, Ni, As, Al, Mo, Ti, and Fe. In addition, theoretical models have been devised to explain the variation of threshold energies for face-centered and body-centered elements, predict resistivity changes in the metals studied, and explain the recovery behavior in pure and impure copper.

7.41

General Physics Research Lab., ARP, ARL, Dayton, Ohio.
NUCLEAR STRUCTURE STUDIES BY NUCLEAR DECAY SCHEMES, J. W. Olness. Project 7112(802A), Internal.

Scintillation spectroscopy and coincidence techniques are used to measure the decay schemes of excited nuclei. The gamma-ray energies and intensities are measured with the aid of a large NaI(Tl) crystal and a three-crystal pair spectrometer. In addition to energy-level determinations, spin and parity assignments are made to several low-lying levels in the isotopes under study, and conclusions are drawn as to the relative transition probabilities for the various multipolarity radiation present. To date, studies of Ti^{49}, Hg^{200}, Cl^{36}, Mn^{56}, Co^{56}, and Fe^{57} have been completed and published.

7.42

General Physics Research Lab., ARP, ARL, Dayton, Ohio.
NUCLEAR LEVEL SCHEMES, J. W. Olness. Project 7112 (802A), Internal.

It has been the purpose of this effort to investigate the low-lying level structure of selected nuclei in the region of atomic number $Z < 20$. In the first stage of this research, attention was centered on the study of the gamma rays proceeding from proton capture reactions. Experiments are being set up in which proton elastic scattering will be studied to obtain the additional information necessary to complete the detailed description of the levels reached through decay of the capturing state. This type of research is especially well suited for the ARL Van de Graaff accelerator since the capture process is favored in the region of proton bombarding energy below 2 Mev, the range open to this machine.

7.43

Illinois U., Urbana.
BUBBLE CHAMBER RESEARCH IN THE 300 MEV BETATRON, E. L. Goldwasser. Project 9751(801A), Contract AF 49(638)-594; SRPM, AFOSR.

New measurements of meson photoproduction cross-sections and meson interactions are to be made using the University of Illinois 300 Mev betatron and a liquid hydrogen bubble chamber as a detector. The use of the bubble chamber permits observation of mesons of very low energy. The energy of each event will be identified through a direct measurement of the range or momentum of the meson produced in the bubble chamber. The aim of the effort is to provide a correlation between experimental photoproduction of low energy mesons and low energy meson scattering data.

7.44

Indiana U., Bloomington.
INELASTIC ELECTRON SCATTERING AT MEDIUM ENERGIES, R. A. Bonham. Project 9760(802A), Grant AF-AFOSR-62-322; SRC, AFOSR.

Determination and comparison with theoretical calculations, of inelastic and elastic scattering cross sections for excitation of argon and neon to $3P^54S$ and $2P^53S$ states, respectively, and low lying excited states of simple diatomic molecules like nitrogen. Similarly with inelastic scattering by molecules like benzene and comparison to molecular orbital and free electron theoretical calculations. Also resonance near a K absorption edge and coherent molecular patterns of low lying excited states with hindered rotation.

7.45

Institut de Recherches Nucleaires (France).
ENERGY LEVELS OF LIGHT NUCLEI, S. Gorodetsky. Project 9751(801A), Contract AF 61(514)-1400; SRPN, AFOSR.

Excited levels of light nuclei will be studied for the purpose of learning something of the spin, parity, and energy levels. The first method will employ the method of angular correlation of positive and negative electrons (internal conversion pairs), these electrons being in competetion with gamma radiation. In this method the multi-polarity of the corresponding gamma radiation can be obtained and from this the spins and parities of the corresponding levels. Instead of the usual G-M counters, the investigator uses thin anthracene crystals, the crystals having properties such that the energy of a single definitive pair of electrons can be measured. This method is particularly well adapted to light nuclei and high energies. The second method measures heavy particle-gamma and gamma-gamma coincidence by use of fast coincidence circuitry. The existence of particular gamma transitions, as well as angular correlations, can be determined by this method. The angular correlations are most effective in determining spins, energy levels, multi-polarity, and angular moment of radiation. The third method will be the use of rapid coincidence to study gamma radiation between excited levels, gamma cascades and gamma schemes in general. Emphasis will be on the use of internal conversion pairs.

7.46

Imperial Coll. of Science and Tech., London (Gt. Brit.).
IRRADIATION OF ALKYL HALIDES, A. J. Swallow. Project 7023(802A), Contract AF 61(052)-456; ARC, ARL.

The radiation chemistry of organic liquids will be studied with the objective of comparing effects of high and low linear energy transfer (LET) radiations on the same system. Alkyl halides will be irradiated as the first step in this program, and the influence of LET and dose rate will be established. Possible synergistic effect of irradiation mixtures of these compounds will be explored. If research findings so indicate, bromides, chlorides, and iodides possessing the same or similar alkyl group may also be investigated.

7.47

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
SATELLITE COUNTER MEASUREMENTS, D. F. Smart. Project 8600(804A), Internal.

Cosmic radiation experiments using active counter techniques are conceived and developed for the specific region of space in which USAF systems do or may operate to determine the radiation environment of these regions of space and to provide information on the dynamics of the radiation which may affect the environment of these regions of space.

7.48

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
SATELLITES EMULSION MEASUREMENTS, H. Yagoda. Project 8600(804A), Internal.

Cosmic radiation experiments are performed on USAF rocket and satellite systems utilizing nuclear emulsion as the primary sensor to determine the intensity charge, and energy spectrum of radiation in the near earth space.

7.49

John Hopkins U., Baltimore, Md.
PROPERTIES AND INTERACTIONS OF NEW PARTICLES, A. Pevsner. Project 9750(801A), Grant AF-AFOSR-62-134; SRPN, AFOSR.

This is research in very high energy physics (Bev

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

range) which is being done to determine the modes of production and decay, the interaction probabilities, the lifetimes and other parameters which are characteristic of mesons and hyperons. Once determined, an attempt is made to fit the experimental data to existing nuclear theory, to modify an existing theory in a rational way so that theory and experiment are compatible, or to evolve a new theory.

7.50

John Hopkins U., Baltimore, Md.
HOT ATOM CHEMISTRY, W. S. Koski. Project 9763(802A), Contract AF 49(638)-481); SRC, AFOSR.

This is a study of ion-molecule reactions in hot atom chemistry. Charged positive ions are produced in a radio frequency ion source, accelerated to a desired energy, sorted magnetically, and ions of a selected charge permitted to react with molecules. The resulting charged intermediates are then analyzed mass spectrometrically.

7.51

Kansas U., Lawrence.
LIFETIME OF POSITRONS IN LIQUIDS AT HIGH PRESSURES, R. Stump. Project 9767(803A), Contract AFOSR 60-17; SRFP, AFOSR.

Studies of the lifetimes of positrons will be made along with the annihilation of positronium in liquids and the effects of pressure and temperature variation. Studies will also be conducted on the adaptability of long lived positronium measurement techniques as a probe of the atomic arrangement in liquids.

7.52

Lund U. (Sweden).
HIGH ENERGY COSMIC RAY INTERACTION, S. von Friesen. Project 9774(804A), Grant AF-EOAR-62-71; SRPM, AFOSR.

The number of charges on the nucleonic component of the cosmic radiation varies from 1 (hydrogen) to at least 26 (iron). These particles evidence themselves in nuclear emulsion by making a track which is characteristic of the particle. The composition of the radiation is being determined by a new method, photometric measurement of the track width, which has been developed by this group. The method is considered to be more accurate at charge determination than any previous method, at least up to charge equal 12. The data is collected by flying the emulsions near the top of the atmosphere. In addition to charge determination, sheets of heavy absorber (Ag, Cu, Au, etc.) are interspersed between the emulsion sheets. The cosmic rays interact with the nucleons of these materials and studies are made of interaction probabilities and fragmentation products. The identified products are then used as "primaries" to study interactions at energies higher than can be attained in terrestrial accelerators.

7.53

Maryland U., College Park.
RAPID COSMIC RAY VARIATIONS AND INTERPLANETARY PHYSICS, S. F. Singer. Project 9774(804A), Grant AF-AFOSR-62-284; SRPM, AFOSR.

Very short time variations in the low energy part of the cosmic radiation are being studied. Attempt is being made to relate the variations to solar induced phenomena such as radio storms, variations in the earth's magnetic field and prominences in the chromosphere of the sun. The data is best collected at high altitude in auroral latitudes since this is the location the radiation can best approach earth; it is where solar effects are most evident. The high sensitivity, high counting rate counter which can collect the data has been developed in this program. A gamma ray telescope is also being flown to try to determine if low energy gammas are arriving from the sun or if they are the result of auroral protons interacting with nitrogen in the upper atmosphere. A concurrent theoretical study is being carried which is concerned with the mechanism of population and depopulation of the radiation belts around the earth.

7.54

Massachusetts Inst. of Tech., Cambridge.
THEORETICAL AND EXPERIMENTAL PHYSICS, M. Deutsch. Project 9750(801), Contract AF (30-1)-2098; SRPM, AFOSR.

The program makes use of nuclear accelerators all over the world and, for the highest energies, uses cosmic rays which attain energies accelerators will probably never produce. In the low energy studies, energy level schemes throughout the periodic table will be determined. Specific researches will center on electromagnetic phenomena, photo-nuclear and photomeson phenomena, i.e., gamma induced, and studies using pion and muon beams as well as neutron, deuteron and alpha particles. Not only will the cosmic rays be used in the interaction studies at energy above 10^{12} ev; there will also be a study made of the cosmic ray origin problem.

7.55

McGill U. (Canada).
VARIATION OF NUCLEAR CHARGE DISTRIBUTION IN FISSION WITH BOMBARDING ENERGY, L. Yaffe. Project 9760(802A), Grant AF-AFOSR-62-24; SRC, AFOSR.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRHE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAWA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESRR- Operational Applications Lab

The independent yields of fission fragments will be determined to obtain data about the distribution nuclear charge, yields will be determined both radiochemically and mass spectrometrically. Much mass distribution data are now available but little nuclear charge or atomic number distribution data exist.

7.56

McMaster U. (Canada).
STUDY OF NUCLEAR STABILITY AND NUCLEAR ENERGETICS BY MEANS OF ATOMIC MASS MEASUREMENTS, H. E. Duckworth. Project 9750(801A), Grant AF-AFOSR-62-33; SRPN, AFOSR.

Purpose of research is to study nuclear stability and nuclear energetics through the determination of atomic masses. These mass determinations are made by the doublet method in which mass differences are obtained between ions whose specific charges are nearly equal. A double focusing mass spectrometer is used. Effort is concentrated on nuclides lying between the 50 neutron and 50 proton shells.

7.57

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
EFFECTS OF NEUTRON IRRADIATION ON THE FATIGUE BEHAVIOR OF METALS, H. A. Lipsitt. Project 7024(802A), Internal.

The neutron irradiation of steel is known to increase the elastic limit of this material. Since the fatigue limit is really a dynamic elastic limit it would be anticipated that the fatigue limit would, as well, be increased. The available data in this area are very few and do not clearly indicate the validity of our hypothesis; this research, then, is an attempt to study the variation of fatigue properties when a steel is irradiated, and determine the validity of the hypothesis.

7.58

Michigan State U., East Lansing.
PROPERTIES OF LOW-LYING NUCLEAR ENERGY LEVELS, G. B. Beard, W. K. Kelly. Project 9750(801A), Contract AF 49(638)-10; SRPN, AFOSR.

The energies, spins and lifetimes of low-lying nuclear energy levels will be studied by techniques which are primarily those of delayed coincidence, resonant scattering and gamma-gamma angular correlations. Results will be compared with predictions of certain nuclear models, emphasis being placed on isotopes which fall in the region of intermediate coupling. Data concerning spin will be obtained by measuring the angular distribution of the nuclear resonant scattering and the lifetime estimated from the level width.

7.59

Universidad Nacional de La Plata (Argentina).
EXCITED LEVELS OF EVEN-EVEN NUCLEI AND NUCLEAR STRUCTURE EFFECTS, H. E. Boech. Project 9751(801A), Grant AF-AFOSR-60-9; SRPN, AFOSR.

This research program is devoted to the study of the properties characterising the nuclear energy levels, such as energy, spin, parity, etc. These properties are studied through the radiation emitted by radioactive atoms and gamma rays emitted in the de-excitation of nuclei. Particular attention will be paid to the systematic study of even-even nuclei and the determination of the nuclear structure effects through the observation of the electron conversion gamma angular correlation, beta-gamma angular correlation and beta-circular polarized gamma angular correlation.

7.60

National Bureau of Standards, Washington, D. C.
RADIATION EFFECTS ON HIGH POLYMERS, L. A. Wall. Project 7023(802A), Contract AF (33-616) 60-4; ARC, AEL.

Investigation of three related aspects of the radiation chemistry of fluorocarbon polymers; semiconduction phenomena; physical changes due to crosslinking or scission; and, radiation degradation at high temperatures. Optical and electron-spin-resonance spectroscopic studies of selected perfluoroaromatic and aliphatic systems in conjunction with electrical measurements to investigate the possibility of formation of trapped electrons and/or holes in these materials by ionising radiation. Studies of mechanisms of degradation of perfluorocarbons subjected to ionizing radiation.

7.61

National Co., Inc., Malden, Mass.
COUPLED ELECTRON AND NUCLEAR SPIN SYSTEMS, A. Gaussen. Project 8503(804A), Contract AF 30(602)-2008; RAOR, RADC.

A concurrent theoretical and experimental study of high negative nuclear polarization in liquids is being made at room temperature using free radicals in solution. Steady state proton inversion has been achieved with a spin temperature of about minus 1.8°K. Studies with activated carbon suspensions have at this writing yielded no measurable proton spin enhancement. Attempts are being made to obtain self sustained oscillation due to stimulated emission of a system of inverted proton spins. Ring time of a circuit containing an r.f. inductor both with and without an inverted proton ensemble as a core is being used as an indication of the approach to the desired oscillating condition.

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CRRE- Propagation Sciences Lab
CRRS- Communications Sciences Lab
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CRI- Geophysics Research Directorate
CRIA- Photochemistry Lab
CRIC- Thermal Radiation Lab
CRIE- Research Instrumentation Lab
CRIG- Terrestrial Sciences Lab
CRIH- Meteorological Research Lab
CRII- Ionospheric Physics Lab
CRIM- Sacramento Peak Observatory

7.62

New Hampshire U., Durham.
COSMIC RAY VARIATIONS, J. A. Lockwood. Project 8600 (804A), Contract AF 19(604)-4552; CRZI, AFCRL.

The study of intensity-time variations of cosmic radiation, particularly the twenty-seven day and diurnal variations of the neutron component. The investigation of the increase and decrease of neutron intensity during and following solar flares. The study of cosmic radiation from satellite and rocket-borne instrumentation particularly utilizing proton and neutron detectors. The investigation of primary cosmic radiation utilizing proton and neutron detectors. The investigation of primary cosmic radiation utilizing the emulsion technique.

7.63

Nobel Inst. for Physics (Sweden).
NUCLEAR REACTIONS AND PROPERTIES OF EXCITED NUCLEAR LEVELS, B. Astrom, I Bergstrom. Project 9750(801A), Grant AF-EOAR-62-86; SRPN, AFOSR.

This involves an experimental study of excited energy levels and decay properties of atomic nuclei and the development of new methods and instruments for such study. Samples are irradiated mainly in the 225 cm cyclotron.

7.64

Nobel Inst. for Physics (Sweden).
GAMMA RADIATION FROM NUCLEAR REACTIONS, K. G. Malmfors. Project 9751(801A), Grant AF-EOAR-62-85; SRPN, AFOSR.

A spectrometer has been constructed in which electrons move in trochoidal orbits making possible the determination of electron energies by the time-of-flight method. Energy resolution of about 1% (full width at maximum) and high transmission characterize this instrument. It has been used as a Compton spectrometer and as a pair of spectrometers to study the reaction F^{19} (p, α) O^{16}. It will be used to investigate the gamma radiation from other reactions.

7.65

New York U., N. Y.
NEUTRON COMPONENT OF COSMIC RADIATION, S. A. Korff. Project 9774(804A), Contract AF 49(638)-635; SRPN, AFOSR.

This investigation of cosmic ray neutrons will be done in two parts. The first part will make use of balloons which will carry neutron monitoring equipment to high altitudes to study the time variation of the neutron component. Special emphasis will be placed on measurements at times of solar activity. This information will be used in conjunction with the ground level neutron monitor which this group has had in operation at College, Alaska, for the last two years. An attempt will be made to correlate the neutron fluctuations with auroral activity, ionospheric disturbances, and fluctuations in the geomagnetic field. The second part of the study will be concerned with changes in the isotopic composition of the earth's crust, atmosphere, and oceans as they may be influenced by fluctuations in the neutron component. These can be identified through build up of radioactive isotopes or through changes in the ratio of stable isotopes. Samples which will be used in the second study, which are on hand, are core ice from Antarctic of age (approximately) 3000 years and iron samples from meteors. The ice will be tested for hydrogen deuterium ratios, tritium content, and other impurities; the meteoritic iron will be studied for isotope ratio and for helium-three content.

7.66

Northwestern U., Chicago, Ill
EFFECTS OF IONIZING RADIATION ON PYRIMIDINES, R. M. Dowben. Project 9777(805A), Contract AF 49(638)-321; SRL, AFOSR.

An attempt will be made to learn the effect of radiation on key molecules found within the cell. Pyrimidines will be irradiated and the products identified and, if possible, synthesized. The effects of various pyrimidine derivatives will be determined on the synthesis of nucleic acids.

7.67

Northwestern U., Evanston, Ill.
RADIATION EFFECTS IN ORDERED POLYMERS, M. Dole. Project 7021(802A), Contract AF 33(616)-5826; ARC, ARL.

Experimental and theoretical studies are being conducted on the mechanisms by which nuclear radiation interacts with ordered polymer systems. Similarities and/or differences in the radiolysis of stereospecific systems and of corresponding non-stereospecific ones are being carefully noted and, wherever possible, explained on a mechanistic basis. The experimental work includes measurements of cross-linking, degradation, gas evolution, effect of dose rate, total dosage, temperature additives as oxygen, etc., on such systems as atactic and isotactic polypropylene (1,4-trans, 1,4-cis, 1,2-isotactic; 1,2-syndiotactic) polybutadiene, and others.

7.68

Notre Dame U., South Bend, Ind.
CONTRIBUTION OF PRIMARY EXCITED MOLECULES TO OBSERVABLE

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARN- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARK- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARE- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRME- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAE- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFWSC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBL- Ballistics Directorate
ESD- Electronics Systems Division
ESSR- Operational Applications Lab

RADIO-CHEMICAL PROCESSES, M. Burton. Project 7367 (802A), Contract AF 33(616)-7075; ASRC, ASD.

A considerable quantity of information is available on energy transfer phenomena; however, the mechanisms of excitation transfer and ionization transfer are not fully understood. The overall objective of this program is to establish more clearly, both qualitatively and quantitatively, the mechanisms of energy transfer. An experimental program will be carried out on the chemical effects of and the physical processes involved in the transfer of ionization or excitation energy in irradiated systems. It is expected that the independent contribution of different excited states of the same molecule can be established by further study in this area. The life times and fates of receptor molecules involved in energy transfer processes will also be investigated. Work will be done in degassed and aerated systems with a variety of solvents and scintillator solutes and the effects and mechanism of action of a variety of quenchers will be studied.

7.69

Oxford U. (Gt. Brit.).
STUDY OF ELASTIC AND INELASTIC NUCLEAR INTERACTIONS BY ELECTRONIC COMPUTER TECHNIQUES, D. H. Wilkinson. Project 7112(802A), Contract AF 61(052)-445; ARP, AEL.

This program is being continued on the following problems utilizing the contractor's computing machine: (1) detailed analysis of stripping reactions, with inclusion of spin-orbit forces and calculation of the polarization of the scattered proton and the direction of emission of gamma rays from the excited nucleus; (2) development of programs to cope with particles of spin-one or more, and their use to analyze new experimental data; (3) study of inelastic processes: (p,p'), (d,d'), (α,α') etc. and the associated gamma correlations by a method similar to that of Levinson and Banerjee; (4) devise or obtain other reliable theoretical treatments of other inelastic processes and, as soon as available, use to analyze the experimental data; and (5) bound states of nuclei are being studied to determine wave functions and energies by computation for specified nuclear potentials and quantum numbers for comparison with level structure found experimentally. This includes study of proton-neutron distribution in the nucleus.

7.70

Office of Director, ARD, AEL, Dayton, Ohio.
AUGER TRANSITION PROBABILITIES, E. J. Callan. Project 7112(802A), Internal.

Radiationless transitions such as the Auger process, with electron emission, compete importantly with radiative transitions, particularly for lighter atoms. Knowledge of the transition probabilities for such processes is needed to understand the intensity relations in spectra and, at the present time, such knowledge is scanty. The work consists of computing such transition probabilities on the basis of several hydrogenic wave functions, with development of the necessary screening numbers for various atoms. Results have been obtained for KLL transitions, and current work is concerned with LLM transitions as well as with tabulation of the appropriate hypergeometric functions.

7.71

Paris U. (France).
PARTICLE POLARIZATION EFFECTS IN HIGH ENERGY PHYSICS, L. Michel. Project 9750(801A), Contract AF 61(052)-474; SRPM, AFOSR.

The main theme of the work is the study of polarization effects in reactions between elementary particles. Also under investigation are: (a) an axiomatic approach and mathematical foundation of quantum field theories; and (b) the full consequence of Lorentz invariance for the existence of superselection rules.

7.72

Pennsylvania State U., University Park.
RADIATION CHEMISTRY OF GASEOUS SYSTEMS, F. W. Lampe. Project 7023(804A), Contract AF 33(616)-7716; ARC, AEL.

To conduct studies of the elementary chemical reactions caused by ionizing radiation which lead to chemical change in small molecules. To use the method of rare gas sensitization of hydrogen atom reactions. Studies are made of reactions of ions with molecules, of atoms and free radicals with molecules and of recombination of these various species. Isotopic labelling techniques are used to differentiate between ion-sensitization and other energy transfer processes.

7.73

Pennsylvania U., Philadelphia.
PHOTO-NUCLEAR REACTION STUDIES, J. Halpern. Project 9750(801A), Contract AF 49(638)-454; SRPM, AFOSR.

These photo-nuclear reaction studies have been made with a 22 Mev betatron which has high precision energy control and a high resolution proton spectrometer. They have been made in an attempt to better understand the nature of photon emitation, line absorption near threshold, and giant resonance phenomena through energy and cross section measurements. The studies have added to our knowledge of the basic structure and nature of matter. Data analysis is still in progress; energy and angular distribution measurements will be analysed to determine the excitation mode of the nucleus as a

function of absorbed photon energy.

7.74

Pennsylvania U., Philadelphia.
SCATTERING AND POLARIZATION OF ELECTRONS UNDER THE G FACTORS OF THE FREE ELECTRON, A. K. Mann. Project 9751(801A), Contract AF 49(638)-537; SRPM, AFOSR.

A beam of slow polarized electrons is to be extracted from an optically pumped diffuse plasma for the purpose of making high precision measurements of the magnetic moment of the free electron in units of the Bohr magneton. It is believed that this type beam will provide the non-depolarizing method which is necessary to perform this experiment. The slow, polarized electrons can then be accelerated to energies at which Mott scattering will be the detecting mechanism. To do this the slow (100 ev) electrons must be accelerated to approximately 100 kev, scattered by a thin foil, and have their aximuthal asymmetry measured in the Mott scattering apparatus. It will then be possible to perform a spin-flip experiment with a polarized beam of slow electrons by means of which measurements of the orbital and spin g factors of the free electron can be determined.

7.75

Physics, Engineering and Chemistry Corp., Boulder, Colo.
BIOMEDICAL EFFECTS ON THE EYE FROM EXPOSURE TO MICROWAVES, INFRARED, AND IONIZING RADIATION, A.R. Buchanan. Project 7163(805A), Contract AF 33(616)-6305; AMRL:

Electromagnetic radiation is a potential source of damage to the human eye. This contract was initiated to conduct a thorough literature survey of the biomedical effects of ultraviolet radiation on the living tissue of the eye. The original contract was extended to determine the biomedical effects on the eye of microwaves; infrared, and ionizing radiation. Specific attention was devoted to the levels of radiation sufficient to cause ocular damage. The ultraviolet study was most successful in delineating areas where protective devices will be useful in space flight.

7.76

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
PROTON IMPACT PHENOMENA, O. Oldenberg. Project 8627(804A), Internal.

At the laboratory an instrument is built and operated in which protons are accelerated to energies between 3,000 and 30,000 ev and shot into an observation chamber in which low pressure nitrogen or oxygen are subjected to the impacts. The light emitted is analyzed. We are interested in determining relative intensities of the various spectral lines and bands. They may be characteristic for the type of impinging particle and thus indicate whether in the aurora the excitation of light is due to protons, electrons, or fast neutral hydrogen atoms. Furthermore, the absolute intensities of some prominent features (such as the green auroral line) are determined for measured currents of protons, electrons, or neutral atoms. It is hoped that the absolute intensities observed in the aurora will allow an estimate of the current exciting the light. An apparatus has been constructed which projects a proton beam of an adjustable energy (5000-30,000 ev) into low pressure nitrogen. In the light emitted the various spectral features of nitrogen molecules, nitrogen atoms, and hydrogen atoms are separated by light filters. Their intensities are measured and the cross sections for excitation by proton impact are calculated. The investigation of oxygen molecules is underway.

7.77

Pittsburgh U., Pa.
RADIATION EFFECTS ON SOLIDS USING CYCLOTRON IRRADIATIONS, J. R. Townsend. Project 5620(802A), Contract AF 19 (604)-3906; CRRC, AFCRL.

The objective of this contract is to investigate the effect of radiation and subsequent annealing on the electrical and mechanical properties of pure crystal whiskers as compared to amorphous materials in wire form and also single and polycrystalline materials in bulk form. Further, the effects of radiation annealing, whereby the effects of irradiation are partially annealed out during the irradiation, are being investigated. A study of effects of radiation on the mechanical properties of tungsten has shown results analogous to those found by Thompson, and Holmes and by Sosin in copper. The unusual clarity of the defect annealing spectrum in tungsten enabled direct observation of the bulk effect of vacancies. A number of mechanical measurements are in progress and contemplated in conjunction with the cyclotron. These include measurements of radiation effects in metallic whiskers, polycrystalline metallic wires, dislocation free silicon and germanium and possibly in insulators.

7.78

Princeton U., N. J.
MEDIUM ENERGY SCATTERING, H. Fumsten. Project 9750(801A), Contract AF 49(638)-920; SRPM, AFOSR.

Nuclear interaction experiments in the medium

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARA- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARS- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEM- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAWA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
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PGBR- Ballistics Directorate
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ESNR- Operational Applications Lab

energy range are being performed in an attempt to strengthen one or another of the models which have been proposed. The spectra and angular distribution of (p,n) reactions is being studied. The polarization of neutrons is being analysed and compared with the (p,p') reaction. This is of considerable interest and can be very important in comparison since the two reactions, (p,n) and (p, p') contain different interaction terms in the theory of direct interactions. Giant photo-resonances and α-like correlations in the nucleon surface will also be investigated.

7.79

Princeton U., N. Y.
QUANTUM THEORY AND APPLICATION TO ELEMENTARY PARTICLE PHYSICS, M. L. Goldberger. Project 9750 (801A), Contract AF 49(638)-304; SRPM, AFOSR.

Theoretical studies will be made to reassess the foundations of modern physics. This research will include studies of the following: structure of relativistic field theories; application of quantum field theory, notably dispersion theory to problems relating to the physics of elementary particles; photo-disintegration of the deuteron and nucleon-deuteron scattering; strange particles and parity conservation in K-meson reactions. In addition, attempts will be made to develop phenomenological models which serve to point both theoretical and experimental research into fruitful directions.

7.80

Raytheon Co., Inc., Waltham, Mass.
EFFECTS OF ION-INDUCED DEFECTS ON SURFACE REACTIONS, Y. Margoninski, D. Shooter. Project 5620(802A), Contract AF 19(604)-8004; CRRC, AFCRL.

This contract supports an internal program concerned with the effects of nuclear radiation on the properties of electronic materials. The interaction of ionized and un-ionized gases with semiconductor surfaces prepared by ion bombardment and annealing in high vacuum are studied, employing a quartz micro-balance and an omegatron type mass spectrometer. The effect of defects introduced by ion bombardment on the adsorption and oxidation phenomena will be studied. Simultaneous measurements of filament lifetime and surface conductivity will be made on clean germanium surfaces to determine the nature of the allowable surface states of clean germanium surfaces. The influence of adsorption of active gases and of defects introduced by ion bombardment on the surface states of clean germanium surfaces will be studied by the simultaneous measurements of filament lifetime and surface conductivity. The work called for under this contract is aimed at fundamental problems encountered in understanding and controlling the semiconductor surface.

7.81

Research Directorate, SWR, AFSWC, Kirtland AFB, New Mexico.
INDUCED ACTIVITY AND SECONDARY REACTIONS, R. E. Linkens. Project 8803(805A), Internal.

This research is to determine the percentage of the total space radiation hazard resulting from induced activity and bremsstrahlung created by the interaction of energetic particles with the space capsule materials and body tissues. Radiochemical analysis of various vehicle materials subsequent to their exposure to high energy particle beams in the laboratory and the space environment will be included. Such analysis will provide data for the selection of space capsule materials which possess the most desirable structural and radiation protection properties. In implementing the laboratory portion of this research, a miniature replica of space vehicles of the same structural materials may be required. Also, laboratory experiments requiring bombardment of materials by particle accelerators will be utilized to expose biological specimens in and out of the miniature capsule. In this manner relative biological effects studies can be initiated.

7.82

Rochester U., N. Y.
PRIMARY COSMIC RAY INTERACTIONS AND HIGH ENERGY PHYSICS, M. F. Kaplon. Project 9774(804A), Grant AF-AFOSR-62-32; SRPM, AFOSR.

The energy spectrum, the composition and, where possible, the isotopic ratio of the primary cosmic radiation are being determined through study of both the charged and uncharged components. Nuclear emulsions and counter techniques are employed. The emulsions are flown at balloon altitudes or exposed at terrestrial accelerators, the latter technique being used for calibration purposes and to learn about the parameters of the K_{μ}^{+} mesons. The isotope ratio studies are being used to learn about the spatial density of matter or the possibility of cosmic ray source region composition. An azimuth and zenith orientable platform is in development. It will be used to examine the charged primaries as a function of latitude and to search for source regions of primary gamma radiation. These latter, being uncharged, are undeviated by magnetic fields and will retain a "memory" of their source region.

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CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRD- Geophysics Research Directorate
CRDA- Photochemistry Lab
CRDC- Thermal Radiation Lab
CRDE- Research Instrumentation Lab
CRDS- Terrestrial Sciences Lab
CRDM- Meteorological Research Lab
CRDI- Ionospheric Physics Lab
CRDH- Sacramento Peak Observatory

7.83

Universidad Mayor de San Andres (Bolivia).
COSMIC RAY VARIATIONS AND ASYMMETRIES, I. Escobar. Project 9774(804A), Grant AF-AFOSR-62-395; SRPM, AFOSR.

Data concerning the time-intensity fluctuations of the low energy cosmic radiation and of the standard meteorological parameters is being collected. It is planned that this knowledge will result in a better ability to relate the mechanisms of magnetic storms, solar-terrestrial relationships and the physics of the upper atmosphere. A Giant Air Shower experiment (which is concerned with very high energy cosmic rays) is in progress which is searching for possible directional preference for the high energy particles. If such an anisotropy is found, this will be a cogent argument for source regions. The experiments are being performed at the highest year-round laboratory in the Western Hemisphere which, in addition, is situated within a degree of the equator. This enhances the possibility of success since this is the best place to view the plane of the galaxy, which is where one would expect to find sources if such exist.

7.84

Universidade de Sao Paulo (Brazil).
DEUTERON AND PROTON REACTIONS AT 3.5 MEV, O. Sala. Project 9750(801A), Grant AF-AFOSR-61-71, SRPM, AFOSR.

Reserach is directed at learning more about the nature of nuclear reactions such as the stripping reactions and involves measurement of angular distributions including the back angles, polarization of the emergent particles and angular correlation.

7.85

University of Southern California, Los Angeles.
RADIATION EFFECTS ON THE SURFACE OF SOLIDS, A. W. Adamson. Project 7022(802A), Contract AF 33(616)-5320; ARC, AFL.

The objective of this contract is to evaluate changes in the surfaces of solids caused by high energy radiation. The effects of X-ray, pile and gamma radiation on the surfaces of finely divided titania, silica, asbestos and carbon black have been investigated. Changes in the surfaces are evaluated by comparison of low temperature (63,77, 90°K) nitrogen adsorption isotherms taken before and after irradiation. From the isotherms, changes in the B.E.T. surface areas are determined. A method is being developed for analysis of the adsorption isotherms to determine changes in site energy distributions caused by irradiation. It is expected that the study will yield results of value in the interpretation and prediction of radiation effects on solids.

7.86

Stanford U., Calif.
DETERMINATION OF SIZE AND STRUCTURE OF NUCLEONS VIA HIGH ENERGY ELECTRON SCATTERING EXPERIMENTS AND STUDIES OF THE PRODUCTION AND PROPERTIES OF MESONS, W. C. Barber, R. Hofstader. Project 9750(801A), Contract N6ONR-25116; SRPM, AFOSR.

Two linear electron accelerators are used to accelerate electrons to energies ranging from 40 to 1000 Mev. The accelerated electrons are scattered by targets. The lower energy electrons primarily give information concerning photonuclear reactions. The higher energy electrons give information on the electromagnetic structure of nucleons, nuclear forces and nuclear charge distribution. The electrons accelerated to 1000 Mev have de Broglie wavelength of the same order of magnitude as the size of the nucleons.

7.87

Stockholm U. (Sweden).
ANTIPROTON AND OTHER ELEMENTARY PARTICLE RESEARCH, G. Ekspong. Project 9750(801A), Grant AF-EOAR-62-15; SRPM, AFOSR.

This is a study of elementary particle physics with emphasis on antiprotons of high energy. Some attention will be paid to possible creation of new forms of anti-matter. Emulsion exposures will be made at Berkeley and CERN. The emulsion will be developed and scanned in Stockholm. The program will include proton-proton and proton nucleus interactions at energies from 10-20 G ev and pion-proton pion-electron interactions at 16 G ev as well as charged hyperon and K mesons.

7.88

Sylvania Electric Products, Inc., Palo Alto, Calif.
DEPENDENCE OF MICROWAVE HARMONIC GENERATION UPON NON-LINEARITIES IN FERRIMAGNETIC MATERIALS, R. M. Hill. Project 4608(760E), Contract AF 19(604)-5512; CRRC, AFCRL.

Conduct research and investigations in the relationship of harmonic generation to resonant modes of the spin system in single crystal ferrimagnetic samples; establish the departure of observed second harmonic power output observed at resonant ferrimagnetic crystal from that predicted by the

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AFR- Hypersonics Research Lab
AFX- Solid State Physics Research Lab
AFZ- Metallurgy & Ceramics Research Lab

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RAOR- Advanced Studies Office
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RAWA- Advanced Development Lab
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simple large cone angle theory; establish the origin of the observed instabilities in the harmonic output.

7.89

Technion Research and Development Foundation (Israel).
VERY HIGH ENERGY COMPONENT, H. Kasha. Project 8600 (804A), Contract AF 61(052)-196; CRZI, AFCRL.

The study of primary cosmic radiation at extremely high energies (near and above 10^{18} ev.), its composition and its spectrum. These studies will include observation on cosmic ray showers using a horoscope of Geiger counters and Cerenkov detectors, as well as theoretical studies based on the results of these observations.

7.90

Texas U., Austin.
PHYSICS OF METASTABLE SYSTEMS, F. A. Matson. Project 9750(801A), Grant AF-AFOSR-62-270; SRFP, AFOSR.

This program is a basic study of both the energy relationships and the kinetics of excited atomic and diatomic helium. Among the species of interest are triplet helium, He(2^3S); triplet helium molecule, $He_2(2^3\Sigma)$; and the molecule made of two triplet helium atoms, $He_2(1\Sigma^*)$. Experimental work involves the generation of excited species by electrodeless and microwave discharge and measuring decay times by ultraviolet absorption. Calculations for the normal-triplet interaction function have been completed. Experimental work has involved a great deal of work on extreme purification of helium and on obtaining ultra high vacuum. Measurements have yielded half-lives for the He(2^3S) of 25 milliseconds at 4°K; it is expected that these are an order of magnitude too low because of traces of impurities. Present work, in addition to continuing the discharge work at ever-increasing purities, is directed along several other promising lines: (1) the mode of production of the triplet helium molecule, and also the effect of solid neon walls on its destruction, (2) the ultraviolet spectra, and also the electron spin resonance, of the helium discharge alone, and when discharged in the presence of selected other gases and metals, and (3) theoretical calculations, of excitation cross section of the atom, and of electronic states of the helium molecule ion.

Universidad Nacional de La Plata see 7.59

7.91

Uppsala U. (Sweden).
LOCALIZED RADIOLESIONS IN THE CENTRAL NERVOUS SYSTEM, B. Larsson. Project 9777(803A), Contract AF 61(052)-183; SRL, AFOSR.

Small lesions are produced in the central nervous system of animals using a beam of high energy protons. The behavior of irradiated animals is then compared with that shown before treatment. neurohistological studies and observations of permeability changes will also be made to evaluate effects of the proton beam on nerves and vessels in the central nervous systems. These studies will assist in mapping out the brain to learn which structures are responsible for different behavior patterns.

7.92

Uppsala U. (Sweden).
PROPERTIES AND ENERGY LEVELS OF NUCLEI, K. Siegbahn. Project 9750(801A), Grant AF-EOAR-62-72; SRFN, AFOSR.

Decay schemes will be studied using internal and external conversion spectra. Internal conversion following neutron capture will be studied at the beginning. Lifetimes of nuclear states and electron-gamma correlations will be studied. Magnetic moments of excited states and angular correlation between successively emitted conversion electrons or electrons and gamma rays will be studied using a four channel coincidence spectrometer. Multiple lines and line profiles will be measured with a new double focusing iron free spectrometer. Conversion coefficients will also be obtained.

7.93

Uppsala U. (Sweden).
HIGH LATITUDE STUDIES, A. Sandström. Project 8600 (804A), Contract AF 61(514)-1312; CRZI, AFCRL.

The evaluation and analysis of cosmic ray data obtained at Uppsala and Kiruna, Sweden and Murchinson Bay, Spitsbergen, including the determination of the amplitude and time of maximum of periodic variations such as the diurnal and twenty-seven day variations, and their correlation with other geophysical parameters of interest such as the K_p index of geomagnetic activity. Events of special interest, such as cosmic ray showers and solar flare effects, are also analyzed.

7.94

Vienna U. (Austria).
HIGH ENERGY RESEARCH ON CERN 28 BEV ACCELERATOR, W. Thirring. Project 9751(801A), Contract AF 61 (052)-433; SRFN, AFOSR.

The work will consist of developing procedures and techniques for analyzing emulsions and bubble chamber photographs taken on the CERN 28 Bev proton

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CRZ- Geophysics Research Directorate
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synchrotron. The initial phase will be concerned mainly with inelasticity and mean number of pions, kaons and barions produced. Later, work will be concerned with reactions between particles and anti-particles.

7.95

Virginia U., Charlottesville.
NUCLEAR INTERACTIONS OF 25-75 MEV PROTONS, S. Berko. Project 9750(801A), Contract AF 49(638)-176; SRPM, AFOSR.

A study of the cross-sections and angular distributions of various (γ,n) reactions is being undertaken with particular emphasis upon light elements. It is planned to study the energy dependence of the $He^4(\gamma,n)He^3$ cross-section at and beyond the giant resonance and interpret the results in the light of applicable theory. Other (γ,n) reactions in which gaseous targets are involved will be investigated, in particular the photodisintegration of A^{40}. Polarization of the X-ray beam emerging from the synchrotron will be investigated since previous results on the polarization of bremsstrahlung radiation have shown unexpected anomalies. Finally, a study of the fine structure of the beam will be made in the hope that millimicrosecond coincidence techniques may be employed to achieve energy discrimination in photonuclear disintegration experiments.

7.96

Washington U., St. Louis, Mo.
PRIMARY COSMIC RAY COMPOSITION AND TIME VARIATIONS, M. Friedlander, J. Klarmann. Project 9774(804A), Grant AF-AFOSR-62-404; SRPM, AFOSR.

Composition, spectra and geomagnetic cut-off as a function of latitude are being investigated. These parameters are known to be related to solar activity and will be continued throughout the present solar cycle. An attempt will be made to differentiate between those variations which are inherent in the radiation and those which are due to solar activity. Data is collected in stripped nuclear emulsions which are flown to high altitudes at various latitudes. The stripped emulsions are needed for the low energy cut-off investigations but they are subject to distortion so they will be complemented by glass backed emulsions for calibration purposes. Instrumentation for better identification of the heavies and more detailed determination of the charge spectrum is being developed. From these studies will come improvements in the theory of origin of cosmic rays. Present studies are concentrated on comparing the spectra of protons and alpha particles.

7.97

Washington U., St. Louis, Mo.
NUCLEAR PHYSICS RESEARCH, F. B. Shull, T. A. Pond. Project 9751(801A), Grant AF-AFOSR-62-428; SRPM, AFOSR.

The cyclotron will be remodeled to allow for higher energies as well as variable energies of protons, alphas and deuterons. The remodeled machine will be used to study the relative importance of the "compound nuclear model" and the "direct interaction model" over a range of energies and for a number of nuclides.

7.98

Washington U., St. Louis, Mo.
NUCLEAR PROPERTIES AND INTERACTIONS IN MEDIUM ENERGY RANGE, E. U. Condon. Project 9751(801A), Contract AF 18(603)-108; SRPM, AFOSR.

At the present, this contract encompasses three separate efforts. The theoretical work is concentrated in the areas on muon and beta decay studies, the experimental work uses (d,p), (d,n) and (d,α) cyclotron induced reactions to study the states, interactions, spins, and parities of nucleons, and the third group is studying composition and spectrum of the primary cosmic radiation.

7.99

Weizmann Inst. of Science (Israel).
CALCULATION OF ENERGIES OF GROUND AND EXCITED STATES OF NUCLEI, I. Talmi. Project 7112(802A), Contract AF 61(052)-56; ARP, AEL.

This program is for the continuation of the investigation of quantitative descriptions of nuclear energy levels and transition probabilities to determine which nuclear states may be described by simple jj-coupling configurations. The contractor is attempting to extend his methods to determine the proper coupling scheme in other cases where a simple jj-coupling configuration is inapplicable. He is investigating the possibility of incorporating these features into his approach by using some elementary configuration interaction and effective operators for transition probabilities. The analysis considers nuclei primarily between O^{16} and Ca^{40}.

7.100

Weizmann Inst. of Science (Israel).
INTERACTIONS ABOVE 20 BEV, G. Yekutieli. Project 8600(804A), Contract AF 61(052)-371; CRZI, AFCRL.

AEL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARR- Thermomechanics Research Lab
ARS- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

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A study of the nuclear interaction of the hard component of cosmic radiation of energies above 20 Bev by means of nuclear emulsion technique.

7.101

Western Reserve U., Cleveland, Ohio.
NUCLEAR SYSTEMATICS, NUCLEAR MODELS AND ORBITAL ELECTRON CAPTURE BY NUCLEI, J. K. Major. Project 9750 (801A), Contract AF 18(603)-61; SRPH, AFOSR.

Theoretical and experimental studies of the interactions of a nucleus and its orbital electrons will continue as will research on the statistical Thomas-Fermi model of nuclear matter; the effect of nuclear structure on internal coefficients; the nuclear surface using meson scattering; nuclear systematics; and, orbital electron capture, including L/K capture ratios. Other related problems include (1) study of the inner bremsstrahlung from orbital electron capture nuclides such as Ca^{41}, Fe^{55}, Cd^{109}; (2) a precision measurement of the energy of the gamma-ray of K^{40}; (3) a search for certain states in magic number nuclei, whose existence is predicted by a unified nuclear model theory; (4) an examination of the possibility of determining the electron capture ration of Tl^{204}, a forbidden electron capture transition; (5) a study of the decay scheme of Sn^{113}.

7.102

Washington U., St. Louis, Mo.
STRONG (CYCLOTRON INDUCED) INTERACTIONS AND WEAK INTERACTIONS OF BETA DECAY, F. B. Shull, T. A. Pond. Project 9751(801A), Contract AF 49(638)-843; SRPH, AFOSR.

The relative importance of the "compound nucleus model" and the "direct reaction model" will be determined over a range of energies and for a number of nuclides in order to delineate the regions in which either is more applicable. In the established nucleon-nucleon interactions where the "direct reaction model" is applicable this model will be employed to improve our knowledge of these reactions. Due to the Coulomb barrier, it is now impossible to do "pick-up" and direct reaction experiments with heavy nuclei with this cyclotron. The cyclotron will be modified so that the energy for a particular particle will be some 50% more than at present. It will thus be possible to do the above-mentioned experiments in addition to the stripping reactions which are presently going on. Specifically, these experiments will include elastic and inelastic scattering of protons, deuterons, and alpha particles to determine energy levels, heavy particle stripping effects, and inelastic scattering wherein both the proton and gamma are detected. The latter leads to spin information about the residual nucleus. Polarization type experiments will be continued. Firstly, these give information about the direct interactions. They are also useful in deriving information concerning residual nuclei, in separating the contributions of the various theories (simple stripping, heavy particle stripping, compound nucleons, etc.) and in determining the relative importance of spin-orbit components of nuclear potential. In the weak interactions two types of studies will be conducted. The first consists of a group of experiments which are to detect and test some of the more subtle points in the theory of universal weak interactions. The second set will make use of weak interaction phenomena to measure nuclear states. A study is being made on the feasibility of an experiment in which the angular distribution of scattered cold neutrons from a pile is measured with the intent of reducing the uncertainty of a charge difference between the proton and the electron to approximately one part in 10^{18}.

7.103

William H. Johnson Labs., Inc, Baltimore, Md.
THEORETICAL PROBLEMS OF RADIATION CHEMISTRY, H. Rosenstock. Project 7023(802A), Contract AF 33 (616)-7638; ARC, AEL.

Theoretical calculations will be performed on the interaction of high energy radiation with matter with the objective of deducing the nature of the principal primary processes in selected systems. Specifically, the effort will: (1) extend current mass spectral theory to radiation chemistry processes, using energy distributions and lifetime parameters appropriate to radiation chemistry; (2) examine the validity of the assumption that mass spectra give a proper representation of fragmentation processes in radiation chemistry; (3) consider whether these concepts may be applied to excited molecules formed directly and/or by ion neutralization; and (4) attempt to modify, extend, and develop theories of unimolecular decomposition to contribute to our understanding of the fundamental processes of radiation chemistry.

7.104

Yale U., New Haven, Conn.
ATOMIC BEAM MAGNETIC RESONANCE AND QUANTUM ELECTRODYNAMICS RESEARCH, V. W. Hughes. Project 9767 (803A), Contract AF 49(638)-545; SRPP, AFOSR.

The purpose of this project is to make precise studies of the electronic and nuclear properties of metastable and excited states of simple atoms and meson complexes by atomic beam resonance methods. Also under study are the formation and decay of short-lived excited complexes such as positronium and muonium. Analysis of this experimental work will give cross-section variations between ground

and excited states of light and medium weight elements and molecules.

See also: 1.11-12, 1.52, 1.76, 2.46, 3.112, 4.52, 5.7, 5.17, 5.29, 6.1, 6.95, 6.114, 8.3, 8.7, 8.10, 8.14, 8.24, 8.26, 8.31, 8.40, 8.43, 8.60-61, 8.66-67, 8.69, 8.72, 8.83, 8.85-86, 8.89, 9.34, 9.71, 12.76, 14.2, 14.59, 14.87, 14.111, 20.05, 20.5, 20.19, 20.32, 20.38, 20.47, 20.78, 20.81, 23.9, 23.15, 23.52, 23.60, 23.65, 23.92-93, 23.103, 23.110

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8. THEORETICAL PHYSICS

Gravitational Theories; Particles (theory); Quantum Chemistry; Quantum Field Theory; Quantum Mechanics; Relativity; Statistical Mechanics.

8.1

Boston U., Mass.
ELEMENTARY PARTICLES, P. Cohen, P. Roman. Project 9751(801A), Grant AF-AFOSR-62-248; SRPM, AFOSR.

Studies in the systematics of elementary particles using S matrix theory and dispersion relationships. Attempts will be made to reduce the number of elementary particles and explain these properties on the basis of composite particle models. Studies of a new relativistic quantum field theory of elementary particles will be carried out.

8.2

Boston U., Mass.
STATISTICAL AND QUANTUM MECHANICS, A. Siegel. Project 9751(801A), Grant AF-AFOSR-62-177; SRPP, AFOSR.

In the case of turbulent velocity fields, it is known that the ordinary approach is only an approximation and the fields do not satisfy the Navier-Stokes equation. Using a method consisting of expanding the velocity field in powers of the Wiener function or the Fourier-Hermite function, it is hoped that a better description of the properties of velocity fields may result. Statistical methods will be used to expand the limit of Brownian motion to include higher approximations of the resistance of the field which may lead to a general solution of the linear Boltzmann equation. Another problem to be attacked is the possibility of a more complete adaption of the methods of mathematical probability to quantum theory. The objective is to establish a relationship between quantum theory and mathematical probability analogous to that which exists between statistical mechanics and thermodynamics using a differential-space quantum theory.

8.3

Brandeis U., Waltham, Mass.
ELEMENTARY PARTICLES AND THEIR INTERACTIONS, S. Deser. Project 9750(801A), Grant AF-AFOSR-61-22; SRPM, AFOSR.

Studies of the theoretical basis for the selection rules, common coupling strength, and symmetry laws as they apply to the creation, scattering decay and annihilation of elementary particles. Study of high energy accelerator data to discover experimental evidence leading to modification of present field theories.

8.4

Brandeis U., Waltham, Mass.
COLLISION PROCESSES IN GASES, E. P. Gross. Project 9751(801A), Contract AF 49(638)-27; SRPP, AFOSR.

This work is aimed at the solution of generalized equations of transport phenomena. This involves studies of the boundary value problems in the kinetic theory of gases and is directed toward the solution of problems in shear flow, heat flow, sound propagation and viscosity. Problems arising from the nonlinear Boltzmann equation are also being pursued. The general theory of fluids is also being investigated with emphasis on the properties of liquid helium. Another aspect of this work is the study of the dynamics of ionized gases and the propagation of radiation through such gases. Also some preliminary work on the interaction of electrons with crystal lattices is being undertaken.

8.5

Brussels U. (Belgium).
NON-EQUILIBRIUM STATISTICAL MECHANICS, I. Prigogine. Project 9751(801A), Grant AF-EOAR-62-16; SRPP, AFOSR.

A quantum field theory for equilibrium statistical mechanics has been developed by Montroll and Ward. Work is being done to extend the method of relaxation processes and to compare the method with the methods developed at Brussels. The group will also concern itself with the study of homogeneous systems slowly approaching equilibrium and the effect of internal degrees of freedom on relaxation processes.

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Some studies of non-homogeneous systems will also be carried out.

8.6

California U., Berkeley.
THEORETICAL PHYSICS OF ELEMENTARY PARTICLES AND THEIR INTERACTIONS, R. Karplus. Project 9750(801A), Grant AF-AFOSR-62-373; SRPM, AFOSR.

This involves the theoretical application of quantum mechanical techniques to the study of phenomena involving elementary particles and the relationship of the principles and fundamental laws, which the elementary particles obey, to experimental work.

8.7

California U., Berkeley.
NUCLEAR STRUCTURE, NUCLEAR MODELS AND ELEMENTARY PARTICLE INTERACTIONS, D. S. Saxon. Project 9750 (801A), Grant AF-AFOSR-62-383; SRPM, AFOSR.

The main emphasis is on: (a) optical model of the nucleus; (b) inelastic scattering and scattering theory; (c) properties of nuclear matter; (d) many body theory of the finite nucleus; (e) symmetry group limitations on the dynamics of elementary particles; (f) quantum electrodynamics; (g) dispersion theory; and (h) interaction of K-mesons with nucleons.

8.8

California U., Berkeley.
MOLECULAR ORBITAL CORRELATIONS IN ORGANIC CHEMISTRY, A. Streitwieser. Project 9763(802A), Contract AF 49(638)-105; SRC, AFOSR.

The purpose of this research was to compare pertinent experimental data and theoretical calculations in suitable systems to determine the range of quantitative applications and the practical limitations of quantum mechanical calculations based upon simple linear combinations of atomic orbitals. The substances studied were hydrocarbons and substituted hydrocarbons. These experiments and calculations will test a theory which may allow the prediction of rates of chemical reactions.

8.9

California U., Berkeley.
ATOMIC PHYSICS SCATTERING PROCESSES, K. Watson. Project 9751(801A), Grant AF-AFOSR-62-121; SRPP, AFOSR.

This is a complementary program to the experimental effort of Professor Hiereaberg which involves a computational program to study errors inherent in the Hartree-Fock method used in describing scattering phenomena and recombination processes relevant to atomic beam experiments, upper atmospheric phenomena, and plasma physics. Other similar computational programs will involve studies in certain atomic scattering problems, such as modifications to the Kohn variational principle method which is used for the study of both elastic and inelastic scattering phenomena.

8.10

Catholic U. of America, Washington, D. C.
WEAK INTERACTIONS AND HIGH ENERGY MU MESON PHYSICS, J. Brennan. Project 9750(801A), Grant AF-AFOSR-62-56; SRPM, AFOSR.

The research is directed at better understanding of the mu meson which ordinarily acts like a heavy electron but also interacts with nucleons through the weak interactions. At attempt will be made to determine the possible departure from conventional electromagnetic processes when high energy muons are scattered by electrons or protons by extending and modifying the Williams-Weizaker calculations of such processes. A fully relativistic treatment will be made of the Cerenkov effect to see if this effect is anomalously high where muons are concerned. The atomic wave function influence will be studied as a means of investigating mu meson atomic capture. Finally, an attempt will be made to see if few super high energy particles can be subetituted for very high flux in the experiment to test the Lee-Yang speculation about the equivalence of the neutrino involved in nuclear beta decay and the neutrino involved in pion and muon decay.

8.11

Catholic U. of America, Washington, D. C.
SOME GENERAL PROBLEMS OF MOLECULAR PHYSICS, V. Griffing. Project 9751(801A), Contract AF 49(638)-906; SRPP, AFOSR.

This program is aimed at developing computational methods of calculating the energy and configuration of molecules and molecular systems. A thorough knowledge of this subject in terms of dissociation energies, and activation energies of complex molecules is being pursued to construct better theoretical models. The method of molecular orbitals is being applied to polyatomic molecules of reaction kinetics which is of vital concern to energy release processes and stability criteria for solids.

8.12

Catholic U. of America, Washington, D. C.
IRREVERSIBLE THERMODYNAMICS, P. H. E. Meijer. Project 9751(801A), Contract AF 49-638)-452; SRPP, AFOSR.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astroservillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZM- Sacramento Peak Observatory

The aim of this work is to examine the relationship between the distribution function and the macroscopic variables. The behavior of systems not too close to equilibrium will be studied and the difference between steady state and minimum entropy production will be investigated. The abnormal fluctuations in the neighborhood of critical importance in plasma physics, combustion problems, magnato fluid dynamics, and the general class of problems where a change of state, as from liquid to gas, occurs.

8.13

Chicago U., Ill.
THEORETICAL CHEMISTRY, S. A. Rice. Project 9763 (802A), Grant AF-AFOSR-61-52; SRC, AFOSR.

The research includes studies of the theory of self-diffusion in crystals, dense rigid sphere fluids, transport phenomena in real fluids, and polymer chemistry. It will consider the theoretical and dynamical aspects of the heat of transport, extension of the theory to binary (impurity) diffusion, more detailed examination of the nature of energy transfer, more detailed study of the structure of the momentum autocorrelation function and the source of randomization. In a more general sense this research is an investigation of the general theory of transport in crystalline media. This research will test theories which may allow for prediction of chemical reactions.

8.14

Chicago U., Ill.
QUANTUM MECHANICAL CALCULATIONS ON ATOMS AND MOLECULES, C. J. Roothaan. Project 9751(801A), Contract AF 49(638)-1068; SRPP, AFOSR.

This is a complementary program to that of Griffing at Catholic University, which concerns completion of the computational portion of her program. The program is designed for the 7090 and 7090A Univac computers at Wright-Patterson Air Force Base and will permit calculations to determine bonding energies and charge distribution functions for carbon dioxide, acetylene and other linear, three and four atom molecules.

8.15

Cincinnati U., Ohio.
ESTIMATION OF BOND ENERGIES AS A GUIDE TO SYNTHESIS, H. H. Jaffee. Project 7342(802A), Contract AF 33 (616)-6900; ASRC, ASD.

This program consists of research leading to methods for the estimation of bond energies from atomic spectral data. In the course of developing these methods, valence state promotion energies, valence state ionization potentials, and overlap integrals will be evaluated. The valence bond method and the molecular orbital method of approximations are being utilized in this treatment. Automatic digital computers will be used in the calculations involved in this research. The effect of various molecular environments on the bond energies will also be investigated in order to determine what is the effect of substituent groups on bond strength.

8.16

Columbia U., New York.
FOUNDATIONS AND GENERAL METHODS OF QUANTUM FIELD THEORY, F. J. Ernst. Project 9750(801A), Contract AF 49(638)-689; SRPN, AFOSR.

The general scope will consist of a study of the methods and formalism of quantum field theory, with particular concern being paid to the creation of soluble field theory models for the nucleon. A study of nucleon structure will also be made through the application of dispersion relations for the nucleon form factors. The specific goals of this project are the creation of and application to theory of models in quantum theory with the expectation of resolving some problems of basic research in this field.

8.17

Columbia U., New York.
VALENCE THEORY AND NUCLEAR RESONANCE, J. F. Verdieck. Project 9751(801A), Grant AF-AFOSR-60-26; SRRP, AFOSR.

This research includes theoretical studies of nuclear quadrupole interactions of polyhalide ions to determine molecular orbitals, the effect of steric hindrance on coupling and the study of various orientation problems and effects on gaseous ions of optical pumping excitation. This research is expected to afford a new insight into second order chemical bonding parameters and improved magnetic models of active and excited halide ions.

8.18

Copenhagen U. (Denmark).
APPLICATION OF THE THEORY OF IRREVERSIBLE PROCESSES TO PROBLEMS OF DIFFUSION AND CHEMICAL REACTION, T. A. Bak. Project 7013(801A), Contract AF 61(052)-133; ARC, ARL.

Research is being conducted on the general statistical mechanical theory of irreversible processes and the theoretical calculation of rate constants for dissociation reactions in gases. In one facet of

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ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARR- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEGR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGNR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

the investigation, the development of a theory of irreversible processes based on the Liouville equation is under study. It has been shown that a master equation of an irreversible character may be derived from the Fourier space representation of the Liouville equation if certain assumptions are made regarding the size of the region of phase space under consideration and the time scale of the particle interactions. This poses an anomaly, since the Liouville equation is reversible in nature and is not affected by the assumptions regarding the scale parameters of the interactions. An analysis of this theory has established the conditions under which the master equation is valid. The rate of dissociation of I_2 in inert gases has been calculated from a priori considerations, assuming a weak interaction between the vibrational motion of the diatomic molecules and the translational motion of the inert gas atoms as well as stepwise activation process. Calculated rate constants were smaller than experimental values by a factor of about 10^3, indicating that weak interactions exert a negligible influence on the dissociation reaction. Work has been started on strong interaction energy transfer in gases but has so far yielded no results.

8.19

Cornell U., Ithaca, N. Y.
INELASTIC MOLECULAR COLLISIONS, B. Widom. Project 9751(801A), Contract AF 49(638)-1047; SRPP, AFOSR.

The object of this research is to find equations for the calculation of the effects of inelastic collisions on the properties of systems. This has been approached from the viewpoint of finding potential functions for which the radial Schrodinger equation is exactly soluble. It has been applied to various one dimensional models to calculate cross sections as explicit functions of energy, angular momentum and magnitude of inelasticity. Also, the relaxation time was derived as a function of temperature. Research will be continued to expand the method to include more complex systems, reaction rate phenomena and efforts will be made to generalize the results.

8.20

Denver U., Colo.
INTERACTION OF SINGLE DOMAIN PARTICLES, A. W. Jenkins. Project 9763(802A), Grant AF-AFOSR-61-50; SRPS, AFOSR.

The objective of this research is a more detailed and accurate theoretical description of single domain fine particle magnetic materials. In this research, the effects on the magnetic properties of interaction between particles in a single-domain powder material will be calculated approximately by means of a dipole-pair model. The total magnetization of a pair of interacting spheroidal single-domain particles will be calculated as a function of the magnitude and direction of an impressed field and the magnetic history of the particles. The elongations, separation, sizes, and orietations of the particles will be parameters in the calculations which will be averaged over appropriate ranges to approximate the bulk sample. The orientation of the magnetization of the two spheroids will be determined from the minimum energy condition, the resulting equations being similar to those derived by Stoner-Wohlfarth. Calculations will be carried out on the Datatron 205 Computer. It is expected that the inclusion of interaction in the Stoner and Wohlfarth calculation will extend the range of validity of this work as well as provide corrections to other calculations which have ignored interactions. It is anticipated that these results will be useful in further extending our understanding of the properties of fine particle magnetic materials and in a further refinement of their applications.

8.21

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
FOUNDATIONS OF SPECIAL RELATIVITY, E. M. Dewan. Project 5635(803A), Internal.

A paper on a new axiomatic approach to special relativity is in progress. A chapter in a projected book on relativity will be written up as a report. It will concern a synthesis of all previous derivations of the Lorentz Transformations.

8.22

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
QUANTUM MECHANICAL MEASUREMENT, E. M. Dewan. Project 5635(803A), Internal.

A paper is in progress treating the problems of Q.M. measurement with emphasis upon the problem of "Preparation of State" and its connection with electron spectral line broadening.

8.23

Free U. of West Berlin (Germany).
NON-EQUILIBRIUM PROCESSES IN REACTING GASES AND QUANTUM FIELD THEORY, G. Ludwig. Project 9767 (803A), Contract AF 61(052)-239; SRPP, AFOSR.

This research concerns the computation of collision cross sections for various gas reactions. The

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results of these calculations will be applied to plasma dynamics and transport phenomena of gases. The initial phase concerns reactions involving hydrogen atoms and hydrogen molecules. Efforts will be made to apply the results to more complex molecules such as oxygen and nitrogen.

8.24

General Physics Research Lab., ARP, ARL, Dayton, Ohio.

DETERMINATION OF ELECTRON COLLISION CROSS SECTION PARAMETERS AND TRANSITION PROBABILITIES OF FORBIDDEN LINES, S. J. Czyzak. Project 7112(802A), Internal.

To accomplish this work, accurate radial wave functions are essential. These are being computed at the present by the Hartree-Fock method for various ions, while computations on ions of P, S, Cl, and A have been completed. Other ions such as those of Fe are being investigated. From these results the wave functions for a complete system have to be determined in order to calculate the target area parameters. To calculate the transition probabilities, the general scheme will be to calculate the magnetic dipole and electric quadrupole radiation and L-S coupling. Essentially, the work will be performed in the following way: (1) self-consistent wave functions with exchange will be determined, or in those cases where they are already known, will be used; (2) calculations on spin-spin and spin-other orbit interactions will be made wherever they are appreciable.

8.25

General Physics Research Lab., ARP, ARL, Dayton, Ohio.

PURE GRAVITATIONAL FIELD, J. N. Goldberg. Project 7114(801A), Internal.

The physical content of the pure gravitational field is being investigated in order to establish whether interacting masses can radiate energy. To accomplish this end the two-body problem is being formulated without recourse to an approximation method. This course is necessary because the slow motion approximation is unclear in its physical significance. Furthermore, to discuss radiation one must have an appropriate definition of energy. For this purpose the conservation laws of general relativity are being studied. The problem of motion is also being investigated through the multipole structure of the gravitational field.

8.26

General Physics Research Lab., ARP, ARL, Dayton, Ohio.

MANY-PARTICLE INTERACTIONS, D. G. Shankland. Project 7112(802A), Internal.

In August, 1961, an investigation was begun on the classical problem of obtaining the distribution function for the energy levels of a crystal lattice. Once this function is known, all the thermodynamic properties of the crystal can be calculated, including especially the specific heat and optical absorption bands. The primary objective of this effort, then, is to determine the vibrational energy level distribution function for CdS, and thereby furnish theoretical predictions of the specific heat at low temperatures, and the IR absorption bands of this material. In the execution of this program, the vibrational distribution functions for the cubic lattices were calculated in order to test the technique. Comparison of the results with those of previous investigators, however, revealed discrepancies outside the errors to be expected, and have led to a more exhaustive check on the previous work. This check has revealed errors, both computational and conceptual, which have persisted for some years. Hence, these results are being prepared as a paper intended to be presented at the January 1962 meeting of the American Physical Society. Meanwhile, work on the CdS lattice has reached the following stage: the secular equation for the Wurtzite lattice has been obtained, including second-nearest-neighbor interactions. The matrix is complex, necessitating a more involved program for diagonalization. This program has been written and checked. It now remains only to include the effect of the long-range coulomb interactions to have the complete matrix. Assembling these programs and testing will complete the work, and the results should be available in the summer of 1962.

8.27

General Physics Research Lab., ARP, ARL, Dayton, Ohio.

QUANTUM FIELD THEORIES, D. G. Shankland. Project 7114(801A), Internal.

Investigation was begun on calculating the mass of the Yang-Mills β field. A calculation was performed, but was found to be in error. Subsequent investigation led to the conclusion that there were internal inconsistencies in the present formulations of quantized field theory. One such inconsistency was investigated in detail, leading to publication of a thesis. Further work planned includes checking convergence properties of non-renormalizable field calculations, and attempting to formulate a relativistic electrodynamics in terms of observables.

8.28

Georgetown U., Washington, D. C.
VIBRATIONAL ENERGY LEVELS OF DIATOMIC MOLECULES, C. L. Beckel. Project 9751(801A), Grant AF-AFOSR-62-160; SRPP, AFOSR.

Theoretical studies of the vibrational energy levels which result from assuming Heitler-London and Rittner potentials have been undertaken with the object of developing a more satisfactory model for diatomic molecules. The resulting model will be used for extrapolation of vibrational energies to dissociation for comparison with known dissociation energies. At present such extrapolation results in differences of about 20% for covalent potentials and as much as 250% for ionic potentials. The esults of the studies will be useful for predicting dissociation energies from measurement of relatively few vibrational energy levels, an important factor in high temperature experiments.

8.29

Hamburg U. (Germany).
MATHEMATICAL PROBLEMS OF GENERAL RELATIVITY AND ELEMENTARY PROBLEMS, P. Jordan. Project 7114(801A), Contract AF 61(052)-567; ARP, ARL.

The contractor shall construct exact solutions of the field equations of the Einstein and Einstein-Maxwell gravitational fields. He will investigate these solutions with special stress on the problems of gravitational radiation and the combined gravitational and electro-magnetic fields. The contractor shall also carry out a systematic investigation of the solution of the Dirac, Jordan, Dicke general relativistic field equations with an additional scaler field; seek empirical tests of the Dirac, Jordan, Dicke theory in geophysics, astronomy, or cosmology; and study generalizations of the present formalism of quantum theory as needed for the theory of elementary particles through the theory of lattices and its generalizations and through the theory of Hilbert spaces with indefinite metric.

8.30

Harvard U., Cambridge, Mass.
INTERACTIONS OF FIELD AND PARTICLES, R. J. Glauber. Project 9750(801A), Contract AF 49(638)-589; SRPN, AFOSR.

The various fields of physics are strongly coupled through the fact that mathematical methods developed for one field are applicable to others. The study of field theory is common to and approached for example through relativistic quantum mechanics or statistical physics. This work will be concerned with the general study of field theory and the mathematical methods required. This will be applicable to the gravitational field, electromagnetic field and the nuclear field theory as well as the field theories of elementary particles and the interactions of various fields and particles.

8.31

Imperial Coll. of Science and Tech., London (Gt. Brit.).
HIGH ENERGY PHYSICS AND ELEMENTARY PARTICLE THEORY, A. Selam. Project 9750(801A), Grant AF-EOAR-62-87; SRPN, AFOSR.

The mathematical and phenomenological basis of quantum field theory and elementary particle physics will be critically examined. The experimental data from the high energy proton experiments at CERN (25 Bev), Berkeley (7 Bev), Brookhaven (3 Bev, 30 Bev) and the high energy electron scattering data from Stanford and Cornell will be examined and interpreted. The interpretation of these data will be the foundation of theories describing nuclear processes with regard to inner structure of the nucleus and nucleons and the production of elementary particles.

8.32

Indiana U., Bloomington.
GEOMETRY AND RELATIVITY, V. Hlavaty. Project 7114 (801A), Contract AF 33(616)-569; ARP, ARL.

Investigations concern the mathematical foundations of Einstein's unified field theory. The theory of generalized almost-complex spaces is being pursued with particular emphasis on the development of those aspects of the theory which will be useful in the study of the unified field theory of Einstein. Research is also being performed in connection with the in-house effort in a direction which will lead to the solutions of the field equations of general relativity by employing the general theory of Lie groups in connection with the holonomy group of Riemannian spaces. Finally, the field equations of Rainich theory for a sourceless electromagnetic field of the third class and for fields of all three classes in the presence of matter are being studied.

8.33

Indiana U., Bloomington.
ELECTRONIC COMPUTER CALCULATIONS ON SIMPLE POLYATOMIC MOLECULES, H. Shull. Project 9760(802A), Grant AF-AFOSR-62-183; SRC, AFOSR.

This study will involve more complex computer techniques and the study of molecules other than diatomic; i.e., H_3^+.

8.34

Institute for Advanced Study, Princeton, N. J.
THEORETICAL ASPECTS OF MODERN NUCLEAR PHYSICS, J. R. Oppenheimer. Project 9751(801A), Contract AF-AFOSR-61-19; SRPN, AFOSR.

Studies are being conducted in the quantum theory of fields and collision processes, the systematics of elementary particles, fundamental symmetries, the study of causality and localizability, the theory of weak interactions and statistical mechanics as it applies to problems in liquid helium and superconductivity. Studies of the possibilities of a unification of ideas concerning elementary particles, reassessment of the foundations of modern physics and a rapprochement of quantum field theory and relativity will be carried out.

8.35

Iowa U., Iowa City.
PRINCIPLES AND APPLICATIONS OF STATISTICAL MECHANICS, M. Dresden. Project 9767(803A), Grant AF-AFOSR-62-122; SRPP, AFOSR.

This research concerns detailed calculations of transport coefficients based upon current methods of non-equilibrium statistical mechanics. Initial calculations would be to determine thermo-conductivities and the pressure dependence of viscosity. The research will be extended to include a formal development of non-equilibrium statistical mechanical methods to provide a non-trivial solution to the case of non-isolated systems. A similar extension to systems which are not spatially uniform is also planned.

8.36

Kansas U., Lawrence.
STATISTICAL MECHANICAL THEORY OF TRANSPORT PROCESSES IN MIXTURES, R. J. Bearman. Project 9763(802A), Grant AF-AFOSR-61-7; SRC, AFOSR.

This research is a study of the statistical mechanical theory which has been developed to account for the transport properties of mixtures. This study will be continued and extended to molecules with internal degrees of freedom, solutions of polar molecules, electrolytes, polymers, imperfect gases and solids, quantum fluids, chemically reacting systems and the change of transport coefficient with temperature. The significance of regular solution theory hypotheses, the phenomena, and the numerical comparison of the theory with experimental data will be investigated.

8.37

King's Coll., U. of London (Gt. Brit.).
RELATIVITY PHYSICS, H. Bondi. Project 7114(801A), Contract AF 61(052)-457; ARP, ARL.

The purpose of this contract is to study the classical theory of general relativity with particular emphasis on the following items: the relativistic basis of Newtonian mechanics, the relationship of local dynamical experiments to astronomical observations; the question of gravitational radiation including generation, propagation, and absorption; the interaction of the gravitational and electromagnetic fields and finally the epistomological foundations of general relativity.

8.38

Lehigh U., Bethlehem, Pa.
RELATIVISTIC THEORY OF INTERACTING PARTICLES, P. Havas. Project 7114(801A), Contract AF 33(616)-7348; ARP, ARL.

The objective of this effort is to study equations of motion in general relativity without restriction to slow motion and examine those equations for evidence of gravitational radiation. At this time a consistent approximation method has been set up and the first order equations of motion have been obtained. These equations exhibit "radiation damping." However, this "damping" leads to an increase of the particle energy. This result is not conclusive as the radiation damping is really a higher order effect. Therefore, there is a need to study the solutions of the second order field equations to obtain corrections to the equations of motion.

8.39

Leyden State U. (Netherlands).
STATISTICAL MECHANICAL THEORY OF MATTER AND IRREVERSIBLE PROCESSES, S. R. deGroot, P. Mazur. Project 9751(801A), Contract AF 61-(052)-16; SRPN, AFOSR.

To study irreversible processes from the statistical mechanics point of view. The question of the similarities and differences between the quantum mechanical distribution functions and the classical distribution functions will be investigated. The effects of the different statistics, i.e., Bose-Einstein, Fermi and Boltzmann will also be investigated as well as the general problem of time dependent functions. The work will include research on the statistical mechanical theory of optical activity in fluids using the methods previously developed. Research on a formalism for the virial expansion of distribution functions using the microcanonical ensemble and studies of the methods and techniques of quantum field theory in quantum statistical mechanics will be pursued.

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ARR- Hypersonics Research Lab
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ASD- Aeronautical Systems Division
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RADC- Rome Air Development Center
RAAW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
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8.40

London U. (Gt. Brit.).
PROPERTIES OF NEARLY SPHERICAL MOLECULES, R. A. Buckingham. Project 7023(802A), Contract AF 61 (052)-151, ARC, ARL.

Calculations are being performed of the energy and form of one-electron orbitals in the field of a central nucleus, and of a nuclear charge uniformly distributed over a sphere concentric with the central nucleus. This approximation may provide a superior choice for molecular orbitals in polyatomic molecules such as CF_4, CCl_4, and SF_6. Empirical determination is being made of the interaction between many-electron atoms such as He, Ne, etc., and solutions obtained of collision integrals such as those involved in the theoretical expressions for transport properties.

8.41

Maryland U., College Park.
FUNDAMENTAL INTERACTIONS IN THE SOLID STATE, R. A. Ferrell, R. D. Myers. Project 9763(802A), Grant AF-AFOSR-62-46; SRPS, AFOSR.

This is a theoretical investigation of fundamental problems in solid state physics with emphasis on the treatment of particle correlation arising in the many-body problem by modern methods of quantum field theory. Detailed study of the superconducting state of metals, giving attention to the basic theory of the electron-phonon and phonon-exchange interaction, will be undertaken to derive the correct superconductivity criterion. In addition, polarization of the degenerate electron gas by a point charge will be computed, exchange corrections in the dielectric constant of a degenerate electron gas will be determined, and the existence of localized lattice vibrational modes explored.

8.42

Maryland U., College Park.
NON-EQUILIBRIUM STATISTICAL MECHANICS, D. A. Tidman. Project 9751(801A), Contract AF 18(600)-1315; SRPP, AFOSR.

This work is aimed at the development of a quantum theory of transport phenomena, the theory of elementary particles, quantum statistical mechanics of interacting particles and the effects of defects and disorder on vibrational thermodynamic properties of crystal lattices. This will be applied to gas, liquid and solid systems as well as compound systems. The energy range of particles considered will be from helium atoms in liquid helium to nuclear particles.

8.43

Massachusetts Inst. of Tech., Cambridge.
PRIMARY GAMMA RAY INDUCED COSMIC RAY SHOWERS, B. Rossi, G. Clark. Project 9774(804A), Contract AF 49(638)-922; SRPN, AFOSR.

The most complete cosmic ray shower detector in existence has been built and is being brought into operation at the highest year-round laboratory in the Western hemisphere. It will be able to detect arrival direction (anisotrophy, if it exists), composition of the charged component, energy and to differentiate between showers due to the charged component and to primary gammas with energy above 10^{12} ev. This last will be possible by taking advantage of the known difference in the distribution of μ mesons around the core of the two types of showers and the deficiency of heavy nuclei in a gamma induced shower. The 60 m scintillator at the center of the array will make this possible. From this experiment we will learn of (1) the distribution of interstellar matter, especially of molecular hydrogen, (2) star formation near the center of the galaxy, and (3) the points of similarity, or dissimilarity, of galaxies through study of the gas and cosmic ray densities.

8.44

Massachusetts Inst. of Tech., Cambridge.
APPLICATIONS OF GLOBAL ANALYSIS TO MODERN THEORETICAL PHYSICS, I. E. Segal. Project 9783(806A), Grant AF-AFOSR-62-229; SRMA, AFOSR.

This research concerns the mathematics of quantum field theory and of the structure of elementary particles as a basis for physical interpretation of mathematical models for empirical fields and particles, involving global analysis and integration theory for the related spaces. Emphasis is currently on the quantization of non-linear hyperbolic equations.

8.45

Massachusetts Inst. of Tech., Cambridge.
MATHEMATICS OF QUANTUM FIELD THEORY, I. E. Segal. Project 9783(806A), Contract AF 49(638)-945; SRM, AFOSR.

This research in mathematical analysis concerns the development of modern analytical and algebraic structures, as they relate to the mathematical formulation of quantum field theories and the structure of elementary particles. A major goal is the classification of free elementary particles with mathematically-natural structure theories as a basis. Another goal is the development of quantum

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field dynamics, for eventually treating the motions of given free elementary particles under the influence of a given interaction. Both of these developments are to include conventional relativistic theory as a special sub-case. It is also intended to develop non-linear quantum field theories in which the dynamics is specified by the total Hamiltonian (mathematical form). In that case the mathematical theory would give rise to the free particles rather naturally.

8.46

Massachusetts Inst. of Tech., Cambridge.
STATISTICAL THERMODYNAMICS, L. Tisza. Project 9751 (801A), Contract AF 49(638)-95; SRPP, AFOSR.

The work under this contract is a unique approach to the problems of statistical thermodynamics. Starting from a general concept of time dependent additive quantities which are considered to be random variables, one makes assumptions concerning their distribution. Under the assumptions chosen, one examines the consequences. For example, the assumption that the functions are independent in time leads to what may be called thermostatics while the assumption of time correlations leads to irreversible thermodynamics. If one assumes the distribution function to be correct to all orders, the system is canonical. It is expected that the approach will lead to a more rigorous derivation of classical theory and the introduction of symmetry consideration into thermostatics. Work will be pursued on a geometrization of thermodynamics using an affine geometry approach to model construction.

8.47

Minnesota U., Minneapolis.
ANHARMONIC POTENTIAL FUNCTIONS OF POLYATOMIC MOLECULES, J. Overrend. Project 9760(802A), Grant AF-AFOSR-62-154; SRE, AFOSR.

This is a study of molecular vibrations using anharmonic potential functions. A suitable approximate potential function and computational techniques for the evaluation of the force constants from vibrational frequencies must be developed.

8.48

Naples U. (Italy).
NOVEL METHODS OF CALCULATION APPLIED TO SEMICONDUCTOR PHYSICS, E. R. Caianiello. Project 9763 (802A), Grant AF-AFOSR-62-104; SRPS, AFOSR.

The purpose of this research is to extend some recent developments of formal field theory to the many-body problem. Improvement in the use of Feynman diagrams, in which certain graphs are inconsistently neglected, will be investigated. The existence and nature of the solutions of the field equations of a many-body system, both real and idealized, will be studied.

8.49

National Bureau of Standards, Washington, D. C.
QUANTUM STATISTICAL MECHANICS, M. E. Green. Project 9751(801A), Contract ISSA 61-2; SRPP, AFOSR.

The purpose of this project is to develop new methods of treating the statistical mechanics of quantized systems especially the many-body system. The methods developed will be applied to specific problems such as the phase transition in helium; the equilibrium and transport properties of systems interacting with lang range forces; and the connection between transport phenomena and superfluidity.

8.50

New York U., Inst. of Mathematical Sciences, N.Y.
PHYSICS OF THE IONOSPHERE, M. Kline. Project 7635 (770A), Contract AF 19(604)-4555; CRZA, AFCRL.

The calculation of upper and lower bounds of parameters which describe the scattering of charged particles by atomic systems at low energies has been extended. In the course of this research it was found that fundamental corrections to scattering theory have to be made in the presence of long range potentials. The Thomas-Fermi model of the atom has been refined to include correlation and quantum corrections. It is planned to investigate this last model for the case of non-zero angular momentum, and for molecules.

8.51

North Carolina U., Chapel Hill.
GRAVITATION AND FIELD THEORY, B. DeWitt. Project 9774(804A), Grant AF-AFOSR-62-120; SRPN, AFOSR.

The research is concerned with nature of the gravitational field, its relation to quantum mechanics and the other force fields. The method of canonical quantization will be applied to the general problem of quantization since it has succeeded in other cases where classical analogues exist. Sets of observables will be generated in the attempt to find a set of "true observables." Attempts will be made to devise critical experiments to test for the existence of gravitational radiation and other purely relativistic effects.

8.52

Oklahoma U. Research Inst., Norman.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESWR- Operational Applications Lab

ELECTRONIC STRUCTURE AND ULTRAVIOLET SPECTRA OF FREE RADICALS, MOLECULES AND IONS, THEORY AND CALCULATIONS, C. C. Lin. Project 7635(770A), Contract AF 19(604)-5576; CRZA, AFCRL.

The research program is directed to the study of the electronic structure and ultraviolet spectra of free radicals, molecules and molecular ions, particularly compounds of nitrogen and oxygen (NO and NO_2) and some others of interest. Machine calculations, now carried out at the computing center of the Univ. of Oklahoma, are essential to the carrying out of the program. Mixtures of configurations are used in finding SCF molecular orbitals formed by linear combinations of atomic orbitals. Work has now been started on the electronic structure of NO^+, the molecular ion of most immediate interest.

8.53

Oklahoma A. and M. Coll., Stillwater.
ATOMIC COLLISIONS , B. Roth. Project 9751(801A), Grant AF-AFOSR-62-105; SRPP, AFOSR.

A theoretical study of single collisions of atoms in the energy region of 100 kev and higher. In such collisions the projectiles suffer varying deflection angles and degrees of ionization. The study will concern the cross section for deflection within a given solid angle and a given degree of ionization. Experimental results on such cross sections and degrees of ionization now exist so that the results of this study can be checked against experiment.

8.54

Oslo U. (Norway).
ELECTRONIC STRUCTURE AND ENERGY LEVELS OF MANY-ELECTRON ATOMS, E. Hylleraas. Project 7023(802A), Contract AF 61(052)-134; ARC, AEL.

Application is made of both relativistic and non-relativistic quantum mechanical methods to selected problems concerning many-electron atoms. The scattering theory of nuclear particles is investigated by applying auxiliary potentials in connection with the variational method. Investigations are in progress with the aim of strengthening the general theory of Bessel functions with respect to asymptotic expansions and accurate evaluation of zeros. Selected problems of nuclear physics are also studied, where the invention and application of more effective mathematical methods is appropriate. A simplification and abbreviation of the wave function for the ground state problem of two-electron atoms by parametric modifications has been found. This may constitute the first real improvement of the Hylleraas method of 1930.

8.55

Paris U. (France).
NUCLEON-NUCLEON INTERACTION AND FORCES, M. Levy. Project 9750(801A), Grant AF-EOAR-62-10; SRPM, AFOSR.

This research includes theoretical investigations of nuclear forces, interactions, and structure with particular emphasis on: (a) electron scattering in hydrogen and complex nuclei; (b) nucleon-antinucleon and nucleon-nucleon interactions; (c) models of field theories applied to scattering theories; (d) Many-body problem; (e) weak interactions; and (f) consistency of quantum electrodynamics.

8.56

Physics, Engineering, and Chemistry Corp. (P.E.C.), Boulder, Colo.
QUANTUM MECHANICAL STUDY OF VISCOSITY OF GASES, N. Ashby. Project 7071(806A), Contract AF 33(616)-7602.

The contractor shall investigate the description of the temporal development of processes in which viscosity plays an essential role in terms of the Green's function of quantized fields. Methods of solving the equations that are to be satisfied by the Green's functions shall be studied, particularly the type of simplifications that are admissible.

8.57

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
CALCULATIONS OF QUANTUM MECHANICAL CROSS SECTIONS, R. A. Mapleton. Project 7635(770A), Internal.

Work is being done currently using a more refined wave function to represent the helium atom.

8.58

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
THEORETICAL STUDIES, R. A. Mapleton. Project 8627 (804A), Internal.

This research is the theoretical study of cross sections and many electron atom matrix elements associated with emission and absorption processes. The discipline of quantum mechanics is used for this investigation. Special attention will be devoted to those processes that are believed to occur in the upper atmosphere.

8.59

Pittsburgh U., Pa.
GRAVITATIONAL RADIATION AND SPACE-TIME, E. Newman.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
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SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
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CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
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CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

Project 7114(801A), Contract AF 33(616)-8288; ARP, ARL.

A technique for generating solutions of the Einstein equations is being used to obtain those solutions which it is felt will shed light on the question of radiation from finite sources. A similar technique will also be applied to the combined Einstein-Maxwell equations and to the Einstein equations with cosmological constant to determine whether boundary conditions at infinity can be avoided. An investigation of the singularity of the spherical waves of Robinson and Trautman is also being undertaken. Finally, a generalization of the Komar procedure for the obtaining of intrinsic coordinates in general relativity is being developed for spaces possessing a group of motions. The results of this study are to be applied to the problem of quantization of general relativity and to certain problems in the theory of radiation and the theory of motion which are thought to be more amenable when formulated in terms of these coordinates.

8.60

Princeton U., Md.
FUNDAMENTAL CONCEPTS IN THEORETICAL PHYSICS, M. Goldberger. Project 9750(801A), Grant AF-AFOSR-62-370; SRPS, AFOSR.

The foundations of modern physics are being reexamined including: structures of relativistic field theories; application of quantum field theory to elementary particle physics, to photodisintegration of the deuteron and to nucleon deuteron scattering; strange particles and parity conservation in K meson reactions. Phenomenological models are developed to help indicate the direction for future theoretical and experimental research.

8.61

Purdue Research Foundation, Lafayette, Ind.
NUCLEAR STRUCTURE AND INTERACTIONS, R. W. King. Project 9750(801A), Grant AF-AFOSR-62-132; SRPN, AFOSR.

Theoretical studies are being made in the following areas: (a) the role of the neutrino in the description of the leptonic modes of the weak interactions; (b) photodisintegration of the deuteron and photoproduction from other light nuclei; (c) nucleon-nucleon scattering by means of a potential-boundary condition model; (d) the application of dispersion relations to pion physics; and (e) transport equation for an electron gas.

8.62

Redlands U., Calif.
ELECTRONIC STRUCTURE OF RARE EARTH ATOMS, R. D. Woods. Project 9768(803A), Grant AF-AFOSR-62-294; SRPP, AFOSR.

This research concerns extensions of recent improvement in methods of calculating single electron equivalent wave functions for heavy elements such as those of the rare earth group. In addition to improvements resulting from accounting for many-electron interactions and the effects of excited states, efforts will also be made to include corrections for relativistic effects. These programs will be developed in Fortran computer language and attempts will be made to generalize the program for most if not all of the rare earth series.

8.63

RIAS, Inc., Baltimore, Md.
INVESTIGATION OF THE ALREADY UNIFIED FIELD THEORY OF GRAVITATION AND ELECTROMAGNETISM, L. Witten. Project 7114(801A), Contract AF 33(616)-8194; ARP, ARL.

Two types of study are being undertaken. The first is the discovery and investigation of properties of particular solutions of the combined Einstein-Maxwell field equations. The second type of study involves the analysis of the general properties of the combined fields whether it be through the Einstein-Maxwell field or some other unified field theory. The ultimate aim for such investigations is to quantize a unified electromagnetic-gravitational theory in an effort to account for the elementary particles of physics.

8.64

Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.
CALCULATION OF VIBRATIONAL FORCE CONSTANTS, E. C. Curtiss. Project 9750(801A), Contract AF 49(638)-1135; SREP, AFOSR.

The purpose of the proposed program is to calculate vibrational frequencies of simple molecules. This will make it possible to correlate observed vibrational frequencies with basic chemical properties (the vibrational force constants) and to predict with some accuracy unobserved frequencies. These results will be used to calculate the thermodynamic properties of a series of compounds that are not very well understood yet, compounds containing N-F, O-F, and N-O groups. It also appears required for the identification of new molecules that are being

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ARZ- Metallurgy & Ceramics Research Lab

AED- Aeronautical Systems Division
AERC- Directorate of Materials & Processes
AERNE- Electronics Technology Lab
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RAUA- Advanced Development Lab
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AEDC- Arnold Engineering Development Center
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developed in this series. Candidate compounds include HNF_2, $ClNF_2$, N_2F_2, N_2F_4, F_2NCONF_2, and F_2NCONH_2.

8.65

Rutgers U., New Brunswick, N. J.
TOPOLOGICAL METHODS IN GENERAL RELATIVITY THEORY, M. Danskin. Project 707(806A), Contract AF 33(616)-7235; ARM, ARL.

The contractor is studying global properties of the solutions of certain partial differential equations of mathematical physics on differential varieties of higher connectivity structure. The general direction of the research is given by the paper of Wheeler and Wisner, "Geometrics" (Annals of Physics, 1957). An effort shall be made to clarify and solve the mathematical questions which have evolved as a consequence of Wheeler's and Wisner's theory.

8.66

Rutgers U., New Brunswick, N. J.
STATISTICAL MECHANICS OF THE IDEAL INERT GAS SOLIDS, G. K. Horton. Project 9763(802A), Grant AF-AFOSR-62-167; SRPS, AFOSR.

Quantitative theoretical calculations of the low temperature thermodynamic properties of the ideal inert gas solids shall be carried out, including in a proper way the true anharmonic effects. These calculations will be compared with available experimental data, particularly the results of slow neutron scattering, and should lead to very reliable information on the forces between atoms. The results of the above calculations shall be used to study the thermal conductivity. The appropriate Boltzmann equation will be solved using the precise nature of the dispersion law.

8.67

Sheffield U. (Gt. Brit.).
ELECTRON CORRELATION IN METALS, N. H. March. Project 7112(802A), Contract AF 61(052)-317; ARP, ARL.

In this research the electron correlation in metals is being investigated using a variational calculation. Particular emphasis is placed on looking for a connection between this approach and the perturbation methods of Brueckner, et al. An attempt is being made to apply the method to the treatment of impurities and to excited states, and to generalize the results to the study of non-uniform gases. From the variational program, differential equations have been obtained which can, in principle, be used to evaluate the first and second order density matrices. Recent work has concerned itself with the explicit calculations of the electron pair function in the high-density region (numerically), and with obtaining qualitative characteristics of the density matrices by extrapolating from both low and high density limits. The effect of spin-waves upon the pair function has also been considered. Some beginnings have been made in treating non-uniform electron distributions.

8.68

Stanford U., Calif.
EXPERIMENTS AT LIQUID HELIUM TEMPERATURES ON MICROSCOPIC QUANTUM EFFECTS AND GENERAL RELATIVITY, W. M. Fairbanks. Project 9750(801A), Grant AF-AFOSR-62-119; SRPN, AFOSR.

Experiments will be performed at liquid helium temperatures on macroscopic quantum effects and general relativity. These experiments will include a study of a superconducting gyroscope with the immediate objective of measuring the gyroscope's torque in the presence of an alternating magnetic field. A long range objective of these experiments will be to check the general theory of relativity by means of a gyroscope which is forced to go around the earth either in a stationary laboratory fixed to the earth or in a satellite. Investigations will also be made to determine whether the flux through a superconducting loop is quantized and to check for the existence of quantized vortices in rotating superfluid He^4.

8.69

Stanford U., Calif.
HIGH-ENERGY ELECTRON SCATTERING BY NUCLEI, THEORY OF GRAVITATION AND LOW TEMPERATURE PHENOMENA, L. I. Schiff. Project 9760(801A), Contract AF 49-(638)-388; SRPN, AFOSR.

The broad objective of this research group is to conduct fundamental scientific research in any area of theoretical physics. The current research includes theoretical studies of elastic and inelastic scattering of high-energy electrons by protons, deuterons, and heavier nuclei; radiative corrections to electron scattering; single and pair production of μ-mesons by electrons and photons; pair production of π-mesons by photons; electron-positron pair production at large angles, and other problems in quantum electrodynamics; lattice-space field theory; high-energy nuclear photodisintegration; low-energy nuclear physics, including the structure of the ground and low excited states of nuclei; theory of gravitation; and approximation methods in atomic physics. New areas of interest, such as the phenomena associated with extremely low temperatures, will also be included in the research program.

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- SRM- Directorate of Mathematical Sciences
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- CRZR- Sacramento Peak Observatory

8.70

Stevens Inst. of Tech., Hoboken, N. J.
RELATION OF QUANTUM THEORY AND THE GENERAL THEORY OF RELATIVITY, R. Schiller. Project 7114(801A), Contract AF 33(616)-8146; ARP, ARL.

Quantization of general relativity, though it has been studied for a decade or more, is still not satisfactorily achieved. The contractor is applying to the gravitational field of general relativity a quantization technique which he developed and applied successfully to the electromagnetic field. The possible character of the singularities of the gravitational field is also under study with an eye toward the formulation of models for the elementary particles.

8.71

St. John's U., Jamaica, N. Y.
CALCULATION OF CROSS-SECTIONS FOR ELECTRON COLLISIONS, S. N. Milford. Project 9768(803A), Grant AF-AFOSR-61-10; SRPP, AFOSR.

Calculations are continuing on collisions of electrons and protons with excited states of hydrogen up to n = 10. The range of validity of the Born approximation is being determined as well as simple approximate electron atom cross-sections for forbidden inelastic collisions. A smaller amount of effort has been devoted to high energy cross-sections.

8.72

Stockholm U. (Sweden).
GENERAL RELATIVITY AND RELATED PROBLEMS, O. Klein. Project 7114(801A), Contract AF 61(052)-47; ARP, AFOSR.

The first goal of this program is the development of an extended field theory embracing the quantized Einstein theory of gravitation, quantum electrodynamics and meson field theory, with the aim of attaining an adequate description of the behavior of baryons, leptons, and mesons. The second aim of the program is a study of cosmology. Current efforts are concerned with a study of the metagalactic system which, in the ordinary sense of the word, is finite but which at an early state of its evolution was sufficiently dense to require for its study the equations of general relativity.

8.73

Syracuse U. Research Inst., N. Y.
ELEMENTARY PARTICLES AND RELATIVITY THEORY, R. Arnowitt. Project 7114(801A), Contract AF 33(616)-8362; ARP, ARL.

This effort is comprised of two parts. The first is a study of the nature of energy and of gravitational radiation in general relativity. Emphasis is being placed on determining whether energy is a positive definite quantity and whether a unique energy density is definable; on determining what conditions are necessary so that a "test particle" at infinity will have an energy given by the classical Newtonian definition; and on investigating whether invariant definitions of angular momentum are indeed available, as would be hoped for from physical considerations. The second portion of this effort is concerned with a study of the quantization of the Yang-Mills field as a preliminary to the further study of the quantization of general relativity. This study includes an investigation of the q-number gauge transformations and a determination of whether a consistent quantum theory of the combined Yang-Mills and Yang-Lee (heavy particle number) fields exists.

8.74

Syracuse U., N. Y.
QUANTUM FIELD THEORY AND ELEMENTARY PARTICLES, A. O. Barut. Project 9751(801A), Grant AF-AFOSR-62-382; SRPN, AFOSR.

Studies of the methods and formalisms of quantum field theory with reference to soluble models and apparent inconsistencies and limitations. Evaluation and examination of field theory and relativity at small dimensions will be carried out. Symmetry properties of existing particles and their interaction with reference to the connection between space-time symmetry and the symmetry in the internal space will be examined.

8.75

Syracuse U. Research Inst., N. Y.
QUANTIZATION OF GENERALLY COVARIANT FIELD THEORIES, P. G. Bergmann. Project 7114(801A), Contract AF 33(616)-6867; ARP, ARL.

The objective of this effort is to develop a technique for the quantization of generally covariant field theories, in particular the gravitation theory of Einstein. Major progress has been made in that the commutation relations of the "true observables" have been constructed in a Komar intrinsic coordinate system. These results will be used to study the quantizations of the gravitational field.

8.76

Syracuse U., N. Y.
RELATIVITY AND IRREVERSIBLE PROCESSES RESEARCH, P. Bergmann. Project 9750(801A), Grant AF-AFOSR-62-36; SRPN, AFOSR.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
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The research is directed toward studies of the fields of irreversible processes and general relativity. These two fields are not disjoint but have, through analogy, many formal similarities with regard to quantization of fields. Work will be directed toward the solution of the integro-differential equations of the statistical mechanical description of irreversible processes and the more general problem of quantization of the gravitational field and defining observables in the framework of the quantized gravitational field.

8.77

Technion Research and Development Foundation, Haifa (Israel).
COLLECTIVE MODES OF MOTION IN A PLASMA DUE TO TRANSVERSAL INTERACTION, G. Kalman. Project 7073(806A), Contract AF 61(052)-393; ARH, ARL.

Most theoretical work on collective motion in a plasma is done without regard to the magnetic effect. It appeared to be worthwhile to study to what degree of approximation such a description holds. It has been done in this analysis by using the random-phase approximation for the behavior of the moving particles. Only magnetic effects were taken into account. The result is that two (magnetic) modes exist. They both just compensate one another in thermal equilibrium (Maxwellian-velocity distribution). If the velocity distribution is not Maxwellian then one of the modes persists in a prefixed direction.

8.78

Technion Research and Development Foundation, Haifa (Israel).
GRAVITATIONAL WAVES EMITTED BY A MATERIAL SYSTEM, N. Rosen. Project 7114(801A), Contract AF 61(052)-02; ARP, ARL.

The purpose of this contract is to establish conclusively whether a material system can emit gravitational waves. This is to be accomplished by seeking an approximate solution of the gravitational field equations which possess spherical waves with various symmetry properties. The radiation problem is also being pursued by study of the algebraic properties of the curvature tensor in the presence of matter.

8.79

Texas U., Austin.
GENERAL RELATIVITY AND OTHER GRAVITATIONAL THEORIES, A. Schild. Project 7114(801A), Contract AF 33(657)-7482; ARP, ARL.

Dr. Schild will investigate the conformal geometry of the space time of general relativity theory and will continue to study gravitational theories of the Whitehead type. He will also examine the interaction of particles with charge, spin, and intrinsic magnetic moment.

8.80

Turin U. (Italy).
SCATTERING OF NUCLEI AT HIGH ENERGIES, M. Verde. Project 9750(801A), Grant AF-EOAR-62-101; SRPH, AFOSR.

A theoretical investigation of electron and nucleon scattering at high energies. The effects of exchange and spin dependent forces on the scattering will be investigated. Problems in the field of many body interactions will also be investigated. The emphasis on the many body problem will increase as more is understood about the two body forces.

8.81

Universidad de Zaragoza (Spain).
PERTURBATIONS IN QUANTUM AND CLASSICAL MECHANICS, L. M. Garrido. Project 9751(801A), Contract AF 61(052)-438; SRPP, AFOSR.

This work is directed toward the application of perturbation methods developed for quantum mechanics to classical mechanics. Classical equivalents to the quantum mechanical evolution apparatus will be constructed and the concept of interaction introduced, particularly along the lines of action principles and operator theory to adiabatic invariants.

8.82

University Coll., London (Gt. Brit.).
d-ATOMIC ORBITALS IN COVALENT BOND, D. P. Craig. Project 9760(802A), Contract AF 61(052)-61; SRC, AFOSR.

This research is an examination, using methods of molecular quantum mechanics, of the conditions under which d-orbitals can be used to form chemical bonds in atoms after the first row of the periodic table.

8.83

University Coll., London (Gt. Brit.).
APPLICATION OF DISPERSION RELATIONSHIPS, J. Hamilton. Project 9750(801A), Grant AF-EOAR-62-3; SRPH, AFOSR.

The methods of dispersion theory will be applied to studies of elementary particles and field theory. Proton-neutron dispersion relations, photo

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production of pions, photo production of K-mesons, and production of K-mesons by π-mesons will be studied. Inelastic pion scattering models will be examined by applying the dispersion relation for inelastic pion scattering symmetries and spin orbit dependence of nuclear forces will be investigated.

8.84

Uppsala U. (Sweden).
QUANTUM THEORY OF MANY-PARTICLE SYSTEMS, P. O. Lowdin. Project 7023(802A), Contract AF 61(052)-351; ARC, ARL.

This effort is to conduct studies on the electronic structure of atoms and molecules and is being accomplished by the application of the principles of quantum mechanics to the wave functions of materials which are in the ground and lower excited states. The investigations are directed toward obtaining: the Hartree-Fock functions; the generalized Hartree-Fock functions in the case of different orbitals for different spins; the wave functions of higher accuracy separation of space and spin, and treatment of symmetry by projection operators and the generalized first and second order density matrices together with the natural spin-orbitals and their occupation numbers. The progress is mainly in the direction of the construction of pure spin functions by means of projection operators, the problem of getting upper and lower bonds for eigenvalues by means of the variational principle, the problem of describing the electronic correlations due to their mutual Coulomb repulsion and the use of natural orbitals in describing many-electron systems. Some progress is also noted in the solving of secular equations in quantum mechanics by means of electronic computers, treatment of the Hartree-Fock approximation to include correlation, study of the relation between the Brueckner orbitals and natural spin-orbitals and study of the variation theorem for excited states.

8.85

Vienna U. (Austria).
BASIC SYMMETRIES IN NATURE AS REFLECTED BY THE INTERACTION OF FUNDAMENTAL PARTICLES, W. E. Thirring. Project 9751(801A), Contract AF 61(052)-265; SRPN, AFOSR.

The objective of this research is to study the basic symmetries in nature as they are reflected by the interactions of fundamental particles. Specifically, this study will include an investigation of the experimental and basic theoretical consequences of the existence or non-existence of the following symmetry properties: (1) parity conservation in strange particle interactions; (2) charge independence at high energies; (3) the universality of weak interactions; (4) the approximate conservation of axial vector in weak beta interactions.

8.86

Washington U., St. Louis, Mo.
THEORETICAL PHYSICS, E. Feenberg. Project 9751 (801A), Grant AF-AFOSR-62-412; SRPN, AFOSR.

This is a theoretical research program aimed at improving perturbation theory in quantum mechanics, applying perturbation theory to the calculation of stationary states of nuclei in terms of the shell modal and solving problems relating to the angular distribution and polarization properties of nuclear reactions. The group also serve as theoretical advisers in regard to the analysis and interpretation of the data obtained from cyclotron experiments.

8.87

Weizmann Inst. of Science, Rehovot (Israel).
MANY PARTICLE SYSTEMS, H. J. Lipkin. Project 9750 (801A), Grant AF-EOAR-61-55; SRPN, AFOSR.

This will be a study of the various approximation methods for describing many particle systems with emphasis on systems obeying Fermi-Dirac statistics.

8.88

Weizmann Inst. of Science, Rehovot (Israel).
THREE BODY PROBLEM IN ATOMIC PHYSICS, C. L. Pekeris. Project 9751(801A), Contract AF 61-(052)-510; SRPP, AFOSR.

This research is an investigation of the three-body problem in atomic physics. The purpose of the project is to obtain solutions of very high accuracy of the Schrodinger wave equation for two-electron atoms. In particular it is expected that the investigation will: (a) allow a comparison to be made between the theoretical and experimental values of the Lamb shift in two-electron atoms; (b) provide accurate values of oscillator strengths for applications to astrophysics and to Lamb shift calculations; (c) provide accurate values of the absorption coefficient by the negative hydrogen ion -- the major process in stellar opacity; (d) provide accurate term-values for the spectra of two-electron atoms, in addition to the ground state; (e) furnish a value for the electron density at the nucleus with an accuracy comparable or better than the accuracy achievable in the latest fine-structure measurements (several parts in 10^8); (f) provide accurate wave functions for other applications, such as polarisability, molecular potentials, etc.; and

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(g) develop methods for the eventful treatment of the nuclear three-body problem.

8.89

Yale U., New Haven, Conn.
ELECTRON NUCLEAR INTERACTIONS AND RELATED PROBLEMS, G. Breit. Project 9750(801A), Grant AF-AFOSR-62-42; SRPN, AFOSR.

This is a theoretical study of the interactions between electrons and nuclei and of related aspects of nuclear structure. Areas being considered include: (a) photodisintegration of the deuteron; (b) atomic electron effects on proton-proton scattering; (c) Coulomb excitation; (d) scattering of mu mesons, electrons and positrons by nuclei; and (e) electric polarizabilities of the neutron and proton.

8.90

Yeshiva U., New York.
STATISTICAL MECHANICS OF TRANSPORT PROPERTIES IN NON-EQUILIBRIUM AND DISSIPATIVE SYSTEMS, J. L. Lebowitz. Project 9751(801A), Grant AF-AFOSR-62-64; SRPP, AFOSR.

This project is devoted to the understanding of non-equilibrium processes. There is no general applicable theory in this field. Brownian motion and the time evaluation of the distribution function describing it will be studied. Plasmas, dense gases, and other fluids will be studied with regard to their transport properties under conditions where equilibrium does not exist.

See also: 1.7, 1.12, 1.22, 3.14, 3.43, 3.79, 3.140, 7.37, 7.44, 7.49, 7.54, 7.60, 7.69-71, 7.79, 7.86-87, 7.98, 7.103, 9.38, 11.42, 11.55, 12.19, 12.87-88, 13.26, 14.115, 17.33, 20.16, 24.13

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9. ELECTRIC AND MAGNETIC PROPERTIES

Electric Resistivity; Ferrolectric Properties; Thermoelectric Properties; Magnetic Properties; Photoelectric Effects; Thermionic Emission; Superconductivity; Electronic Properties of Surfaces.

9.1

Advanced Development Lab., Raua, RADC, Rome, N.Y.
ELECTRON TRANSPORT PHENOMENA, R. Kosiewicz. Project 8503(803A), Internal.

An investigation will be made of temperature dependent properties related to electron transport mechanisms at low (cryogenic) temperatures. Preliminary instrumentation in the form of a pumping system capable of lowering the vapor pressure over a liquid helium reservoir for achieving temperature less than one degree absolute will be completed shortly. The work has been directed toward the eventual measurement of the properties of superconductors using the above vacuum system when it is completed. Plans are for measurements of thermal conductivity and specific heats of superconductors.

9.2

Bartol Research Foundation, Franklin Inst., Swarthmore, Pa.
CATHODE EMISSIVE MATERIALS, W. E. Danforth. Project 4619(760E), Contract AF 19(604)-3904, CRRC, AFCRL.

The research objectives are: determining of the potential emission density and useful life of a thorium impregnated tungsten matrix chathode; and a study of evaporation and thermionic emission of the system thorium on tungsten. Quantitative thermionic data using known single crystal planes of tungsten is being obtained.

9.3

Battelle Memorial Inst., Columbus, Ohio.
RARE EARTH OXIDE CATHODES, G. B. Gaines. Project 4619(760E), Contract AF 19(604)-5691; CRRC, AFCRL.

The objective of this research is to evaluate the thermal electron emission behavior of certain of the rare-earth oxides. Gadolinium oxide and neodynium oxide, and mixtures of these are of particular interest.

9.4

Brandeis U., Waltham, Mass.
THEORETICAL INVESTIGATION OF RELAXATION PHENOMENA IN PARAMAGNETIC CRYSTALS, D. L. Falkoff, E. P. Gross. Project 5621(802A), Contract AF 19(604)-4107; CRRC, AFCRL.

To study theoretically relaxation processes in paramagnetic materials. This includes extensive study of spin-spin cross relaxation. Implications of this work for line shapes and widths will be considered. The effect of coherence and phase in relaxation will be studied by quantum mechanical density matrix.

9.5

Brandeis U., Waltham, Mass.
PHOTO-IONIZATION, ELECTRON TRAPPING AND PHOTO-CONDUCTIVITY IN GLASSES, H. Linschitz. Project 5620 (802A), Contract AF 19(604)-4536; CRRC, AFCRL.

This program has as its object the study of trapped or conduction electrons in glassy media. The project will provide information on such matters as binding energy, absorption spectrum, mobility, mechanism of movement and chemical reactivity as a function of solvent composition. Moreover, quite apart from the trapped electron problem study of the photoionization process itself provides important chemical information.

9.6

British Columbia U. (Canada).
PHYSICAL PROCESSES AND FLUCTUATIONS IN SEMICONDUCTOR SYSTEMS DISPLAYING NEGATIVE RESISTANCE, R. E. Burgess. Project 9768(803A), Grant AF-AFOSR 61-91; SRPP, AFOSR.

This is an investigation of certain processes in semiconductors which yield negative resistance and are associated with high electric fields and/or current densities. One project relates to ambipolar flow under conditions of heavy injection or extraction and related to it is the use of longitudinal magnetic fields to reduce lateral diffusion and hence minimize surface recombination. The second project is concerned with fluctuations in tunneling currents and also the noise associated with hot carriers in semiconductors both in the absence and presence of impact ionization.

9.7

Brown U., Providence, R. I.
LOW TEMPERATURE INVESTIGATION OF THE INTERACTION BETWEEN ULTRASONIC WAVES & ELECTRONS, R. W. Morse. Project 9760(802A), Contract AF 49(638)-6; SRPS, AFOSR.

The attenuation of ultrasonic waves in both normal and superconducting metals down to temperatures as low as 0.25°K will be measured, and its dependence on such parameters as frequency, wave polarization, applied magnetic field, and parity of metal will be investigated. Single crystals of such materials as gold, copper, aluminum, tin, sodium, and lithium

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will be studied over the frequency range from 150 to 1500 Mc/Sec in fields up to 10 kilogauss. The results of such measurements will be interpreted in terms of: (1) the character of the superconducting energy gap, (2) the shape of the Fermi-surface, and (3) the nature of the electron-lattice interaction.

9.8

California U., La Jolla.
FERROMAGNETISM AND SUPERCONDUCTIVITY IN SOLIDS, B. T. Matthias. Project 9763(802A), Contract AF 49(638)-1040; SRPS, AFOSR.

Special attention will be given to superconductors with extremely low (0.3°A), as well as extremely high (18°A), transition temperatures. In addition, the inter-relationships between ferromagnetism and superconductivity will be studied. Materials will be prepared which display both phenomena at the same time. This investigation aims primarily at elucidating the nature of the relationship of these coexisting properties as well as the synthesis of superconducting and ferromagnetic materials.

9.9

California U., La Jolla.
THEORY OF SOLIDS, H. Suhl. Project 9763(802A), Contract AF 49(638)-1038; SRPS, AFOSR.

A general program of fundamental research in the theory of solid state physics, specific topics to be studied include: (1) fundamental nature of the interactions between magnetic and superconducting effects; (2) the many-electron problem and the higher-order random phase approximation; (3) electron damping effects in the theory of superconductivity; and (4) the frequency limitations of parametric amplification.

9.10

Carnegie Inst. of Tech., Pittsburgh, Pa.
EXPERIMENTAL STUDY OF TRANSPORT PHENOMENA IN METALS, E. M. Pugh. Project 9760(802A), Contract AF 49 (638)-257; SRPS, AFOSR.

The purpose of this work is to conduct an active experimental program designed to provide current and refined data which will check the predictions of existing theories of electron transport in metals and which will aid in reformulating these theories to give more accurate mathematical descriptions. The following types of experiments are being carried on over wide temperature ranges: (1) the measurement of the ordinary and extraordinary Hall effects; (2) the measurement of resistivities and magnetoresistance; (3) the measurement of magnetic susceptibilities; and (4) the measurement of thermoelectric powers. Metals being studied include high purity copper, ordered and disordered nickel-manganese alloys, nickel containing palladium, and pseudonickel.

9.11

Case Inst. of Tech., Cleveland, Ohio.
FERMI SURFACE OF METALS AND DILUTE ALLOYS, W. L. Gordon, T. G. Eck. Project 9760(802A), Grant AF-AFOSR-62-222; SRPS, AFOSR.

The topology of the Fermi surface of metals and very dilute alloys and the effective masses will be investigated using the techniques of the de Haas-van Alphen effect in d. c. magnetic fields and pulsed fields up to 300 Kilogauss, of measuring magnetoresistance, and of cyclotron resonance. Single crystals of magnesium, mercury, beryllium, lithium, zinc, cadmium, and aluminum will be included.

9.12

Catholic U. of America, Washington, D. C.
FERROELECTRIC AND OTHER ELECTRONIC MATERIALS, C. F. Pulvari. Project 7031(803A), Contract AF 33(616)-6233; ASRNE, ARL.

Research on the switching mechanism of ferroelectrics will be continued in an effort to determine criteria for a threshold switching field. Work will be concentrated on newly discovered mixed crystals which require such a minimum field for switching with particular emphasis on materials with high Curie temperatures.

9.13

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
ELECTRON BEAM INTERACTIONS ON SURFACES, E. L. Kern. Project 7022(802A), Internal.

An approach to the understanding of the electronic nature of surfaces is under investigation. Techniques will be used to produce ultra-clean surfaces of a high degree of smoothness. These will include mechanical and electrolytic polishing, positive ion surface bombardment and outgassing in an ultra-high vacuum in the 10^{-10} mm. Hg. range. A feasibility study on the generation of the desired vacuum conditions is currently in progress. The surface cleanliness and crystalline structure will be investigated by low energy electron diffraction. The method of investigating the electronic surface properties will be to study the effect of the forces, existing just outside the atomic surface, upon a low energy collimated electron beam. This will include an analysis of the surface work function. Construction of the collimated electron beam generating apparatus has commenced.

9.14

Chicago U., Ill.

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ELECTRONIC PROPERTIES OF SEMICONDUCTORS AT LIQUID HELIUM TEMPERATURES, H. Fritzsche. Project 9760(802A), Grant AF-AFOSR-62-178; SRPS, AFOSR.

The research involves the investigation of the electronic properties of semiconductors in the temperature range of liquid helium. Some of the objectives are: (1) to further elucidate the complicated phenomenon of impurity conduction, which is due to a resonant exchange interaction of the impurity centers; (2) to study the detailed structure of the impurity states and their wave functions; and (3) to study the band parameters and the scattering mechanisms in degenerate semiconductors containing large impurity concentrations. The use of (1) controlled compensation by means of slow neutron irradiation and nuclear transmutation, (2) high compressional and tensile shear stresses, and (3) alternating currents over a large frequency range in the study of impurity conduction at low temperatures, are the novel features in this research program. Present research involves germanium. The methods will be extended to other semiconductors, particularly to the III-V and II-VI intermetallic compounds and to the unfilled d-shell transition metal oxides.

9.15

Compagnie Generale de Telegraphie Sans Fil, Paris (France).
PREPARATION AND STUDY OF COMPOUNDS OF THE II-IV TYPE AND MIXTURES THEREOF TO DETERMINE THEIR USEFUL SEMICONDUCTING PROPERTIES, P. Aigrain, N. Thein-Chi. Project 4608(760E), Contract AF 61(052)-243; CRRC, AFCRL.

A study and investigation shall be made of the methods of preparation, of the semi-conductor properties (in particular, those which are important from the thermoelectric point of view), and of the physical properties (thermal conductivity) of the compounds of formula M_2N where M is divalent and N quadrivalent, and of their alloys. Preparation of the compounds in both the pure and doped states, and determination of their electrical-physical properties as well as of their stoichiometry. Study of the quasi-binary diagrams of the compounds taken in pairs and in combinations. Study of the semiconductor and physical properties of the alloys.

9.16

Ecole Normale Superieure, Paris (France).
EMISSION OF HOT ELECTRONS FROM A COLD LATTICE, P. Aigrain. Project 5634(803A), Contract AF 61(052)-403; CRRC, AFCRL.

Investigation of semiconductors as electron emitters for high vacuum electron devices. This represents an entirely new approach in the use of solid state materials as electron emitters in vacuum tubes. A search of known materials as well as new combinations of materials will be made in an effort to produce emitters capable of operating in vacuum tubes.

9.17

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
FERROMAGNETIC AND FERROELECTRIC MATERIALS, F. A. Olson. Project 5635(803A), Internal.

Experimental and theoretical work leading to novel microwave devices using ferromagnetic and ferroelectric materials. To get a better understanding of the basic physical mechanism, the theory and the materials aspect are especially emphasized. Another project is the generation of spin waves in ferromagnetics of intermediate wavelengths.

9.18

Electronic Material Sciences Lab., CRR AFCRL, Bedford, Mass.
PROPERTIES OF FERRIMAGNETIC SINGLE CRYSTALS, B. R. Capone. Project 5621(802A), Internal.

The objective of this research is to investigate in some detail certain properties exhibited by single crystals of ferrimagnetic materials like rare earth iron garnets. The particular phenomena currently being investigated are: (a) saturation magnetization of magnetostatic modes and (b) non-linear behavior. Magnetostatic modes are excited by placing the sample in an inhomogeneous region of an r.f. field in a cavity. By proper selection of cavity and position of the sample any desired mode can be obtained.

9.19

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
EXTREMELY HIGH TEMPERATURE RESEARCH, H. Fischer. Project 5634(803A), Internal.

Theoretical and experimental investigations into electrical breakdown phenomena of maximum energy density. Ultra high temperature studies in the microsecond range at high pressures where thermalization is no problem and at low pressures where thermalization is brought about through acceleration and confinement by external magnetic fields. Electro-optical studies in the 10^{-10} sec domain. Applications and utilizations of nanosecond light pulses for studying high velocity events or short duration processes.

9.20

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.

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MAGNETIC ANISOTROPY, P. Gianino. Project 5621(802A), Internal.

The objective of this research is to investigate the origin and nature of magnetocrystalline anisotropy in ferrimagnetic materials. Present emphasis is on the verification and possible extension of the one ion theory of anisotropy using the Neel concepts of ferrimagnetism.

9.21

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
EMISSIVE MATERIALS STUDIES, A. Matthewson. Project 4619(760E), Internal.

The in-house work on emission consists of several investigations. The objective of this work is to obtain more reliable and higher current density emitters for cathodes. Investigation of pressed dispenser cathodes has reached the actual test of cathodes fabricated by pressing metallic powders and activators into a homogeneous mass which is presintered for strength and then assembled into a test structure. Measurements are now in progress to evaluate these cathodes. Studies of titanium dioxide as a cathode material have been in progress. Work is in progress to improve the emission density and life in this mechanically very strong type of cathode.

9.22

Electronics Technology Lab., ASRNE, ASD, Dayton, Ohio.
LOGIC FUNCTION REALIZATION, S. E. Cummins. Project 7031(803A), Internal.

Switching theory, mathematical logic, and extensions of switching theory will be investigated. Physical phenomena in materials will be investigated for application to desired switching or other information handling functions. Investigation of ferrielectric properties of contractor-prepared crystals will be accomplished under the experimental effort.

9.23

Electronics Technology Lab., ASD, Dayton, Ohio.
FERROELECTRIC PHENOMENA, G. B. Kidd. Project 7031 (803A), Internal.

The literature survey of ferroelectric phenomena will be continued as will efforts to correlate reported switching characteristics with the theory developed by Professor Pulvari at Catholic University of America. Efforts will also be continued to correlate optical properties of ferroelectrics with switching behavior. Experimental research will be conducted with the objective of evaporating films of ferroelectrics possessing threshold characteristics including those materials developed by Professor Pulvari.

9.24

Electronics Technology Lab., ASRNE, ASD, Dayton, Ohio
MATHEMATICAL RESEARCH ON LOGICAL MODELS, G. B. Kidd. Project 7031(803A), Internal.

From symbolic models of the solid state, magnetic, and electrical and magnetic phenomena the following efforts will be continued: (1) studies of the elements of the models that arise from thresholds and coincident effects; (2) determination of the criteria functions such as energy realization, dissipation, and state change duration in connection with the general switching function models; and (3) from the functions abstracted attempts will be made to project new elements back into the physical domain for specific applications.

9.25

Electronics Technology Labs., ASRNE, ASD, Dayton, Ohio
THERMAL COMPUTING CONCEPTS, G. B. Kidd. Project 7031(803A), Internal.

Investigation will be continued of the bi-stable characteristics of thermal devices. This will include evaluation of the change in temperature and total heat required for switching, methods of heat transfer, and switching time expressed as a function of input power. Research on the feasibility of utilizing thermo-resistor phenomena for computation purposes, based on marked resistive changes with small temperature changes near phase transition points, will be continued. The investigation of the bi-stable characteristics of thermal devices will consist of a survey of the literature. Experimental work using evaporated and chemically deposited films of the sulphide and the telluride of silver and of vanadium oxides will be undertaken. Bi-stable elements will be made and evaluated.

9.26

Florida U., Gainesville.
COLLECTIVE ELECTRON EXCITATIONS IN SUPERCONDUCTORS, W. B. Ard. Project 9760(802A), Contract AF 49(638)-956; SRPS, AFOSR.

Collective excitation of electrons in superconductors will be investigated by measuring the energy lost by 40 kev. electrons in transmission through thin superconducting films. This data will give the energy of the collective excitations, the cross-sections for exciting and the mean life of the excitations. The

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results will be compared with that from the same metal in the normal state in order to determine what effect the superconducting state has on the collective modes of electron excitation in the metal.

9.27

Franklin Inst., Philadelphia, Pa.
MAGNETIC AND STRUCTURAL PROPERTIES OF PRECIPITATING FERROMAGNETIC SYSTEMS, S. Strikman. Project 9760 (802A), Contract AF 49(638)-159; SRPS, AFOSR.

The purpose of this investigation is to clarify some of the relationships between various magnetic and structural properties of systems in which ferromagnetic precipitates appear in a non-magnetic matrix. This research is concerned with the kinetics and structural features of the nucleation and growth of precipitates in these systems.

9.28

General Electric Co., Schenectady, N. Y.
VARIOUS ACTIVATOR-REFRACTORY SUBSTRATE COMBINATIONS, J. H. Affleck. Project 4619(760E), Contract AF 19 (604)-4093; CRRC, AFCRL.

A study is being made of the emission constants and evaporation rate of cathodes of refractory salts and activator elements to determine in what way these quantities might be related. In addition, various activator-refractory substrate combinations are being examined for their ability to produce high emission density cathodes with reasonable life. Further work is continuing to combine a substrate, such as tungsten carbide, and an activator that evaporates at a lower rate. Similar studies are in progress on tantalum and molybdenum systems. The results of this investigation are applicable in the design of thermionic cathodes for electron tubes and electrodes for thermionic converters.

9.29

General Electric Co., Schenectady, N. Y.
THERMIONIC CONVERTERS, J. Houston, H. F. Webster. Project 6694(750F), Contract AF 19(604)-8424; CRZA, AFCRL.

Fundamental research related to the thermionic conversion process in the plasma thermionic converter is being performed. Areas of activity include the effect of special gas fillings, unusual electrode surfaces, electron emission from coated surfaces, work functions of single crystal emitters and emission from composite surfaces.

9.30

General Telephone Labs., Bayside, N. Y.
ELECTRON TUBE MATERIALS AND THERMIONIC EMISSION PHENOMENA, T. G. Polanyi. Project 4619(760E), Contract AF 19(604)-7286; CRRC, AFCRL.

Objectives are to determine the basic thermionic properties of oxide cathodes operating in an extremely passive ambient obtained through the use of an ultrapure nickel base and careful choice of materials, processings and test diode design. Studies are planned of the high temperature chemico-physical properties of selected materials and materials system used in vacuum tubes. Investigation of thermionic emission phenomena through images on the screen of an emission microscope is a further objective.

9.31

Georgia Inst. of Tech., Atlanta.
PHENOMENA THEORY AND TAXONOMY, E. J. Scheibner. Project 4150(803A), Contract AF 33(657)-7867; ASRNE, ASD.

The objective of this program is to gain a more fundamental understanding of certain phenomena which occur in composite layers of thin films, at their surfaces, or interfaces. Specifically, studies will be made on the following: (1) tunnel emission phenomena; (2) photoemission of electrons from a metal into an insulator or semiconductor; (3) the characteristics of hot electrons in thin films of metals and semiconductors; (4) the electron behavior of metal-insulator or metal semiconductor contacts; (5) network properties of the above phenomena.

9.32

Harshaw Chemical Co., Cleveland, Ohio.
PHOTOVOLTAIC CELLS, F. Shirland. Project 7885 (802A), Contract AF 33(616)-6548; AEX, ARL.

This contract comprises theoretical and experimental research on the fundamental nature and the essential characteristics of photovoltaic cells made from II-VI compound semiconductors. It includes basic research on ultra-purification and controlled doping of ZnO, ZnTe, CdSe and CdTe, and on new methods for evaluation of ultra pure and doped materials. It involves, also, studies of (1) rectifying barriers in these materials, (2) configurations arising from the juxtaposition of different compounds like n-CdS and either n-CdTe or p-CdTe, with special reference to the photovoltaic effect, (3) a theoretical analysis of mixed semiconductor junctions, with initial emphasis on the CdS-CdTe configuration, and (4) a basic study of the general nature of mixed semiconductor contacts.

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9.33

Harvard U., Cambridge, Mass.
FUNDAMENTAL PHYSICS OF FERROMAGNETIC AND FERROELECTRIC MATERIALS, R. V. Jones. Project 5633(803A), Contract AF 19(604)-5487; CRRD, AFCRL.

Conduct research relating the performance of microwave antennas, devices, and components to the detailed characteristics of various types of media, including ferromagnetic media and ferroelectric media. This research will also include investigations of materials which may simultaneously be both piezoelectric and ferromagnetic, or ferroelectric and ferromagnetic. In the future attention will turn to the investigation of new magnetic systems, particularly those which may also be ferro-electric or piezoelectric. The development of special ferrites whose large internal fields partially alleviate the external magnet requirements of present ferromagnetic devices will continue.

9.34

Hebrew U. (Israel).
ELECTRON SPIN RESONANCE EXPERIMENTS IN PARAMAGNETIC IONS, ATOMS, AND FREE RADICALS, W. Low. Project 9763(802A), Contract AF 61(052)-59; SRPS, AFOSR.

The purpose of this series of investigations is to obtain a better knowledge and understanding of paramagnetism in single crystals. The experiments are so designed as to yield information on: (a) the nature of the electronic ground state and excited states of paramagnetic ions; (b) the magnetic anisotrophy; (c) the relaxation mechanisms operative in these ions; (d) the effect of irradiation in inducing paramagnetism in crystals. In order that the experiments can yield data which are amenable to theoretical treatment, the experiments are performed on selected crystals of high symmetry i.e.,cubic or axial symmetries in which the paramagnetic ions are incorporated as substituted impurities.

9.35

Illinois U., Urbana.
DIFFUSION IN SEMICONDUCTORS, J. Bardeen. Project 9763(802A), Contract AF 49(638)-417; SRPS, AFOSR.

This research will include (1) study of Drift-and-Hall Mobility and trapping of carriers in amorphous and liquid selenium, (2) measurement of the magnetic susceptibility of crushed germanium and silicon powders from room temperature to liquid helium temperature, (3) experiments on tunnel diodes at liquid helium temperature, including investigations of oscillations in the current-voltage characteristics, (4) investigations of avalanche breakdown in narrow gap semiconductors using high microwave fields, (5) investigation of methods for stabilization of semiconductor surfaces, possibly by diffusing suitable impurities into the surface region, and (6) investigation of the structure of semiconductor surfaces by use of magnetic resonance methods.

9.36

Illinois U., Urbana.
ELECTRONIC PROPERTIES OF ALKALI HALIDES, F. C. Brown. Project 9760(802A), Contract AF 49(638)-579; SRPS, AFOSR.

The electronic properties of suitably prepared silver and alkali halides are being studied by means of electronic and optical measurements at temperatures down to liquid helium. The purpose of this investigation is to obtain an understanding of such aspects of the electronic properties of the halides as trapping mechanisms, energy levels of traps, factors affecting mobility of electrons and holes, and scattering processes. At the present time attention is being directed toward the properties of holes in AgBr, the magneto resistance for photoelectrons in AgBr, scattering in AgCl and KCl, conductivity in KCl resulting from ion bombardment, and attempts to measure cyclotron resonance in AgBr.

9.37

Illinois U., Urbana.
ELECTRONIC PROPERTIES OF NON-METALLIC CRYSTALS, R. J. Maurer. Project 9760(802A), Contract AF 49(638)-529; SRPS, AFOSR.

Research will be conducted upon the intrinsic photoconductivity of alkali halides for the purpose of determining the energy gap between the valence and conduction bands and other details of the energy level structure. The trapping of electrons and holes in alkali halides will be investigated with emphasis upon the details of the trapping centers as revealed by magnetic resonance techniques. Studies will be made to determine the potential value of thermoelectric power measurements on ionic crystals such as the alkali and silver halides and may be followed by measurements of thermoelectric power of pure and doped ionic crystals.

9.38

Illinois U., Urbana.
THEORY OF SUPERCONDUCTIVITY AND RELATED THEORETICAL PROBLEMS OF THE SOLID STATE, J. R. Schrieffer. Project 9763(802A), Contract AF 49(638)-882; SRPS, AFOSR.

This research will include the following: (1) the treatment of more realistic models of metallic superconductors, taking into account anisotrophy of the electronic band structure, phonon-electron matrix elements, phonon spectrum, etc., as well as the effects of alloying and lattice defects on the

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SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

superconducting state; (2) a quantum field theoretical investigation of the fundamental basis of the BCS approach to the many thermion problem; and (3) general related problems in the area of theoretical solid state physics, including the theory of the many-body problem, spin relaxation processes in solids and the theory of liquid metals.

9.39

Illinois U., Urbana.
PHYSICS OF SOLIDS, F. Seitz. Project 9763(802A), Contract AF 49(638)-528; SRPS, AFOSR.

Current research being performed includes: (1) the depletion of the zero momentum states at both zero and non-zero temperatures of an interacting Bose gas; (2) the calculation of the wave-function and size of the ground state of holes in germanium; and (3) the study of the idea of a continuous electron field associated with the electron gas in metals in which the characteristic metallic phenomena are the consequences of elementary excitations.

9.40

Laboratory for Electronics, Inc., Boston, Mass.
DOMAIN WALL CONTROL IN FERROMAGNETIC THIN FILMS, H. W. Fuller. Project 5632(803A), Contract AF 19 (604)-8349; CRRB, AFCRL.

Research is being done into the physics of intentional creation and controlled motion of domain walls in thin ferromagnetic films, including means of controlling wall motion and effects of imperfections on motion.

9.41

Louvain U. (Belgium).
ELECTROLUMINESCENCE, A. Luyckx. Project 8503(803A), Contract AF 61(052)-166; RASG, RADC.

Studies previously made of CdS will be extended to other crystals and to ZnS crystals with various activators. The magnetoresistance of sulfides will be investigated and a study of the semi-conductive properties of metallic alloys will be commenced. Investigation will continue on the photomagnetoelectric effect in bismuth foils, and alloys and on the investigation of thermomagnetoelectric effect in junction of various metal and their alloys.

9.42

Laboratoire Centrale des Industries Electriques, Fontenay-aux-Roses, Seine (France).
THERMOMAGNETOELECTRIC EFFECTS IN SEMICONDUCTORS, P. Aigran. Project 6694(750F), Contract AF 61(052)-408; CRZA, AFCRL.

The goal of this contract is the development of a new type of thermoelectric generator. Small band-gap semiconductor mixtures such as alloys of magnesium, tin and lead are investigated with reference to their ability to function as thermomagnetoelectric heat flux detectors. The thermodynamics of such phenomena are analysed in relation to the bipolar Nernst effect.

9.43

I. W. Kluge, Stuttgart (Germany).
THERMIONIC ENERGY CONVERTERS, I. W. Kluge. Project 7073(806A), Contract AF 61(052)-443; ARH, ARL.

An exhaustive study of the phenomenon of electron emission from solid surfaces was undertaken which shall lead to the selection of effective electrode materials. Existing theories have been critically compared, bridging gaps with original thoughts, to create a more complete physical picture of the process.

9.44

International Telephone and Telegraph Corp., Nutley, N. J.
SEMICONDUCTING DIAMONDS, H. G. Nordlin. Project 5621(802A), Contract AF 19(628)-225; CRRC, AFCRL.

The research required on this contract is to be performed on evaluation of the semiconducting properties of diamonds. This includes measurement of pertinent and interrelated properties as a function of crystal structure and imperfections in the material. Evaluation of impurity content and band structure in terms of the measured phenomena is desired.

9.45

Instituto Elettro-Technico Nazionale (Italy).
SPECIAL PROPERTIES AND STRUCTURES OF SOLIDS, G. Bonfiglioli. Project 9760(802A), Contract AF 61(052)-328; SRPS, AFOSR.

The purpose of this research is to conduct further refined studies of the surface electrical conduction, distribution of traps and the grain "sub-structure" of selected solids such as metals, silicon, germanium, and Al/Cu solid solutions. Specifically, the work is divided into three problem areas: (1) the fundamental processes involved in F-center thermoluminescence will be studied and the role played by electron and hole radiative recombination in this phenomenon will be investigated. Experiments will be carried out to determine the effects of both DC and AC external electric fields on the thermoluminescence problem; (2) a study will be made of a bombardment induced disarrangement of single crystal surfaces, using transmission electron microscopy techniques. The structure of the distorted regions of the crystal

structure will be investigated, and (3) investigations will be started to determine the effects of temperature on F-center thermoluminescence.

9.46

Maryland U., College Park.
SOLID STATE THEORY, R. D. Meyers, R. A. Ferrell. Project 9763(802A), Contract AF 18(600)-1015, AF 49(638)-399; SRPS, AFOSR.

This is a theoretical investigation of several fundamental problems of the solid state. These problems are: (1) electron-electron and electron lattice interactions. It includes: (a) electromagnetic properties of the degenerate electron gas, the objective being to be able to compute the effect of interaction on the orbital magnetic susceptibility of the degenerate electron gas; (b) momentum distribution in a degenerate Fermi liquid, the objective being to calculate the increase in kinetic energy of the gas, and using the virial theorem, the increase in the ground state energy; and (c) polarization of the degenerate electron gas by point charge, a positive point charge placed inside an electron gas causes an increase in the electron density in its vicinity, the objective being to calculate the induced electron density at the position of the positron, and from that, the polarization correction to the positron lifetime in metals; (2) superconductivity, the objective being to study the sensitivity of the ground state energy with respect to coulomb and phonon interactions in an effort to elucidate the difference between the theories of Bardeen and Bogolinboff; and (3) low temperature ferromagnetism, in which the objective is to determine whether Bose or Fermi-Dirac statistics should be applied in calculating the weak interactions of spin waves.

9.47

Massachusetts Inst. of Tech., Cambridge.
PHYSICAL NATURE OF PHOTOELECTRIC TRAPPING AND RECOMBINATION CENTERS IN SINGLE CRYSTAL MATERIALS, A. Smakula. Project 5621(802A), Contract AF 19 (604)-8483; CRRC, AFCRL.

Examination of the photoelectric properties provides an important method of obtaining data on the properties of semiconductor crystals which affect both electrical and optical parameters. The bonding involved at localized imperfection sites is to be examined in crystals of controlled high quality, and correlated with the resulting photoelectric parameters. High precision techniques are applied for determining such parameters as lattice constant and crystal density and in determining the effects of annealing and quenching on the redistribution of imperfections.

9.48

Massachusetts Inst. of Tech., Cambridge, Mass.
FERROELECTRIC MATERIALS AS THEY REACT TO MICROWAVES, A. R. Von Hippel. Project 5635(803A), Contract AF 19(604)-6155; CRRD, AFCRL.

An investigation of microwave properties of ferroelectric materials, especially with regard to low losses at microwave frequencies and the fabrication of such materials will be made. The emphasis will be on the basic principles associated with ferroelectric materials especially for a comparison of high- and low-dielectric-constant materials.

9.49

Massachusetts Inst. of Tech., Cambridge.
THERMOELECTRICITY, D. C. White, R. B. Adler. Project 5621(602A), Contract AF 19(604)-4153; CRRC, AFCRL.

Theoretical and experimental research in thermoelectricity and other transport phenomena with particular reference to compound semiconductors and their solid solutions of interest for thermal and/or electrical properties. Obtain and interpret data to formulate theories that link parameters which are vital for device design to basic properties of the semiconductor materials. Investigate material preparation methods of particular use in device construction. Investigate methods of analysis and design techniques for thermoelectric and other devices that will relate performance to material parameters.

9.50

McGill U. (Canada).
ELECTRICAL PROPERTIES OF SEA ICE, E. R. Pounder. Project 8623(804A), Contract AF 19(604)-8378; CRZG, AFCRL.

A study of the best methods of measuring the electrical conductivity, dielectric coefficient, and loss factor of saline ice at a variety of frequencies ranging from D-C up to and including microwave radar frequencies. A program of measurements of the electrical parameters.

9.51

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
ELECTRICAL AND MECHANICAL PROPERTIES OF SELECTED HALIDES AND OXIDES, N. M. Tallan. Project 7021 (802A), Internal.

The study of ceramic materials, including selected

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halides and oxides, is centered primarily about their electrical properties. The dielectric loss of guarded samples of single crystal and polycrystalline materials is being studied at sub-microwave frequencies over a wide temperature range.

9.52

Michigan U., Ann Arbor.
MAGNETIC AND ELECTRICAL PHENOMENA IN FERRIMAGNETIC MATERIALS, D. M. Grimes. Project 9760(802A), Contracts AF 18(603)-8, AF 49(638)-986; SRPS, AFOSR.

The objective of this research is to obtain a better understanding of the source of the magnetic and electric properties of ferrimagnetic materials and to determine possible means of controlling them. The approach is two fold. Use will be made of the techniques of differential thermal analysis, optical and electron microscopy, X-ray analysis, density and heat-capacity determinations as appropriate. Measurements will be made of the electric and magnetic properties as a function of biasing magnetic field, the magnetization, and the temperature. The spontaneous magnetic moment and magnetic anisotropy will be measured from helium to room temperature.

9.53

Minneapolis-Honeywell Regulator Co., Hopkins, Minn.
ELECTRICAL PROPERTIES OF CLEAVED SURFACES, S. R. Morrison. Project 9761(802A), Contract AF 49(638)-597; SRPS, AFOSR.

Extremely clean surfaces are prepared by a technique of cleaving crystals in a very good vacuum. This cleavage technique makes possible a comparison between theory of surfaces and experiments on ideal surfaces possible to an extent not previously possible. The materials being examined at present are germanium and silicon. In addition to examination of the surface in vacuum, the properties of surfaces in atmospheres of oxygen between 10^{-9} mm to 15 mm are being studied. Particular attention is being directed toward a more accurate description of fast states of about 0.1 electron volt on the surfaces.

9.54

Minnesota U., Minneapolis.
MICROWAVE STUDIES OF SEMICONDUCTOR CRYSTALS, K. S. Champlin. Project 9763(802A), Contract AF 49(638)-747; SRPS, AFOSR.

The purpose of this research is to investigate basic electronic processes in semi-conductors by employing microwave techniques. Experiments involving energy transfer mechanisms, carrier transport, and recombination processes will be performed. In addition, techniques will be employed to measure the "hot" (energized) electron effects by completely electrodeless techniques.

9.55

Minnesota U., Minneapolis.
MAGNETIC RESONANCE IN STRONGLY COUPLED DIPOLE SYSTEMS, A. H. Morrish. Project 9760(802A), Contract AF 49(638)-803; SRPS, AFOSR.

Ferromagnetic resonance measurements at x and k band frequencies and at temperatures down to liquid helium and magneto-optical experiments will be performed on single crystal garnets to obtain information on internal magnetic fields, line widths, relaxation processes, anisotropy, and nonlinear coupling modes. Domain wall motion will be studied by permeability measurements in the rf range at temperatures near the compensation point. Spin wave resonances in thin permalloy films, giving particular attention to boundary conditions, will be studied.

9.56

Minnesota U., Minneapolis.
BASE NICKELS FOR OXIDE COATED CATHODES, W. G. Shepherd. Project 4619(760E), Contract AF 19 (604)-3890; CRRC, AFCRL.

The work consists of basic research on base nickels for oxide-coated cathodes and a systematic study of the many factors influencing the emission performance of oxide-coated cathodes under various operating conditions. Experiments varying the rate at which carbon, a reducing agent, can reach the oxide coating are being completed. The study of the correlation between the development of cathode activity and a controlled Ba pressure in the pores of the oxide is still in progress. The effects of continuous current density, cathode temperature, and cathode history on electrolytic activation are being investigated. Studies of changes occurring in evaporated thin films of BaO are under way. Measurements of band structure as well as thermionic properties are being taken.

9.57

National Bureau of Standards, Washington, D. C.
EVALUATION TECHNIQUES FOR THERMOELECTRIC AND ELECTROLUMINESCENT MATERIALS, G. Harman. Project 5621(802A), Contract CSO and A-60-601; CRRC, AFCRL.

The objectives of this research are to study the electroluminescent and thermoelectric properties of silicon carbide and to develop improved techniques for making these measurements.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

9.58

New York U., N.Y.
ELECTRICAL PROPERTIES OF ALLOYS AND SEMICONDUCTORS, I. Cadoff. Project 6694(750F), Contract AF 19(604)-8076; ERZA, AFCRL.

Work is directed toward the preparation of new thermoelectric generating materials and is mainly concerned with the problems of fabrication of doped semi-conductor domains and their stability under conditions of severe thermal stress. The experimental program includes the preparation of hot junction contacts, a study of thermal diffusion processes and rates of contact deterioration as a function of various ambient conditions.

9.59

Ohio State U. Research Foundation, Columbus.
EFFECTS OF TEMPERATURE AND MAGNETIC FIELDS ON ELECTRICAL RESISTIVITY, P. M. Harris. Project 7031 (803A), Contract AF 33(616)-5986; ASRMM, ASD.

The contractor shall investigate the phenomena causing changes in resistivity with phase transitions in materials. The required changes in total heat and in temperature to effect such transitions will be determined. The effects of magnetic fields and electromagnetic radiation will be determined. Measurements will be made of Hall constant, mobility, and resistivity in the neighborhood of transition temperatures. Present efforts will be concentrated on, though not restricted to, the sulphide, telluride, and selenide of silver and to vanadium oxides. The reversal of the sign of the Hall constant previously observed at about 80° K for silver telluride will be further investigated to determine the cause.

9.60

Ohio State U. Research Foundation, Columbus.
PHYSICAL ELECTRONICS AT MILLIMETER WAVELENGTHS, M. O. Thurston. Project 4150(803A), Contract AF 33(616)-6435; ASRM, ASD.

Theoretical and experimental work on the behavior of silicon at millimeter wavelengths has continued. Studied particularly is the interaction with specifically doped silicon of the Cherenkov radiation, resulting from an electron beam passing over a suitable dielectric.

9.61

Ohio State U. Research Foundation, Columbus.
SPECIAL SEMICONDUCTOR PHENOMENON, M. O. Thurston. Project 7220(805A), Contract AF 33(616)-8384; MSRB, AMRL.

To discover why certain transistors produce input impedances in the range of 10^9 ohms while other transistors of the same type and from the same firm operate within given specifications.

9.62

Ohio State U. Research Foundation, Columbus.
RF SPECTROSCOPY AND PARAMAGNETIC RESONANCE, D. Williams. Project 9768(803A), Contract AF 49 (638)-745; SRPP, AFOSR.

Microwave and magnetic resonance spectra of materials are being studied and new methods and techniques developed. A study of resonance in crystalline solids is being conducted and those having possibilities as maser type devices are being thoroughly investigated. The theory of resonance and the parameters which affect it is being studied concurrently to obtain a better understanding of the basic physical processes involved.

9.63

Oklahoma A. and M. Coll., Stillwater.
SEMICONDUCTING PROPERTIES OF TYPE IIb DIAMONDS, W. V. Leivo. Project 9763(802A), Contract AF 18(603)-40; SRPb, AFOSR.

The present research is directed toward achievement of a basic understanding of the electronic properties of diamonds through study of natural type IIb and attempts to synthesize this type from ordinary diamonds. The following research is being performed: (1) determination of rectification at the junction of various metals with the diamond and comparison with theoretical rectification equations; (2) study of the absorption spectrum of the diamond; (3) study of the phosphorescent and thermoluminescent properties of diamond; (4) measurement of Hall effect as a function of temperature to determine activation energy of the carriers; (5) measurement of photoconductivity and comparison with activation energy; (6) determination, if possible, of carrier drift mobility; and (7) study of photovoltaic effect and carrier lifetime.

9.64

Oxford U. (Gt. Brit.).
MAGNETIC PROPERTIES OF RARE EARTH AND TRANSITION GROUP IONS, W. P. Wolf, B. Bleaney. Project 5621 (802A), Contract AF 61(052)-125; CRRC, AFCRL.

The objective of this contract is to conduct research work on the properties of rare earth and transition group ions and their interactions in materials with selected structures of importance for microwave applications, and to establish correlations between the structure and the behavior of the magnetically active ions.

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CRRD- Electromagnetic Radiation Lab
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9.65

Pennsylvania State U., University Park.
FIELD INDUCED REACTIONS, E. W. Mueller. Project 6694(750W), Contract AF 19(604)-8336; CRZA, AFCRL.

The objectives of the work are twofold: (1) to perform studies on field-induced chemical surface reactions, (2) to make a survey of composite surface field emitters by means of field emission microscopy.

9.66

Pennsylvania U., Philadelphia.
SELECTED SOLID STATE PHENOMENA, M. E. Caspari. Project 4150(803A), Contract AF 33(616)-6640; ASRMM, ASD.

The objective of this program is to gain a more fundamental understanding of the mechanisms by which atomic and molecular composition and structure influence the microscopic electric and magnetic properties of materials which are of interest in molecular electronics. The following problems are being investigated: (1) the mechanisms of hyperfine magnetic interactions of rare earth elements in dilute metal alloys and compounds using an advanced Mossbauer technique, gamma-gamma angular correlation, and nuclear magnetic resonance; (2) the mechanisms of the polarization of conduction electrons by incomplete electronic shells of paramagnetic ions or other atoms incorporated into a diamagnetic lattice; (3) the mechanisms of the magnetization process in thin films of ferromagnetic materials will be investigated by ferromagnetic resonance experiments using a modified electron spin resonance spectrometer; (4) mechanisms of paramagnetic resonance of rare earth ions in various host lattices as functions of temperature using the electron spin resonance spectrometer.

9.67

Pennsylvania U., Pa.
PROPERTIES OF SINGLE CRYSTAL GERMANIUM SURFACES, M. Green. Project 9761(802A), Grant AF-AFOSR-62-155; SRPS, AFOSR.

Studies will be conducted on the surface states which are intrinsic to pure germanium surfaces, which arise from imperfections, and which arise from adsorbate species. Clean surfaces will be prepared by heating in vacuum, and surface resistivity and contact potential changes with illumination will be measured. Adsorption will be studied by measuring pressure changes in temporarily-isolated small volume systems.

9.68

Polytechnic Inst. of Brooklyn, N. Y.
EFFECTS OF PHASE TRANSFORMATIONS ON THE PROPERTIES OF SOLIDS, E. Banks, B. Post. Project 9760(802A), Contract AF 49(638)-827; SRPS, AFOSR.

Materials such as low alkali bronzes of hexagonal or tetragonal structure, the transition metallic silicides and germanides including rare earths and the ordering effects of substituting aluminum and antimony for silicon and germanium will be studied from the viewpoint of their effects on the electricalresistivity of the material. Phase transformations in single crystals of alkali halides such as cesium chlorids will be investigated also. In general, emphasis will be given to the interpretation of the relationships between the mechanisms of the atomic transformations to the accompanying changes in the electrical, optical and thermal properties of the crystalline substance.

9.69

Purdue U., Lafayette, Inc.
OXIDATION AND STOICHIOMETRY OF PRASEODYMIUM AND CERIUM OXIDES, A. F. Clifford. Project 9760 (802A), Contract AF 18(538)-45; SRPS, AFOSR.

This research is concerned with: (1) a careful correlation between the thermoelectric power and the stoichiometry of praseodymium and cerium oxides; (2) the determination of magnetic susceptibility of these oxides as a function of composition to obtain information concerning the electronic properties in non-stoichiometric crystals; (3) the determination of dielectric loss in the above compounds to complement the studies (1) and (2); and (4) a study of the solid state kinetics by which some of the rare earth nitrates convert to rare earth oxides upon heating.

9.70

Remington Rand Univac Div., Sperry Rand Corp., Philadelphia, Pa.
THIN FERROMAGNETIC FILMS, T. Bonn, E. Kostroff. Project 5633(803A), Contract AF 19(604)-4978; CRRB, AFCRL.

This contract is concerned with research on the physical, chemical and magnetic properties of thin ferromagnetic films with special regard to such films that can be used for information storage in digital computers. The physical phenomena occurring in the magnetization of such film, as well as factors influencing their properties, e.g., the methods and conditions of deposition, nature of the substrate, etc., are being investigated. Properties measured are: $B_r/B_m, H_c$, switching time, and anisotropy.

9.71

Rochester U., N. Y.
OPTICAL AND ELECTRICAL PROPERTIES OF SOLIDS, D. L. Dexter, Project 9761(802A), Contract AF 49(638)-433; SRPS, AFOSR.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARB- Thermomechanics Research Lab
ARA- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARE- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMM- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESWR- Operational Applications Lab

This research may be described broadly as an experimental investigation of those phenomena, for example, photoconductivity and luminescence, associated with the electronic transfer of energy in ionic crystals. The questions of particular interest include the nature of the optical excitation processes, the mechanism of energy transfer, and the role of the simpler kinds of lattice imperfections. The experimental work will consist of such measurements as the spectral dependence of optical absorption and of excitation and quenching of photoconductivity and luminescence; temperature dependence of thermal charge release, of infrared quenching of photoconductivity, and of "fundamental" optical absorption, effects of imperfections introduced by irradiation, annealing, cold work, or addition of impurities; excitation and emission spectra of "fundamental" luminescence; study of the role of intergrain potential barriers in the mechanism of photoconductivity; and a study of hole excitation in photoconducting crystals. These studies will be performed primarily on single crystals of the alkali halides, and such others as the silver halides and CdS and PbS.

9.72

Rutgers U., New Brunswick, N. J.
INTERACTION OF CHARGE CARRIERS WITH THE CRYSTAL LATTICE, G. M. Rothberg. Project 9763(802A), Contract AF 49(638)-1018; SRPS, AFOSR.

It is proposed to study the effect of the phonon-drag upon the thermoelectric power as a function of temperature and pressure over the range from room temperature to liquid helium temperatures and from one atmosphere of pressure to at least two thousand atmospheres, and possibly higher. Additional information on atom-lattice coupling will be sought using the Mossbauer effect to follow the superconducting phase transition in suitable materials.

9.73

St. John's U., Jamaica, N. Y.
MAGNETIC PROPERTIES OF SOLIDS, H. A. Brown. Project 9760(802A), Grant AF-AFOSR-61-20; SRPS, AFOSR.

Using a classical spin approximation, calculations will be made to define the limitations of the semi-classical model now available and to indicate the directions in which improvements could be usefully made. Calculations of the susceptibilities for ferro and antiferromagnetics, the field dependence of the transition temperatures and the magnetic contribution to the specific heats will be made and interpreted. The series expansion method will be extended to include the ferrimagnetic spinels and garnets and the next-nearest - neighbor interactions for ferro and antiferromagnetics. In the ferromagnetics consideration will be given to the effects of distribution of the magnetic species. In the case of the antiferromagnetics a modification of the approach will be sought in an attempt to distinguish, more satisfactorily than the current semi-classical model allows, between the ferro and antiferromagnetic conditions. Finally an evaluation of the non-zero susceptibility will be attempted.

9.74

Technion Research and Development (Israel).
INFLUENCE OF COLD WORK ON THE MAGNETO-RESISTANCE EFFECT OF PURE FERROMAGNETIC METALS, A. A. Hirsch. Project 9760(802A), Contract AF 61(052)-81; SRPS, AFOSR.

The mechanism of the influence of cold work on the magnetoresistance effect in pure ferromagnetic metals will be theoretically and experimentally studied. It is expected that the cold work changes drastically the uniaxial magnetic anisotropies due to internal stresses, domain shape and interactions between domains.

9.75

Washington U., Seattle.
MAGNETIC INTERACTIONS IN SOLIDS, J. G. Dash. Project 9760(802A), Contract AF 49(638)-1004; SRPS, AFOSR.

Research will be conducted on the hyperfine magnetic field interactions on nuclei in ferrimagnetic crystals. Emphasis will be applied to questions of the relationships between the hyperfine fields and the saturation magnetization and of the influence of dilute magnetic impurities in the lattices. The methods of low temperature physics such as specific heats at very low temperatures, nuclear magnetic resonance or Mossbauer Effect (recoiless emission or absorption of gamma rays by isotopes of the same chemical constitution as the solid under study or by suitable isotopes used to "dope" the lattice) will be used. Specific emphasis will be applied to solids exhibiting "strong" magnetic properties; ferro- and ferrimagnets, and where possible, correlations will be made between the hyperfine and domain magnetic fields. The hyperfine fields of Co^{57} and Fe^{57} nuclei ir a single crystal of hexagonal cobalt metal. The results of such an investigation would be expected to include magnitudes and directions of the fields, anisotropies relative to the crystal axes, and depolarization effects of the K-electron capture decay of Co^{57}.

9.76

Washington U., St. Louis, Mo.

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AFCRL- Air Force Cambridge Research Laboratories
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CREB- Computer & Mathematical Sciences Lab
CREC- Electronic Material Sciences Lab
CRED- Electromagnetic Radiation Lab
CREI- Astrosurveillance Sciences Lab
CREK- Propagation Sciences Lab
CREM- Communications Sciences Lab
CREE- Control Sciences Lab
CRI- Geophysics Research Directorate
CRIA- Photochemistry Lab
CRIC- Thermal Radiation Lab
CRIR- Research Instrumentation Lab
CRIG- Terrestrial Sciences Lab
CRIH- Meteorological Research Lab
CRII- Ionospheric Physics Lab
CRIR- Sacramento Peak Observatory

EMISSION PROCESSES, R. N. Varney. Project 6694(750F), Contract AF 19(604)-8435; CRZA, AFCRL.

Studies are being performed on ionic charging of surfaces and the resultant field emission of electrons by the high local fields near the ions. Various types of surfaces, which varied both as to composition and to coating, are used as emitters under varying experimental conditions.

9.77

Wayne State U., Detroit, Mich.
ULTRASONIC ATTENUATION IN METALS, H. V. Bohm. Project 9760(802A), Contract AF 49(638)-832; SRPS, AFOSR.

The purpose of this investigation is to gain a further understanding of some of the fundamental properties of metals, in particular a further understanding of the nature of ultrasonic attenuation in superconducting metals. Specifically, magnetoacoustic phenomena in aluminum, lithium, sodium, and other metals is being investigated. Studies include temperature dependency of magnetoacoustic effects and the superconducting transition in metals. The research is directed toward a further experimental exploration of the theory of superconductors as proposed by Bardeen, Cooper and Schrieffer.

9.78

Wentworth Inst., Boston, Mass.
ELECTRONIC PROPERTIES OF SEMICONDUCTOR & PARAMAGNETIC MATERIALS, M. J. Davin. Project 5621(802A), Contract AF 19(604)-8021; CRRC, AFCRL.

Investigate the preparation of and measure physical properties of semiconductor crystals as a function of crystalline orientation, mechanical stress, and temperature. The physical properties to be examined include thermomagnetic, thermoelectric, piezoelectric, and optical properties. Investigate the preparation and measure the properties of solid state materials of interest to the field of paramagnetic resonance.

9.79

Western Reserve U., Cleveland, Ohio.
CONTACT POTENTIAL OF SEMICONDUCTING COMPOUNDS, S. Machlup. Project 9761(802A), Grant AF-AFOSR-62-223; SRPS, AFOSR.

This program will use the Kelvin method of measuring contact potential as a function of ambient gases and illumination to study the species of surfaces states in the II-VI materials. The following variables will be studied to determine their effect on the contact potential: (1) bulk resistivity (doping), (2) surface history, (3) surface ambient (gas atmosphere), (4) temperature, and (5) illumination (spectrum & intensity).

9.80

Westinghouse Electric Corp., Pittsburgh, Pa.
THERMAL CONDUCTIVITY AND THERMOELECTRIC POWER OF SOLIDS AT LOW TEMPERATURES, P. G. Klemens. Project 9760(802A), Contract AF 49(638)-1165; SRPS, AFOSR.

Two separate investigations in the field of low temperature thermal conductivity and thermoelectric power of solids will be carried out (1) the measurement of the thermal conductivity, electrical conductivity and thermoelectric power of alloys over a wide range of temperatures from 2°K up, in order to study the lattice components of the thermal conductivity and of the thermoelectric power, to intercompare these quantities, and to relate them to the electronic band structure of these alloys and to the imperfection of their crystal lattice; and (2) measurement of the thermal conductivity or the thermal diffusivity of a number of non-crystalline solids in the temperature range of 2°K to about 90°K, in order to test the theory of thermal conductivity of these solids, and to deduce information about long-range correlations in their structure.

9.81

Wheeler and Wheeler Associates, Brandford, Conn.
CRYOGENICS AND MAGNETO OPTICS, R. G. Wheeler. Project 7885(802A), Contract AF 33(616)-8314; ARX, ARL.

This contract requires the design and assembly of a special system for performing research at temperatures in the neighborhood of 0°K. The contractor shall then perform various studies utilizing this equipment. These studies include the Zeeman splitting of emission lines of cadmium sulfide at liquid helium temperatures, measurement of the magnetic susceptibilities of cadmium sulfide and zinc sulfide at low temperatures, and other low temperature experiments approved by the contract monitor. The results are to be analysed for their implications with respect to extant theories of the solid state.

See also: 1.53, 2.21, 2.54-55, 2.61, 2.67, 2.70, 3.5-6, 3.16, 3.26, 3.67, 3.73-74, 3.94, 3.103, 4.21, 5.1, 5.4, 5.16, 5.19, 5.53, 6.12, 6.25, 6.32, 6.36, 6.84, 6.86, 6.89-90, 6.95, 6.109, 7.14, 7.25, 7.31, 7.40, 8.20, 8.34, 8.41, 10.19, 11.47, 11.51, 11.108, 12.51, 12.70, 12.73, 12.80, 12.120, 12.123, 12.126, 14.11, 14.16, 14.64, 14.107-108, 16.46, 18.54, 23.86-87, 24.35

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ARH- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
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ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
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- CRRI- Astrosurveillance Sciences Lab
- CRRK- Propagation Sciences Lab
- CRRS- Communications Sciences Lab
- CRRE- Control Sciences Lab

CRE- Geophysics Research Directorate
- CREA- Photochemistry Lab
- CREC- Thermal Radiation Lab
- CREE- Research Instrumentation Lab
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10. ELECTRIC DEVICES AND NETWORKS

Electric and Electronic Devices; Tunnel Diodes; Electric Networks; Microwave Networks; Active Networks; Probabilistic Networks; Combinational Networks.

10.1

Advanced Studies Office, RADC, RAOR, Rome, N. Y.
NEURON NETWORKS, I. Gabelman. Project 8505(803A), Internal.

Synthesis procedures for combinatorial circuits using majority decision elements will be investigated for the case when there are certain restrictions on the number of input variables per MD element. Sequential circuit aspects of networks containing MD elements will be investigated for the case where there is memory associated with the coupled numbers.

10.2

Case Inst. of Tech., Cleveland, Ohio.
TOPICS IN NETWORK THEORY AND IN ANISOTROPIC DIELECTRIC MEDIA, R. E. Collin, R. Hazony. Project 5635(803A), Contract AF 19(604)-3887; CERD, AFCRL.

Generalized synthesis procedures which include the Bruna, Darlington, and Bott-Duffin procedures. One-half of the effort under this contract is devoted to a basic study of anisotropic properties of artificial dielectric media.

10.3

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
ELECTRONIC INSTRUMENTATION FOR COMMUNICATIONS, S. Ayer. Project 4645(760E), Internal.

This will include special electronic devices and circuits to provide modulation, demodulation, data processing, control, sensing, and tracking in communication schemes involving optical emissions. Material properties at these frequencies will be studied for novel approaches to the above functions.

10.4

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
RELIABLE CIRCUIT TECHNIQUES, S. Ayer. Project 4645 (760E), Internal.

This will include investigation of all forms of integrated type circuit techniques to determine reliability criteria and possible failure mechanisms. Materials and techniques will be studied in an attempt to improve capabilities for the simple fabrication of integrated circuits which will be highly resistant to environmental influences. One approach is chemical etching of multilayer preformed module plates.

10.5

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
HIGH FREQUENCY SEMICONDUCTOR CAPABILITIES, R. A. Bradbury. Project 4645(760E), Internal.

Investigation of semiconductor devices for generation of high frequencies at relatively high power by transistors and combinations of transistors, tunnel diodes, and parametric diodes as frequency multipliers and dividers. Includes studies of gain, bandwidth, stability and noise factor at frequencies up to millimeter waves. Fast pulse generation is also considered.

10.6

Communications Sciences Lab., CRRI, AFCRL, Bedford, Mass.
CIRCUIT NETWORK THEORY, K. Haase. Project 5628 (803A), Internal.

An objective of this effort is to systematize and simplify the synthesis of circuit networks according to the methods of modern network theory due to Darlington. It is desirable for the network design engineer to have available means for finding all equivalent networks which will realize a particular transfer function so that he may select the one most suitable for his application.

10.7

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
SELF-SYNCHRONIZING MULTIPLE-STATE RECEIVER, R. Massa. Project 5628(803A), Internal.

In order to obviate the need for code generator synchronization in secure communications a logical design for a receiver which alters its state dependent

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on the incoming information will be attempted. The object is to allow multiple station intermittent operation without extensive net presynchronization. Initial work will center on flow-graph representation of such a receiver and derivation of expressions for the output error-rate as a function of the input error-rate, and for lock-in time as a function of number of receiver states, interconnections and error-rate. It is anticipated that the techniques of sequential analysis will be applicable both to the particular problems that arise and to providing theoretical bounds on operation.

10.8

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
AVALANCHE TYPE SEMICONDUCTOR DEVICES AND APPLICATIONS, C. M. Stickley. Project 4645(760E), Internal.

Theoretical and experimental investigation of high current mode transistor operation, tunnel diodes, multilayer diodes, and other negative resistance devices. The goal is thorough understanding of the phenomena in order to obtain better design characteristics for these devices and circuits in which they may be used.

10.9

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
ADVANCED CIRCUIT COMPLEXES, M. E. Brooking. Project 4645(760E), Internal.

Determination and study of circuit complexes with promising functional characteristics. Support of analytic and programming efforts and contract monitoring.

10.10

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
NON-LINEAR PHENOMENA AND DEVICE CONCEPTS, M. E. Brooking. Project 5632(803A), Internal.

Studies in the field of non-linear phenomena and device concepts to evaluate their applicability to data processing and their fundamental limitations in such an environment; also experimentation with and testing of contractor and in-house developed device models. Also included is the investigation of network theoretical aspects of novel concepts and their impact on the logic organization of data processing systems. At present work is underway to expand the present measurement facilities to accommodate high-speed, high-current pulse measurements for thin magnetic film work.

10.11

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
THRESHOLD NETS, R. H. Urbano. Project 5632(803A), Internal.

To investigate efficient economical methods of synthesizing networks containing threshold elements and other types of elements with those states which can be externally controlled. To use the relatively large number of parameters inherent in such elements to construct networks capable of realizing a large number of input-output functions by adaptation and learning techniques.

10.12

Directorate of Engineering, RAS, RADC, Rome, N.Y.
DISTRIBUTED DIELECTRIC TRANSMISSION LINES, D. Kenneally. Project 8505(803A), Internal.

An extension of work concerning the use of suitable mathematical methods from variational calculus in the synthesis of non-uniform transmission line sections with prescribed performance. An analysis approach led theoretically to a taper design exhibiting considerable improvements over conventional tapers. This design is presently being experimentally evaluated.

10.13

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
GEOMETRIC-ANALYTIC THEORY OF MICROWAVE NETWORKS, E. F. Bolinder. Project 5635(803A), Internal.

Attempt to create a generalized geometric analytic network theory based on a study of the invariant properties of n-port networks. Analysis and synthesis of n-port networks in stationary and transient cases. Noisy networks.

10.14

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
NONLINEAR COUPLED OSCILLATORS, E. M. Dewan. Project 5635(803A), Internal.

Coupled nonlinear oscillators, apart from their intrinsic interest, are important in the operation of sophisticated computer networks. The presence and effects of certain disrhythmic elements and hypersynchronisms will be investigated. On the basis of this a theory of epilepsies will be presented.

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CRSI- Ionospheric Physics Lab
CRSR- Sacramento Peak Observatory

10.15

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
TRANSMISSION LINE NETWORKS, E. J. Post. Project 5635 (803A), Internal.

The aim of this work is a generalized study of amplitude and phase response of transmission lines with special emphasis on structures with low distortion. Special attention will be given to the physical compatibility of the amplitude and phase functions as expressed by the Hilbert transform relation.

10.16

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
ELECTRON TUBE MATERIALS STUDY, J. H. Bloom. Project 4619(760E), Internal.

An in-house study of some of the interesting and unique properties of a bulk getter material. The objective of this study was to get scientific data on its vacuum properties and its ability to pump gases over a very large range of temperatures.

10.17

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
INTEGRATED CIRCUITRY TECHNIQUES, R. P. Dolan. Project 4608(760E), Internal.

The successful epitaxial growth of semiconductor layers by gaseous decomposition has made feasible the design and construction of device configurations which were previously considered impractical or impossible of attainment. Fabrication techniques such as precise photo etching, formation of shallow alloy contacts, and the thermo compression bonding of lead wires to ohmic and alloy contacts are being developed in order to utilize the unique properties of these epitaxial layers in these new devices.

10.18

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
SURFACE PASSIVATION, R. P. Dolan. Project 4608(760E), Internal.

There is great promise at the present time of significant advances in integrated solid circuits through the application of a variety of new techniques. The final success, however, will depend on the protection of the transistors and diodes against dispurities in the local ambient, which tend to collect on the device surface, from shorting paths across the junctions. On silicon devices, a tightly bonded oxide protective layer 2500 Å thick was formed at 1100°C. An attempt is being made to lower the formation temperature of the protective layer to below the Si-Al eutectic temperature of 577°C.

10.19

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
TUNNEL DIODE STUDIES, F. D. Shepherd, A. C. Yang. Project 4608(760E), Internal.

Tunnel diodes made from GaAs, Si and Ge are being studied in detail in order to understand the tunneling mechanism and the IV characteristics of the diodes quantitatively. On the theory side, a more complete band model for degenerate material is proposed with the necessary calculations being carried out. Experimentally, temperature dependence of the IV characteristics and circuit parameters such as junction capacitance, series resistance of the diode are being measured. We will compare these measurements with parameters calculated using the proposed band model. Techniques of fabrication of tunnel diodes are also being investigated with emphasis on using Si as the matrix material.

10.20

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
TUNNEL EMITTER TRANSISTOR, F. Shepherd. Project 5621(804A), Internal.

It is the objective of this research to theoretically and experimentally investigate a new device concept invented in this laboratory. This device, called a tunnel emitter transistor, has the following properties: (a) current gain greater than unity with no loss in voltage gain; (b) control over input impedance for better matching; (c) the choice of zero or 180 degree phase shift between input and output signals. Experimental circuits have demonstrated these properties using separate tunnel diodes and transistors. Techniques for fabrication of this new device and its design parameters are almost ready for trial.

10.21

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
ELECTRON DYNAMICS AND GASEOUS ELECTRONICS, R. L. Taylor. Project 4619(760E), Internal.

Several experiments are underway in an effort to utilize various plasma properties in possible device oriented applications. These efforts include: (1) Investigation of plasma afterglow quenching as a

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detector of microwave energy; and (2) exploration of electron dynamics in high pressure, rare gas systems under the influence of magnetic fields. Operating as a video detector this device is sensitive to 1 milliwatt peak power at S-band. Future work will be directed towards enhancing the sensitivity. Measurements are currently being made to determine E versus I curves with various magnetic fields in high pressure rare gas discharges.

10.22

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
TUNNEL TRIODE RESEARCH, A. Yang. Project 5621(802A), Internal.

The objective of this new work is to investigate the possibilities and limitations of tunnel triodes. No substantial success has yet been reported on this class of device which requires metal-metal oxide sandwich constructions with thickness dimension of the order of 30-100 Å. Both theoretical understanding of the mechanisms of conduction in such thin films and adequate fabrication techniques must be developed to evaluate this class of device.

10.23

Electronics Technology Lab., ASRNE, ASD. Dayton, Ohio.
ACTIVE NETWORK STUDIES, G. R. Branner. Project 7031 (803A), Internal.

Expand and improve present synthesis procedures in active network theory. Develop new synthesis techniques using conventional active and passive elements. Devise synthesis strategies employing, where possible new elements that have been conjectured by the network theorist, or developed by the solid state device engineer. Utilize modern mathematical concepts in the development of the theory. With an understanding of solid state phenomena and effects, attempt to construct network synthesis procedures motivated totally by the utilization of phenomena possessed by various solid state devices. Attempt to formulate new synthesis techniques which optimize the use of solid state phenomena.

10.24

General Electric Co., Schenectady, N. Y.
APPLICATIONS OF TUNNELING TO ACTIVE DIODES, R. Hall, N. Holonyak. Project 4608(760E), Contract AF 19(604)-6623; CRRC, AFCRL.

The purpose of this work is to obtain a basic understanding of the physical processes involved in tunnel diodes and to establish the material parameters of semiconductors which can be used for making tunnel diodes. Electrical measurements are being made of the properties of semiconductors which are crystallized from impurity-rich solutions.

10.25

General Electric Co., Schenectady, N. Y.
DEVELOPMENT OF CERAMIC BODIES FOR ELECTRON TUBES; H. R. Wisely. Project 4619(760E), Contract AF 19(604)-7410; CRRC, AFCRL.

The object of this program is to develop a series of ceramics with widely varying physical and electrical properties to be used for electronic applications. The proposed efforts will deal with a systematic investigation of ceramic compositions necessary to produce ceramic bodies with high temperature stability, wide range thermal expansion characteristics, and improved mechanical and electrical properties.

10.26

Illinois U., Urbana.
TRANSISTOR RC NETWORK STUDIES, M. E. Van Valkenburg. Project 9768(803A), Grant AF-AFOSR-62-126; SRPP, AFOSR.

This research covers active network synthesis, with attention to network theory involved in complicated active networks which include transistor-RC combinations and require computational facilities for solution. Included are idealized active networks and investigations of new amplifier configurations using transistors, and of active element networks such as will be equivalent to an actual transistor amplifier. The broad areas being covered include: realization methods for active networks (synthesis of transistor-RC networks); studies in sensitivity of active networks; time-varying synthesis methods (of use in adaptive systems and parametric devices); approximation problems; and switching circuit synthesis.

10.27

International Business Machines Corp., Yorktown Heights, N. Y.
NON-LINEAR CIRCUITS, H. Cohen. Project 9769(803A), Contract AF 49(638)-1139; SRMA, AFOSR.

This research consists of the study of bistable systems, to include the application of the potential function of J. Moser, a perturbation analysis of bistable systems, study of multiple limit cycles, and the effect of time dependent driving functions.

10.28

Michigan U., Ann Arbor.
NONCLASSICAL CIRCUIT ANALYSIS AND SYNTHESIS, W. M. Brown. Project 7031(803A), Contract AF 33(616)-7630; ASRNE, ASD.

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CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
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Circuit theory studies concern matrix and tensor methods of network synthesis with emphasis on the theory for the construction of parameter matrices corresponding to given immittance functions. This work will be applied to one or more of the following problems: (a) synthesis of active networks; (b) transformerless synthesis of transfer impedance; (c) minimal element synthesis; and (d) synthesis with constraints such as fixed input and output capacitance. Also concerned are theory and application of quasi time invariant circuits, and theory of the exact synthesis with continuously distributed parameter components. Information processing concerns: (1) a survey of the role of information, optimum filtering, and detection theories in the analysis and optimization of information processing systems will be made; (2) optimization and performance limitations of systems which include multi-element phased array antennas will be studied in terms of the model mentioned above; (This study is expected to lead to new insight for information processing systems which involve large transmitting and receiving antennas);(3) two-dimensional processing systems which are discrete in one dimension and continuous in the other will be studied; and (4) optimum processing for information rate, resolution, and parameter (specifically position on the t-axis) estimation will be compared.

10.29

Microwave Lab., Stanford U., California.
HIGH POWER MICROWAVE CONCEPTS, M. Chodorow. Project 4619(760E), Contract AF 19(604)-1930, CRRC, AFCRL.

The objective is to investigate the generation, amplification and detection of radiation in the microwave region with emphasis on plasma physics aspects. Major efforts are in velocity-modulated electron beams in long gaps, electron beam parametric amplifier, crossed field electron guns, electrostatic beam-type parametric amplifier, electron beam interaction with a plasma, plasma parametric amplifier, ferrite nonlinear resonance, and ferrite frequency multiplication.

10.30

Montana State Coll., Bozeman.
THEORY OF GENERALIZED MULTIPLE-OUTPUT BINARY COMBINATIONAL NETWORKS, W. L. Kilmer. Project 5632(803A), Contract AF 19(604)-6619; CRRS, AFCRL.

A study of the properties of networks composed of a number of identical cells, each cell receiving inputs from adjacent cells and from outside the circuit and giving outputs to adjacent cells and to the external world. It has been found that such circuits may exhibit memory with suitable definitions of basic cells and if the network has a sufficient number of these basic cells.

10.31

New York U., N. Y.
MATHEMATICAL REALIZATION OF NETWORK MODELS, M. S. Ghausi. Project 7031(803A), Contract AF 33(657)-8817; ASRMT, ASD.

It is the ultimate objective of this work to make available the theory which will lead to the realization of the gyrator as another element for the circuit designer. Shekel has shown that a nonreciprocal two port admittance matrix can be divided into symmetric and skew symmetric components. The skew symmetric matrix is the same as that of a gyrator; therefore, if cancellation of the symmetric matrix can be effected, the resultant network will have the properties of a gyrator. This contractual effort will investigate the cancellation of the symmetric part by utilizing tunnel diode or transistor negative impedance converters.

10.32

New York U., N. Y.
GEOMETRIC TECHNIQUES IN THE MICROWAVE FIELD, D. J. R. Stock. Project 5635(803A), Contract AF 19(604)-7486; CRRD, AFCRL.

Continuation of extension of non-Euclidean techniques towards the representation of a general n-port geometric-analytic study of the multi-mode problem. This includes extensions of the work by Daschampe and Bolinder on non-Euclidean geometric models for the representation of circuit transformations through generalized functions.

10.33

Northeastern U., Boston, Mass.
CIRCUIT APPLICATION OF TUNNEL DIODES, R. E. Scott. Project 5621(802A), Contract AF 19(604)-7271; CRRC, AFCRL.

This work has been directed toward the non-computer applications of tunnel diodes, with emphasis on amplifiers, sinusoidal oscillators, variable frequency oscillators, and super-regenerative detectors. A possibility exists for increasing the bandwidth of a tunnel-diode amplifier by means of compensating circuits. The theoretical work for the design of a broad-band amplifier has been completed and experimental work on a model which should operate out to 180 megacycles has been started.

10.34

Norwegian Defence Research Establishment, Bergen.
ACTIVE NETWORK THEORY, A. Tonning. Project 5635 (803A), Contract AF 61(052)-484; CRRD, AFCRL.

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AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESLR- Operational Applications Lab

Continuation of the study of (a) transformation theory of active networks; (b) invariant properties of active networks under various imbeddings; (3) canonic forms of active networks, and (4) particular physical realizations of active networks including a study of time invariant networks.

10.35

Polytechnic Inst. of Brooklyn, N. Y.
ELECTRIC CIRCUIT THEORY, H. Carlin. Project 8505 (803A), Contract AF 30(602)-2213; RAS, RADC.

The various areas of effort are as follows: (1) realization criteria for distributed parameter networks; (2) realization procedures for driving point and transfer immittance functions; (3) unification of microwave network theory with lumped theory; (4) formulation of known new solid state devices in terms of circuit theory; (5) incorporation of the above unconventional elements into present network theories. Modern mathematical concepts will be used in model analysis. Experimental work will be conducted to test validity of predicted performance of non-classical networks. Future work includes: (1) synthesis of more exact equivalent microwave circuits of the Esaki diode and Varactor diode; (2) conversion of the mathematical theory of performance of finite lengths of non-uniform lines with prescribed performance characteristics; (3) determine the classes of lumped and distributed parameter network functions that are realizable with negative resistances and time variable reactances added to the synthesist's conventional arsenal; (4) statistical network theory.

10.36

Polytechnic Inst. of Brooklyn, N. Y.
ELECTROMAGNETIC NETWORKS AND RELATED SOLID STATE AND PLASMA TOPICS, L. Felsen. Project 5635(803A), Contract AF 19(604)-4142; CRRD, AFCRL.

(1) Network synthesis with distributed-parameter passive and active elements. (2) Analysis of the electromagnetic characteristics of interfaces whose physical properties vary along the boundary (ionized shock fronts; modulated surface waves, etc.).

10.37

Polytechnic Inst. of Brooklyn, N. Y.
STUDIES IN ELECTROMAGNETIC NETWORKS, N. Marcuvitz. Project 5635(803A), Contract AF 19(604)-4143; CRRD, AFCRL.

Basic research will be performed in microwave network theory, including all electromagnetic phenomena of a modal nature. A new algorithm for the factorization of rational matrix functions of a complex variable has just been developed and will be applied to matrix Wiener-Hopf integral equations.

10.38

Polytechnic Inst. of Brooklyn, N. Y.
SYNTHESIS OF COMBINATIONAL NETWORKS, E. J. Smith. Project 5628(803A), Contract AF 19(604)-6620; CRRS, AFCRL.

Carries out a research program on the synthesis of combinational networks which include the following: (a) the mathematical synthesis of multi-output or multi-terminal combinational networks; (b) the mathematical synthesis of sequential networks to include a joint treatment of memory conditions and combinational component networks; (c) development of computer techniques to execute topographical procedures more effectively; (d) determination of the variables of partial symmetry in order to find the best circuit arrangement.

10.39

Radio Corp. of America, Princeton, N. J.
SEMICONDUCTOR ACTIVE DIODE AMPLIFIERS, K. K. N. Chang. Project 4645(760E), Contract AF 19(604)-4980; CRRS, AFCRL.

The contractor will perform a theoretical and experimental study of two-part semiconductor devices which will include the following: (a) examination of tunnel diode distributed circuits with emphasis on circuit stability and noise performance studies; (b) fabrication of improved frequency response tunnel diode devices; (c) study of new device configuration for controlling tunneling current in a tunnel diode; (d) study of other non-reciprocal devices to be used in conjunction with semiconductor active diodes; (e) furnish state-of-the-art samples of active diodes developed above.

10.40

Raytheon Co., Waltham, Mass.
PASSIVE SOLID STATE LIMITER, E. Schlomann. Project 5621(802A), Contract AF 19(604)-7297; CRRC, AFCRL.

The purpose of this contract is to investigate nonlinear phenomena in garnet single crystals with the intention of developing in this way a passive solid state microwave power-limiting device. The effects of greatest interest at present are those observed in the case of "parallel pumping" (dc magnetic field parallel to rf field). The occurrence of loss above a critical power level as a consequence of energy transfer to spin waves (or magnetostatic modes, depending upon the conditions) offers a possible power-limiting mechanism. The critical power depends upon the relaxation rates of the spin waves. A part of this program is devoted to the experimental study of

parallel pumping phenomena over a wide range of frequencies and temperatures. In addition to the above-described fundamental studies, working models of limiters based on this work are being evaluated.

10.41

Remington Rand Univac Div., Sperry Rand Corp., Philadelphia, Pa.
CIRCUITS RESEARCH, G. Kaskey. Project 5632(803A), Contract AF 19(604)-5189; CRR, AFCRL.

The purpose of this study is to arrive at procedures to establish mathematical models adaptable to machine computation of circuits conceived and to perform the task of optimization and assessment of probability of malfunction by machine computation.

10.42

Reza, F. M., Syracuse, N. Y.
PROBABILISTIC CIRCUIT THEORY, F. M. Reza. Project 8505(803A), Contract AF 30(602)-2582; RAWE, RADC.

Research on the properties of systems whose excitation-response relationships are statistical in nature due to statistical properties of internal elements.

10.43

Rome U., Italy.
PROPAGATION OF ELECTROMAGNETIC WAVES IN GUIDES LOADED WITH MAGNETIZED FERRITES, G. Barsilai. Project 5635 (803A), Contract AF 61(052)-101; CRRD, AFCRL.

Directed toward a better understanding of the characteristics of ferrite loaded wave guides, an intensive study of the field configurations, propagation constants, and cut-off conditions for modes existing in rectangular waveguides filled and partially filled with magnetized ferrites is the objective of this contract. After an extensive theoretical and experimental analysis of the case of a transversely magnetized guide, the longitudinally magnetized configuration, including conjugate modes, is presently being studied and supporting experiments are under performance. It is anticipated that this analysis will be extended to plasma filled waveguides.

10.44

Royal Inst. of Tech., Sweden.
AMPLIFICATION AND GENERATION OF SIGNALS IN ELECTRIC CIRCUITS, P. H. Laine. Project 5628(803A), Grant AF-EOAR-61-43; CRRS, AFCRL.

Conduct a theoretical investigation to see to what extent complex H-transformations can be used in the solution of active and passive networks.

10.45

Seshu, D., Syracuse, N. Y.
SELECTED TOPICS IN SEQUENTIAL CIRCUIT THEORY, D. Seshu. Project 8505(803A), Contract AF 30(602)-2294; RAW, RADC.

Four topics have been selected for study. These include: (1) characterization of circuit properties of an interesting class of networks. The characterization property sought for has properties analogous to those of convolution and impulsive response of continuous linear systems; (2) discovery of compact techniques of analysis of systems mixed in the sense that they contain both continuous and discrete elements; (3) probabilistic nets; and (4) sequential circuits with noisy inputs.

10.46

Stanford Research Inst., Menlo Park, Calif.
APPLICATION OF ELECTRON BEAM MACHINING TECHNIQUES TO SEMICONDUCTORS, K. Shoulders. Project 4608(760E), Contract AF 19(604)-6114; CRRC, AFCRL.

The research objectives of this program are (1) to design, develop, and fabricate a high resolution electron optical system that will incorporate the features of a scanning electron microscope, an X-ray fluorescence probe, and an electron mirror microscope, which are necessary for micromachining, geometrical and chemical analysis, and measurement of electrical characteristics of microelectronic structures, and (2) to apply electron-beam activated machining techniques to silicon and silicon carbide with the aim of determining the reproducibility for fabricating microscopic connections to active areas.

10.47

Stanford U., Calif.
STUDIES OF THE HIGH POWER KLYSTRON AND ASSOCIATED CIRCUITS, E. Ginston, M. Chodorow. Project 4751 (803A), Contract NONR 225(48); SRPP, AFOSR.

This research is concerned primarily with the study of high power microwave tubes of the klystron and related types and their use in connection with radar countermeasures, and with linear accelerating devices.

10.48

Syracuse U. Research Inst., N. Y.
TIME RESPONSE CHARACTERISTICS OF LINEAR NETWORKS AND TRANSFORMATION METHODS IN NETWORK SYNTHESIS, N. Balabanian. Project 5632(803A), Contract AF 19(604)-6142; CRRS, AFCRL.

Study the characteristic properties of time functions to be used as impulse response functions of time

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARA- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAGR- Advanced Studies Office
RAS- Directorate of Engineering
RAWA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
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domain networks to find rules for the possibility of realization and classification of those networks. Study the possibilities of transforming a given network into other configurations. These problems include the following: (a) specific properties of network response correlated to network classes, such as initial slope, properties of poles and zeros and time moments; (b) find useful methods to generate equivalent networks starting from either the desired network frequency function or time response or from one realization. One of the important aspects is the minimization in space and weight in ladder realization.

10.49

Technion Research and Development Foundation, (Israel).
GEOMETRIC ANALOGUE FOR CIRCUIT TRANSFORMATIONS, F. Ollendorff. Project 5635(803A), Contract AF 61(052)-551; CRRD, AFCRL.

Investigation of the feasibility of stereoscopic oscillographic representation of non-Euclidean network calculations. This will consist in the analysis of the analogue operations required for the representation of network transformations, and in the experimental check of important phases of this analysis.

10.50

Transistor Products, Inc., Boston, Mass.
STUDY, ANALYSIS, AND DESIGN OF TRANSISTOR CIRCUITS, A. W. Carlson. Project 4645(760E), Contract AF 19 (604)-4089; CRRS, AFCRL.

This includes analyses of avalanche or high current mode transistors, the application of pulse transistor circuits for linear signal amplification, and investigation of a lumped circuit, non-linear delay line using junction capacitors. This delay line is unique in that rise time is reduced progressively along the line.

See also: 2.51, 6.38, 9.35, 9.49, 11.49, 11.51, 11.60, 11.88, 11.119, 13.9, 13.14, 13.28, 13.32, 13.52, 13.62, 22.14-15, 22.145

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AFCRL- Air Force Cambridge Research Laboratories
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CRRZ- Control Sciences Lab
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11. ELECTROMAGNETIC RADIATION AND OPTICS

Antennas; Coherent Radiation; Electromagnetic Field Theory; ELF Radiation; VLF Radiation; Millimeter and Submillimeter Electromagnetic Radiation; Scattering of Electromagnetic Radiation; Diffraction of Electromagnetic Radiation; Propagation of Radio Waves in the Ionosphere; Propagation of Radio Waves in the Atmosphere; Electromagnetic Radiation Interaction with Plasmas; Optics; Optical Masers; Masers; Luminescence of Solids; Electromagnetic Radiation Interaction with Ionized Gases.

11.1

Air Technology Corp., Cambridge, Mass.
SLED OPTICAL ENTRY PROBLEMS, R. E. Clapp. Project 7856(806A), Contract AF 29(600)-3070; SRA, AFOSR.

This research is concerned with studies of optical schemes permitting a considerable reduction of refractive effects due to port contour, aero- and thermodynamic phenomena encountered during sled motion, accelerative loading and sled internal conditions. Preference was given to the analysis of conditions associated with a spherical entry port as the density field surrounding it has been explored in considerable detail. The variation of the refraction angle was determined and its minimization attempted for a variety of environmental and operational conditions. Only that portion of the wave length spectrum which is easily accessible to standard photographic techniques has been considered.

11.2

Alabama U., University.
SUBMILLIMETER RADIATION FROM RELATIVISTIC ELECTRONS, R. M. Whitehurst. Project 9767(803A), Grant AF-AFOSR-61-69; SRPP, AFOSR.

This research consists of investigation of the generation of submillimeter radiation by a bunched beam of high-energy electrons. The objective of the research will be the production of a significant amount of radiation in the submillimeter range and the study, both theoretical and experimental, of the frequency spectrum of the radiation. Use will be made of a linear electron accelerator provided by the University of Alabama.

11.3

Alaska U., College.
ARCTIC PROPAGATION, V. P. Hessler. Project 5631(803A), Contract AF 19(604)-5574; CRRK, AFCRL.

This will be a continuation of work which calls for Arctic propagation studies at ionospheric modes of propagation directed towards the improvement of communication systems. Emphasis will be placed on the Arctic ionosphere to determine its ability to support trans-polar propagation and on the influence of auroral effects on Arctic propagation. The prediction of aurora and Arctic ionospheric storms will be investigated.

11.4

American Systems, Los Angeles, Calif.
TRANSVERSE DOPPLER TECHNIQUE FOR NEAR FIELD ANTENNA PATTERN MEASUREMENTS TO OBTAIN FAR-FIELD PATTERNS, R.W. Bickmore. Project 4600(760K), Contract AF 19(604)-8362; CRRD, AFCRL.

Obtaining far-field antenna radiation patterns by direct measurement in the far field becomes increasingly difficult for large antenna apertures since the far-field region can be 10 to 250 or more miles from the aperture. By means of a transverse doppler technique using narrow band filters, whose center frequencies are swept as a function of time, together with a moving probe and suitable mixing and detection techniques it is possible to make field measurements wherein range reductions of 100 or more are possible. This investigation will continue a critical analysis of such a scheme and determine the types of apertures, aperture distribution and electronic components and procedures required to obtain far field radiation patterns of large aperture antennas.

11.5

Arkansas U., Fayetteville.
OPTICAL POLARIZATION BY ELECTRONIC IMPACT, R. Hughes. Project 9767(803A), Contract AF 49(638)-559; SRPP, AFOSR.

A high-precision spectroscopic study will be made of the variation in the polarized light emitted from atoms excited into spectral emission by electron impact at various discrete energies. Pressure and temperature dependence of the polarization maximums will also be investigated. Investigations will also be made of initial polarization at the threshold of optical excitation and of lifetimes of excited states under magnetic field depolarization. The work will then be extended to the detection of excited states of positronium from Lyman-alpha radiation and to the determination of atomic lifetimes by spatial distribution of radiation intensity in crossed electric and magnetic fields. This work program will provide improved data and models of excitation cross sections, excited state lifetimes and decay processes for gases and vapors subjected to electric discharges and electron impacts.

11.6

Astrosurveillance Sciences Lab., CRR, AFCRL, Bedford, Mass.
MHD AND EM INTERACTIONS, M. Bruce. Project 5633(803A), Internal.

This work is both theoretical and experimental in nature. It involves an extension of the existing theoretical model of electromagnetic-acoustical wave interactions in the upper atmosphere so that meaningful calculations can be made given realistic data. In particular, it involves the study of shocks and the modulation of electromagnetic waves in a magneto-ionic medium. It includes the frequency de-

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CRRE- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRI- Control Sciences Lab
CRE- Geophysics Research Directorate
CRRA- Photochemistry Lab
CRRC- Thermal Radiation Lab
CRRE- Research Instrumentation Lab
CRRG- Terrestrial Sciences Lab
CRRM- Meteorological Research Lab
CRRI- Ionospheric Physics Lab
CRRR- Sacramento Peak Observatory

pendence of the transferred modulation, the magnitude of the expected modulation, and the effects of the relative geometry.

11.7

AVCO Corp., Wilmington, Mass.
MIE SCATTERING, R. Penndorf. Project 7670(770A), Contract AF 19(604)-5743; CRZC, AFCRL.

This work is a comprehensive theoretical and analytical study of Mie scattering (i.e. large particle scattering) of infrared radiation by particles. During the past year two efforts have been completed: (a) The scattering diagrams of spherical particles possess maxima and minima which can be interpreted as sequences of bright and dark rings. These rings were investigated for refraction indices of 1.33, 1.40, 1.44 and 1.50; (b) An atlas of scattering diagrams was completed.

11.8

Block Associates, Inc., Cambridge, Mass.
ATMOSPHERIC INFRARED OPTICS, M. Block, N. Young. Project 8603(804A), Contract AF 19(604)-8062; CRZC, AFCRL.

Research directed towards problems in AFCRL infrared optics, (e.g., the measurement of the transmissivity of the atmosphere as affected by aerosols and the radiative transfer of energy within the atmosphere.)

11.9

Block Associates, Inc., Cambridge, Mass.
HIGH RESOLUTION STUDIES, M. Block. Project 7670(770A), Contract AF 19(604)-8044; CRZC, AFCRL.

The efforts of this contract include studies involving high resolution infrared absorption band studies and atmospheric scattering. The group works in close collaboration with inhouse efforts to obtain and analyze high resolution spectral data for various molecular absorption bands and data obtained by scattering of solar radiation in the earth's atmosphere. For example, recent efforts have been directed toward the development of a digital readout system and other improvements in the White spectrometer and its auxiliary equipments and the development of computer programs for carrying out the above analyses.

11.10

Boston U., Mass.
CORRELATION THEORY OF STATIONARY ELECTROMAGNETIC FIELDS, P. Roman. Project 5631 (803A), Contract AF 19(604)-8022; CRRD, AFCRL.

Extend the correlation theory of stationary electromagnetic fields by: (a) deriving higher order conservation laws; and (b) formulating a canonical basis for the correlation theory (e.g., derivation of the correlation theory from a variational principle).

11.11

Brandeis U., Waltham, Mass.
INTERACTION OF ELECTROMAGNETIC WAVES WITH PLASMAS, E. P. Gross. Project 4619(760E), Contract AF 19(604)-4553; CRRC, AFCRL.

An approach to the solution of the spatial and time-like behavior of the electric and magnetic fields in an ionized gas and the density and velocities of the gas material (or the probability distribution for the position and velocities of the particles when the gas is very thin), uses the "self-consistent field" formalism in which a "guess" solution is put into basic equations which generates a new solution, the entire process being repeated until the solutions converge to a final solution. Using this approach, the correlation between the probability distribution at one point and velocity at one time and the probability for another point, velocity and time has been used to discuss turbulence for a plasma described by such a self-consistent field. In the theory of vortices a mathematical treatment has been obtained. Hence an intensive study is now being made into vortices in plasmas. Vortices may be as important as plasma oscillations.

11.12

Brown U., Providence, R. I.
RADIATION OF ELECTROMAGNETIC WAVES, L. Wetzel. Project 5635(803A), Contract AF 19(604)-4561; CRRD, AFCRL.

Theoretical investigation of the physics of electromagnetic waves in nonhomogeneous media, such as dielectric-covered, plasma-covered, or otherwise modified surfaces of diverse shapes. The analysis of scattering and diffraction is based on mathematical techniques, such as the Schwinger-Marcuvitz formalism, variational methods, and special noise theory.

11.13

Bureau of Aeronautics, Washington, D. C.
RADIOWAVE DUCTING IN EXOSPHERE, L. Bauer. Project 5631 (803A), Contract CSO MIPR 59-719; CRRK, AFCRL.

To perform theoretical studies on the possible ducting of radio waves for very large distance propagation in the exosphere at the very low and the high frequency bands. Emphasis will be on the conditions which are required regarding the magnetic field and the electron density distribution in the ionosphere and the exosphere in order that trapping of radio waves in exospheric ducts can be sustained. In these studies a detailed analysis will be made on variations of the ionospheric and exospheric refractive index, due to the non-uniform electron-density distribution and non-uniform geomagnetic field.

11.14

California Inst. of Tech., Pasadena.
ANTENNAS, PLASMAS AND NON-LINEAR COMPONENTS, C. H. Papas.

AFL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
AFF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
AFR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARH- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARB- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMM- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAE- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

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Project 9768(803A), Contract AF 18(60 .3; SRPP, AFOSR.

The research includes: theoretical and experimental work on optimizing the bandwidth of a rod antenna by modification of its surface impedance; analysis of the transient behavior of a center-fed linear antenna by both the transform and the modal method; study of propagation properties of low-frequency electromagnetic waves traveling in an inhomogeneous gyroelectric medium; theoretical and experimental studies of propagation properties of a surface wave traveling along a metallic structure coated with a natural or artificial dielectric; magnetic guidance of electromagnetic waves; and high-frequency plasma oscillations.

11.15

California U., Berkeley.
ELECTRON PHYSICS OF TRAVELING WAVE INTERACTIONS, C. K. Birdsall, T. E. Everhart, C. Susskind, A. W. Trivelpiece, D. B. Cummins, S. Colgate. Project 4150(803A), Contract AF 33(616)-6139; ASRM, ASD.

The following topics are being investigated under this contract: (1) field analysis of fast waves in plasmas and electron beams; (2) electron-beam-parametric amplifiers; (3) interaction of a drifting electron stream with the backward-wave mode of propagation in a ferrite rod; (4) a study of space-charge waves in plasmas; (5) slow-wave circuits for millimeter wavelengths; (6) fast-wave interaction with an undulating stream; and (7) properties of high-temperature high density plasma. Theoretical work on the properties of high temperature plasma is being undertaken. The effort on microwave tubes has been decreased but still encompasses the areas outlined above.

11.16

California U., Berkeley.
BASIC RESEARCH IN MICROWAVE ELECTRONICS, J. R. Whinnery. Project 9768(803A), Contract AF 49(638)-102; SRPP, AFOSR.

Theoretical and experimental investigations in microwave electronics, with emphasis on noise studies in long electron beams, especially hollow beams, and on non-linear effects resulting from large signal excitation of the beam. The studies include beam modulation, beam current uniformity, and beam focusing. Also included are studies of solid state microwave amplifiers such as the maser, and also traveling-wave and plasma resonance types. In the maser research, investigations of new materials for possible maser application at infrared and optical frequencies are being emphasized as well as theoretical investigations of the quantum electronic aspects of optical and infrared masers.

11.17

Centro Radioelettrico Sperimentale (Italy).
BACKSCATTER STUDIES, I. Ranzi. Project 5631(803A), Contract AF 61(052)-139; CRRK, AFCRL.

High-frequency backscatter is studied at a location at which land and sea alternates with azimuth and distance. Various influences on backscatter are investigated, in particular tropospheric effects, effects of the scattering ground surface, of the vertical antenna pattern, of ionospheric disturbances, and of solar eclipses. Correlation of the backscatter data with other observational material (e.g., riometer recordings), is intended.

11.18

Chicago U., Ill.
MODE PROPERTIES OF AN OPTICAL MASER BEAM, Y. H. Pao. Project 9768(803A), Grant, AF-AFOSR 62-292; SRPP, AFOSR.

Research on the modal behavior of a coherent optical Maser beam especially as affected by the characteristics of the Maser crystal. Rare earth chelates will receive special emphasis.

11.19

Colorado U., Boulder.
ANTENNAS ON FINITE GROUND PLANES, C. T. Johnk. Project 5635(803A), Contract AF 19(604)-4556; CRRD, AFCRL.

The contract studied the general input impedance and radiation pattern characteristics of antennas mounted on a small ground plane surrounded by an imperfect earth. Extensive measurements were performed that verified theoretical work by J. Wait.

11.20

Colorado U., Boulder.
REFLECTION AND TRANSMISSION PROPERTIES OF THIN FILMS IN THE VACUUM ULTRAVIOLET REGION, W. A. Rense. Project 8627(804A), Contract AF 19(604)-5533; CRZA, AFCRL.

The research being conducted under this contract is concerned with the reflection and transmission of ultraviolet radiation by thin films. The thin films of interest are metals and dielectrics and are studied at varying angles of incidence from normal to grazing. The wave length region in which these studies are being carried out extends from 2000 A° to below 300 A°. In addition to uncovering basic scientific data concerning the reflection and transmission of ultraviolet radiation by materials, this research is conducted for the purpose of finding suitable reflective materials for use in the rocket-borne instrumentation which is used in other phases of the research under this task.

11.21

Columbia U., N.Y.
PROPAGATION OF AN E. M. FIELD IN A TURBULENT INHOMOGENEOUS MEDIUM, D. Bugnolo. Project 9768(803A), Contract AF 49(638)-350; SRPP, AFOSR.

Theoretical studies are being made of the effects of turbulence on propagation over a long line of sight path which

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CRRS- Communications Sciences Lab
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includes the ionosphere. These studies also include propagation of a pulse in a randomly inhomogeneous medium, as well as an investigation of the influence on channel capacity of turbulence in the propagation medium.

11.22

Columbia U., New York, N. Y.
INFRARED AND OPTICAL MASER RESEARCH, P. Kusch. Project 9768(803A), Grant AF-AFOSR 62-49; SRPP, AFOSR.

Work on a cesium maser is expected to produce coherent infrared radiation.

11.23

Columbia U., New York, N. Y.
MILLIMETER WAVE GENERATION CIRCUITS AND MICROWAVE SPECTROSCOPY, R. Novick. Project 4751(803A), Contract DA 36-039-sc-78330; SRPP, AFOSR.

A broad investigation of microwave physics, including infrared and optical maser studies, generation of high frequencies in the millimeter infrared and optical wavelength region, atomic hyperfine structure, and atomic and molecular properties.

11.24

Columbia U., New York, N. Y.
FERRO-ELECTRICALLY SCANNED ANTENNAS, P. Schlesinger. Project 5635(803A), Contract AF 19(604)-3879; CRRD, AFCRL.

The contract analyzed a new type of transmission line, in which the index of refraction of a dielectric wedge between two V plates is a function of radius.

11.25

Communications Sciences Lab., Bedford, Mass.
OPTICAL DEVICES AND TECHNIQUES FOR COMMUNICATIONS, R. A. Bradbury. Project 4645(760E), Internal.

This includes all phases of optical phenomena which appear to be applicable to communications technology. Initially the capabilities of the stimulated ruby emitter will be explored fully. Methods of conveying information by optical transmission links will be investigated thru studies of amplitude, frequency, and polarization control. All means of coherent optical radiation generation will be investigated.

11.26

Copenhagen U. (Denmark).
RADIATION FIELDS ASSOCIATED WITH SHORTWAVE ANTENNAS IN ARBITRARY LAND-SEA AREAS, H. L. Knudsen. Project 5635 (803A), Contract AF 61(052)-503; CRRD, AFCRL.

Theoretical investigation based on the compensation theorem of radiation of a short wave antenna placed in an environment of irregularly shaped land-sea boundaries. This work will consist of (1) an examination of the reliability of the compensation theorem approach by solving simple problems by that method and comparing the results with known solutions obtained by traditional methods; (2) an extension of the compensation theorem method to curved boundaries, with emphasis on the numerical calculation of the low angle fields in a mixed land sea area.

11.27

Cornell U., Ithaca, N. Y.
RADIO SCATTERING IN THE TROPOSPHERE, R. Bolgiano. Project 5631(803A), Contract AF 19(604)-3494; CRRK, AFCRL.

This contract provides for theoretical and experimental studies to determine the wavelength (or frequency) dependence of the troposphere and the correlation between meteorological phenomena and received field strength.

11.28

Dayton U., Ohio.
FUNDAMENTAL EMISSION IN II-VI COMPOUNDS (SEMICONDUCTORS), W. R. Rambauske. Project 7885(802A), Contract AF 33 (616)-7500; AEX, ARL.

Experimental and theoretical research is performed on the optical properties of II-VI compound semiconductor single crystals, of their band structure, and of their interactions with visible, ultraviolet and infrared radiation. High resolution measurements are made over the specified spectral range on crystals of CdS, ZnS, CdSe, ZnSe, ZnTe, at temperatures down to that of liquid helium. The implications of these measurements with respect to extant theories are studied in an attempt to provide a better understanding of the fundamental nature of the materials tested.

11.29

Dominion Physical Lab. (New Zealand).
ANTIPODAL RECEPTION OF VLF, D. Crombie. Project 5631 (803A), Contract AF 64(500)-08; CRRK, AFCRL.

The signals from the very low frequency transatlantic GBZ etc. can be received via a great variety of great circle paths, in New Zealand, because of its quasi antipodal location. An extremely accurate measurement of phase and group velocity of these waves will be made. Present information suggests that differences exist along different propagation paths, and the verification and interpretations of these differences are the basic objectives of this work.

11.30

Ecole Normale Superieure, Paris (France).
STUDY OF WHISTLERS BY PHASE TECHNIQUES, A. A. Delloue. Project 5631(803A), Contract AF 61(052)-427; CRRK, AFCRL.

The phenomena of the whistler propagation mode is not well understood at the present time, particularly the modification of the waves as they pass from planetary space through the upper ionosphere to the ground, and vice versa. The present

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ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRME- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
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work calls for measuring the various field components and their phase relation at several geographical sites so as to deduce the complex field parameters.

11.31

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. BASIC FIELD THEORY, W. W. Gerbes. Project 5635(803A), Internal.

One of the basic difficulties in solving problems of electromagnetic radiation is the fact that Maxwell's equations can be separated for a few geometrical configurations only; configurations rarely are realized in practical applications. An effort is made to give the field equations another form more fitted to the solution of practical problems through the introduction of integral transformations and certain matrix representations into the basic equations.

11.32

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. REDUCTION OF SCATTERING CROSS-SECTION, B. B. Gorr, R. B. Mack. Project 5635(803), Internal.

The scattering properties of reactively loaded dipoles are being investigated to determine the effectiveness of this approach to lowering both backscatter and bistatic scattering. Particular attention is being given to methods applicable to long thin bodies. The cross section as a function of frequencies for reactive loaded dipoles must be determined.

11.33

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. SCATTERING PROPERTIES OF DIELECTRIC SPHERES, B. B. Gorr, F. S. Holt. Project 5635(803A), Internal.

The backscatter cross section of dielectric spheres in the resonance region is being investigated. In some cases there is a considerable "enhancement" over the return from metal spheres. Work is in cooperation with the GRD of AFCRL This work is directly related to Dr. Atlas's work (GRD)on scattering from rain and hail.

11.34

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. COHERENCE THEORY OF MASER MODULATION, E. J. Post. Project 5635(803A), Internal.

An investigation of the statistics of coherence theory with special reference to modulation aspects of optical masers. Special attention will be given to self-modulation (instability) of actual maser structures.

11.35

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. FIELD THEORY OF SCALAR POTENTIALS, E. J. Post. Project 5635(803A), Internal.

An investigation of the use of scalar potentials in electromagnetic field theory. The present aim is to check the performance of these potentials in applied field problems.

11.36

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. DIFFRACTION OF PULSED RADIATION, R. A. Shore. Project 5635(803A), Internal.

An investigation of the diffraction of electromagnetic pulses by conducting objects. The principal objective is to study the effect on the pulse shape in the far-field diffraction region. Work will center on the sphere and cylinder but the method of analysis will be applied to any conducting shapes.

11.37

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. PARTIAL POLARIZATION, R. A. Shore. Project 5635(803A), Internal.

An extension of the concepts of coherence theory to analyze the interaction of partially polarized vector fields. Emphasis is to be placed on funding parameters to characterize the interference pattern and polarization properties of the resultant field.

11.38

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. PLASMA DIFFRACTION, R. A. Shore. Project 5635(803A), Internal.

A thorough analysis of radiation in the presence of anisotropic plasmas. Radiation from dipoles, line sources,and ring sources immersed in plasmas with impressed static magnetic fields is being investigated. Both uniform and stratified regions are being considered. It is hoped to develop a form of geometric optics appropriate to the complication introduced by the double index of refraction characterizing the plasma region.

11.39

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. SCATTERING CROSS-SECTION OF PROLATE SPHEROIDS, R. A. Shore, B. B. Gorr. Project 5635(803A), Internal.

A number of approximate solutions of scattering from prolate spheroids are available but few measurements of scattering cross-sections of long, thin spheroids are available. These measurements should provide experimental results for comparison with theory.

11.40

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass. COHERENCE OF ELECTROMAGNETIC PROPAGATION THROUGH PLASMAS, T. J. Skinner, G. Maltz. Project 5635(803A), Internal.

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AFCRL- Air Force Cambridge Research Laboratories

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- CRRC- Electronic Material Sciences Lab
- CRRD- Electromagnetic Radiation Lab
- CRRI- Astrosurveillance Sciences Lab
- CRRK- Propagation Sciences Lab
- CRRS- Communications Sciences Lab
- CRRZ- Control Sciences Lab

CRE- Geophysics Research Directorate
- CREA- Photochemistry Lab
- CREC- Thermal Radiation Lab
- CREE- Research Instrumentation Lab
- CREG- Terrestrial Sciences Lab
- CREH- Meteorological Research Lab
- CREI- Ionospheric Physics Lab
- CRER- Sacramento Peak Observatory

The investigations will examine the coherence length of a plasma as function of the mean electron density and the connection between the Debye length and the coherence interval. Experiments will be performed to measure the latter quantity. This information is derivable from the power patterns of interferometer elements that are surrounded by a homogeneous stationary plasma.

11.41

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass.
PARTIAL COHERENCE IN TURBULENT MEDIA, T. Skinner. Project 5635(803A), Internal.

The problem of electromagnetic wave propagation through a random medium is reexamined in light of the theory of partial coherence. Emphasis is placed upon the problem of finding the change in the degree of coherence of the wave in terms of the coherence and geometry of the random medium. Application will include the problem of finding minimum beamwidth of the pattern of microwave, infrared, and optical radiators by a turbulent medium.

11.42

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass.
BASIC CONCEPTS OF PARTIAL COHERENCE, F. J. Zucker. Project 5635(803A), Internal.

Certain fundamental aspects of the theory of partial coherence - the statistical theory of electromagnetic radiation, requires close study. One of these is the concept of coherence itself, its measurement over the entire spectrum, and its precise meaning in connection with so-called "incoherent" sources. A second aspect, which will also be studied, is the connection between partial coherence and thermodynamics, for example the coherence of black-body radiation, or the relation between radiation through turbid media and non-equilibrium statistical mechanics.

11.43

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass.
ELECTROMAGNETIC BOUNDARY WAVES, F. J. Zucker. Project 5635(803A), Internal.

A unified and comprehensive treatment will be given of the excitation, transmission, diffraction, and radiation of electromagnetic surface, leaky, and related waves, including applications to endfire antenna radiation, to Wood's anomalies in optics, and to electromagnetic-acoustic coupling in magnetized plasmas.

11.44

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford,Mass.
ELECTRONIC ANALOGUE OF COLOR INFORMATION, F. J. Zucker, R. A. Shore. Project 5635(803A), Internal.

The relation between the "color" of an electromagnetic (optical) signal and its spectral components is not one-to-one (i.e., there are infinitely many spectra corresponding to a single color sensation). This study involves common aspects of all possible spectra of one color. We know that the energies and centroids of the spectra are involved, and suspect that their entropy (or coherence) is likewise. A quantitative law on the latter is sought; then, using the theory of partial coherence, microwave analogues of color vision (including the Land phenomena) can be explored.

11.45

Electromagnetic Research Corp., Washington, D.C.
ELECTRONICS, M. Katzin. Project 5631(803A), Contract AF 19(604)-7233; CRRK, AFCRL.

The observations of signals from satellites have shown complicated patterns and exhibited phenomena which are difficult or impossible to explain using existing ionospheric transmission theories. The use of radio signal sources above the ionosphere has introduced new problems in data analysis and interpretation. This contract will provide investigations on a novel theoretical approach and methods of dealing with experimental data obtained under satellite or space vehicle programs.

11.46

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
PHYSICS OF THE IONIZED GAS, S. B. Herskovitz. Project 5634(803A), Internal.

This effort emphasizes theoretical and experimental investigations into the interaction of electromagnetic energy with gaseous discharges. Of major interest, at the present, are the areas of plasma diagnostics, coupling phenomena, and transmissional properties of plasmas. Diagnostic techniques including propagation methods, both guided (as developed by Goldstein at the University of Illinois), and free space; cavity perturbations (Brown at M. I. T.); and physical probes are being investigated. Coupling phenomena, in particular the use of decaying gas discharges as a microwave energy detector, are being experimentally studied. Energy balance experiments utilizing standard interferometry techniques will be performed on large volumes of plasma.

11.47

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
INVESTIGATION ON SEMICONDUCTORS, A. D. Johnson. Project 5621(802A), Internal.

Determine effects of various dopants on the electroluminescent properties of selected crystals and determine mobilities and lifetimes of carriers, recombination kinetics, etc., both theoretically and experimentally. Investigate various photoconductive materials with regard to response times and sensitivities, trapping mechanisms and effects of specific imperfections. Apply existing spectrometer facilities to obtain absorption spectra of semiconducting materials over a wide range of wave lengths from ultraviolet to infrared and at different temperatures

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to determine properties of the band structure, energy gaps and band curvatures.

11.48

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
OPTICAL STUDIES ON SINGLE CRYSTALS, H. G. Lipson. Project 5621(802A), Internal.

The objective of this research is to quantitatively evaluate single crystal properties and phenomena through measurements of their absorption, reflection, fluorescence and phosphorescence spectra in the ultra violet, visible and infrared over a wide range of temperatures from liquid helium (4°K) to several hundred degrees centigrade. Present research is emphasizing optical studies of Mg_2Sn and has obtained new information on the energy gap for samples of varying stoichiometric composition, on a 7.5γ absorption band.

11.49

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
SEMICONDUCTOR LASER RESEARCH, J. Ludman. Project 5621 (802A), Internal.

The objective of this new research is to investigate theoretically and experimentally the possibilities and limitations of laser activity based on the d.c. injection of carriers into semiconductors and the utilization of recombination radiation. The advantages of such a laser for convenient pump power direct from a d.c. source or at the first stage of a multistage laser makes its evaluation very important. This investigation is still in the theoretical stages.

11.50

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
LATTICE DYNAMICS, J. N. Plendl. Project 5634(803A), Internal.

This work covers research on the lattice vibration spectra as such, and in relation to the fundamental properties of solid matter in the optical, thermodynamical, mechanical and electrical aspects. The principal aim is to determine hitherto unknown basic laws. This investigation covers the spectral region lying between optics and microwave electronics. It also covers the ultraviolet with respect to the Raman affect.

11.51

Electronics Technology Lab., ASRMR, ASD, Dayton, Ohio.
MICROWAVE INTERACTIONS, W. C. Eppers. Project 4150(803A), Internal.

The work on this task is concerned with the fast wave interaction of electron beams, amplification by plasmas, and electromagnetic wave interaction with plasmas. Final work on a 3100 MC electron beam parametric amplifier is in progress. Currently, it is not planned to continue the investigation into possible broad banding methods. Theoretical and experimental work has begun to evaluate the negative resistance properties of low temperature gas plasma. Preliminary study has begun to investigate the validity of the assumptions made in plasma analysis by unbounded electromagnetic energy, (i.e. analysis not made in resonant cavities or waveguides where the fields are strictly specified.

11.52

Florence U. (Italy).
DISPERSION AND ABSORPTION MEASUREMENTS OF TROPOSPHERIC GASEOUS CONSTITUENTS, N. Carrara. Project 5631(803A), Contract AF 61(052)-437; CRRK, AFCRL.

Performs laboratory measurements on the dispersion and absorption of radio waves, in the centimetric and shorter wavelengths, by various gaseous constituents of the atmosphere. The pressure levels will range from sea level to ionospheric values. The measurements are being made with a high-sensitivity refractometer previously built under Air Force contract. The refractometer will be extended to its maximum limit of sensitivity, up to 10^{-10} if feasible.

11.53

Florence U. (Italy).
REFLECTION FROM FIELD ALIGNED IONIZATION, N. Carrara. Project 5631(803A), Contract AF 61(052)-447, CRRK, AFCRL.

Employing the radar equipment with which rate and radiant studies of meteors have been made, the reflection of RF energy from ionization distributed along the field will be studied.

11.54

Florence U. (Italy).
ELECTROMAGNETIC THEORY, G. Toraldo di Francia. Project 5635(803A), Grant AF-EOAR 61-28, CRRD, AFCRL.

Analysis of the wave spectrum propagating along a modified surface that optimizes the extraction of millimeter and submillimeter power from an electron traveling along it, and experimental verification by means of model work at microwave frequencies.

11.55

Ford Motor Co., Newport Beach, Calif.
PLASMA-EM Radiation Interaction, S. Katz. Project 8806(802A), Contract AF 29(601)-4593; SWR, AFSWC.

Develop a theory of electromagnetic radiation interaction with a plasma where the frequency range of the impressed radiation is such that the collective modes of the plasma may be excited. This entails a detailed consideration of two problems: (1) the non-equilibrium statistical mechanical problem of electron flow; and (2) the influence of

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the ion constituents upon the electron radiation interaction--essentially free-free transitions. Desired results of this investigation will be presented in the form of either a constitutive relation (i.e., total electron current in the plasma as a function of the magnetic potential, or an appropriate dispersion relation.

11.56

Harvard U., Cambridge, Mass.
ANTENNAE IN CONDUCTING MEDIA, R.W.P. King. Project 7661 (770A), Contract AF 19(604)-7262; CRZI, AFCRL.

Design apparatus and carry out measurements of antenna characteristics in a conducting and stratified medium for various conductivity gradients.

11.57

Harvard U., Cambridge, Mass.
ELECTROMAGNETIC SCATTERING AND ANTENNAS, R. W. P. King. Project 5635(803A), Contract AF 19(604)-4118; CRRD, AFCRL.

A theoretical and experimental investigation of (1) radiators of novel or improved design with emphasis on regular geometrical arrays of elements, and of (2) scattering cross section and diffraction properties of objects of complex shape. Investigations are being carried out on periodic disc arrays and surface waves along ferrite rods.

11.58

Hebrew U. (Israel).
OPTICAL SPECTRA OF TRANSITION ELEMENTS IN SINGLE CRYSTALS, Low. Project 6694(750F), Contract AF 61(052)-549; CRZA, AFCRL.

The principles of microwave or optical pumping of electrons which are now used in masers and lasers respectively are based on the possible excitation states of the atom or ion which then emits the radiation. The work of the contract is concerned with the analysis of such states in transition metal ion guests in host atomic lattices of various geometries. The effects of crystalline fields on the order and magnitudes of the energy levels give criteria for possible maser and/or laser applications of the materials studied.

11.59

Hebrew U. (Israel).
REFLECTIVE SURFACES, M. Tabor. Project 6694(750F), Contract AF 61(052)-279; CRZA, AFCRL.

Investigations are being conducted on the relationship between the structure and the optical properties, and between the manner of formation and the structure of surfaces produced by chemical and electrochemical means and having selective reflection and absorption properties to incident radiation. Studies are being made to relate the information obtained to methods of solar energy collection and utilization.

11.60

Hughes Aircraft Co., Culver City, Calif.
CONTROL OF ELECTROMAGNETIC RADIATION FROM AIRCRAFT AND SPACE VEHICLES, A. Ksienski. Project 4600(760K), Contract AF 19(604)-8386; CRRD, AFCRL.

Stable oscillation with large gain stable amplification with 12 to 23 db gain, as well as phase shift, at frequencies from S to X-band, may be obtained by placing a biased tunnel diode within a slot antenna. The proposed work will include the theoretical and experimental investigation of these active slot elements in transmitting and receiving antenna arrays. It should be possible to construct arrays which scan either by phase variation or amplitude variation, arrays with unusual amplitude tapers for side-lobe reduction, receiving arrays which convert directly from a microwave frequency, a low radio frequency, and slotted traveling wave amplifiers. An investigation will also be made of the influence on the far fields of a refractive layer, such as a plasma sheath, on or near various radiative sources.

11.61

Illinois U., Urbana.
QUANTUM AND SOLID STATE ELECTRONICS, P. D. Coleman. Project 9768(803A), Grant AF-AFOSR 62-287; SRPP, AFOSR.

This work includes several approaches to the problem of mm and sub mm wave generation by the use of "megavolt electronics" such as: investigation of non-linear elements and circuitry for frequency multiplication; use of a Cerenkov radiator to generate fractional watt mm wave energy; and the application of quantum electronics and optical pumping techniques for maser generation of very high microwave, mm wave, and optical frequencies.

11.62

Illinois U., Urbana.
ELECTROMAGNETIC WAVE INTERACTION TECHNIQUES, A. A. Dougal. Project 8605(804A), Contract AF 19(604)-3481; CRZI, AFCRL.

Controlled laboratory experiments on microwave interaction phenomena in ionized gases subjected to steady magnetic fields. Determination of the free electron collisional processes, including collision cross-section recombination coefficients, attachment and detachment coefficients which influence the state of the free electron density when the electron gas is thermally heated by electromagnetic wave absorption near the gyro-resonance frequency and in the absence of gyro-resonance.

11.63

Illinois U., Urbana.
MODULATION AND DETECTION OF COHERENT OPTICAL RADIATION, D. F. Holshouser. Project 9768(803A), Grant AF-AFOSR 62-250; SRPP, AFOSR.

This work includes studies of modulation and detection of

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coherent light from an optical maser employing special Kerr cell techniques for modulation and a dynamic crossed-field electron multiplier for detection.

11.64

Instituto Nacional de Electronica (Spain).
OBSERVATION OF VLF NOISE FROM THE OUTER ATMOSPHERE, M. Espinosa. Project 5631(803A), Contract AF 61(052)-51?; CRRK, AFCRL.

Instrumentation consisting of a loop antenna, preamplifier, amplifier and recorder has been installed at an electrically noise free site near Madrid where measurements are being made of noise burst at five (5) kilocycles per second. These noise bursts, which apparently originate from upper atmospheric sources, will be measured and recorded and this data compared with similar data taken at different parts of the world in order to study the noise source distribution in more detail.

11.65

Ionospheren Inst. (Germany).
IONOSPHERIC STRUCTURE, K. Rawer. Project 8605(804A), Contract AF 61(052)-81; CRZI, AFCRL.

From an analysis of the observations of refraction pattern variations, information will be derived on the fine structure and turbulence of the E-region, on the interpretation of usual three antenna drift observations and on the limitations and possibilities of automatic observing, recording and data reduction methods. Refraction patterns will be observed with both a six antenna and a three antenna system.

11.66

Ionospheren Inst. (Germany).
PULSE TRANSMISSION AT OBLIQUE IONOSPHERIC INCIDENCE, K. Rawer. Project 5631(803A), Contract AF 61(052)-129; CRRK, AFCRL.

High-frequency pulse propagation is investigated. Recordings of pulse propagation times and amplitudes that were obtained on the Breisach-Plum Island link at two frequencies are evaluated especially with respect to absorption phenomena. Sweep-frequency experiments with simultaneous amplitude recordings are prepared. It is planned to compare the expected results with other information on the behavior of the ionosphere and to study correlation of variations on different propagation links.

11.67

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
SOLUTION OF THE TRANSIENT AND QUASI-EQUILIBRIUM DEIONIZATION EQUATIONS IN IONIZED MEDIA, W. Pfister. Project 8605(804A), Internal.

To develop a method for solving the transient and quasi-equilibrium deionization equations in the ionosphere. To improve previous superficial treatments of this problem in which only three variables were considered. Programs are to be developed for high speed digital computers that will generate solutions for any number of individual species be they molecular, or atomic, ionized or un-ionized.

11.68

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
TURBULENT STRUCTURE AND DRIFT MOTIONS, W. Pfister. Project 8605(804A), Internal.

Conduct experimental and theoretical investigations on the reflection of radio waves from the ionosphere by means of probing techniques. This effort is carried out to determine the effects of ionospheric irregularities and motions and of the velocities of ionized matter in these regions. This task includes investigations on the turbulent structure of the ionosphere.

11.69

Little, Arthur D., Inc., Cambridge, Mass.
EMISSIVITY AND REFLECTIVITY OF HOT SOLID MATERIALS, H. H. Blau. Project 5634(803A), Contract AF 19(604)-7485; CRRC, AFCRL.

This contract deals with a critical evaluation of the basic literature dealing with emissivity and reflectivity of hot solid materials. A laboratory investigation of the emissivity and reflectivity of selected hot materials is being made which is based upon the conclusions drawn from the literature survey. A laboratory investigation will be conducted of the spectral emission with emphasis on the infrared region of short time, high temperature arc lamps in the submicrosecond region.

11.70

Little, Arthur D., Inc., Cambridge, Mass.
RADIATION CHARACTERISTICS OF METAL VAPORS, P. E. Glaser. Project 7063(806A), Contract AF 33(657)-7974; ARH, ARL.

A theoretical and experimental investigation of the optical properties of metal or alkali element vapors will be conducted. An analysis of the mechanisms of absorption and re-radiation of energy by the vapors and the effects of vapor temperature and pressure on radiant energy absorption will be made. Experimental apparatus for the measurement of the heat transferred by radiation through metal vapor layers to a calorimeter will be designed and fabricated and experiments will be run to qualitatively determine the optical properties of low boiling point alkali metals such as sodium, potassium, cesium, and lithium.

11.71

Lockheed Aircraft Corp., Palo Alto, Calif.
EXTRA LOW FREQUENCY WHISTLERS, A. J. Dessler. Project 5631(803A), Contract AF 19(604)-5906; CRRK, AFCRL.

ELF propagation phenomena of signals originating from many

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different sources, either in or above the ionosphere out to the limit of the geomagnetic field, will be studied theoretically and experimentally. Data on ELF signals will be taken on a variety of probes, each appropriate to the ELF source, in the range of 0 to 30 cps at a station previously established at Palo Alto, California. The data will be analysed and interpreted so that theories for the propagation of ELF signals in the geomagnetic field can be developed and substantiated. As a part of the ELF studies, a high altitude experimental program will use the Atlas Scientific Pod to carry instrumentation to measure the amplitude and spectrum of hydromagnetic signals above the ionosphere F region and the frequency dependent attenuation through the ionosphere by making simultaneous ground measurements at a down-range station near Recife, Brazil and at Palo Alto.

11.72

Lowell Technological Inst. Research Foundation, Mass.
VLF SOURCES AND PROPAGATION MODES, R. Wexler. Project 5631(803A), Contract AF 19 (604)-7232; CRRK, AFCRL.

The Wachusetts Radio Interferometer Facility will be employed to further investigate (1) accuracy of direction finding with natural and artificial pulses, (2) amplitude and phase stability of VLF propagation modes during day and night, sunrise and sunset, solar flares and auroral activity.

11.73

Maryland U., College Park.
FOUNDATIONS OF SCATTERING THEORY AND APPLICATIONS TO PHYSICAL PROBLEMS, J. S. Toll. Project 9751(801A), Grant AF-AFOSR-62-361; SRPN, AFOSR.

This is a continuation of research which includes the analytic structure of scattering functions and related topics such as Lorentz invariance and the existence of production processes, and the applications of scattering theory to strong and weak interaction problems.

11.74

Massachusetts Inst. of Tech., Cambridge.
COHERENT LIGHT AND RADIO OPTICS, P. A. Miles. Project 9768(803A), Grant AF-AFOSR-62-317; SRPP, AFOSR.

This research covers modulation and detection of coherent EM radiation in the optical region and analyses of the fine structure of optical maser beams. Success with the neodymium glass maser will result in continued investigation of the optical properties of other rare earth ions as possible maser sources.

11.75

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
SCATTER CROSS SECTION STUDY, D. Atlas. Project 8620(804A), Internal.

This effort covers experimental and theoretical investigations of radar reflectivity or the radar back-scatter cross sections of particulate matter occurring naturally within the atmosphere. Emphasis will be placed on the quantitative determination of the back-scatter cross sections of hail of various sizes and shapes in efforts to develop a positive technique for the radar identification and measurement of hail of various sizes and shapes.

11.76

Michigan U., Ann Arbor.
DIFFRACTION BY REGULAR BODIES, R. E. Hiatt. Project 5635 (803A), Contract AF 19(604)-6655; CRRD, AFCRL.

An investigation is being carried out on the scattering of electromagnetic waves by regular bodies (spheres, cones, cylinders, wedges, etc.) covering all frequency ranges from the Rayleigh region to geometrical optics. The objective is to present in a systematic way the diffraction and scattering properties of regular bodies. An extension of the basic diffraction theory by using techniques developed by Kleinman in his solution of the problem of diffraction by a strip and also by employing nonlinear modeling techniques is being pursued.

11.77

Microwave Lab., Stanford U., Calif.
PROPERTIES OF PLASMAS, L. M. Chodorow. Project 4619(760E), AF 19(604)-5226; CRRC, AFCRL.

The major objectives of this program are to investigate the interaction of plasmas with electromagnetic radiation and with electron beams and to investigate the behavior of a plasma as a transmission medium. There are presently four projects under this contract covering work on thermal plasmas, plasma noise, plasma harmonic generation, and cesium tube techniques. Plasma densities of over 10^{11} have been obtained, harmonic generation from S-band up to the ninth harmonic is being evaluated and a bakeable, movable probe for plasma tube research has been designed and constructed.

11.78

Naples U. (Italy).
PROPAGATION OF ELECTROMAGNETIC WAVES IN AN INHOMOGENEOUS MEDIUM, L. G. Napolitano. Project 5631(803A), Contract AF 61(052)-548; CRRK, AFCRL.

This contract will continue to provide for a theoretical investigation of electromagnetic wave propagation in ionized gases, including a survey of the solutions of the Boltzmann equations for ionized gases, indicating the areas of desirable future research, the constitutive equations of the medium for electromagnetic waves in relation to the solutions of the Boltzmann equation, and the development of a general theory of wave propagation in inhomogeneous anisotropic media and the derivation of approximations in this theory usable in certain cases of practical importance.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEGR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

11.79

National Bureau of Standards, Boulder, Colo.
ANTENNA RADIATION IN THE PRESENCE OF LOSSY AND FINITE SURFACES, J. Wait. Project 5635(803A), Contract NBS-CSO A59-529; CRRD, AFCRL.

Impedance and pattern calculations were performed for radiators buried in lossy soil, or surrounded by an ionized sheath, or mounted on a finite ground plane.

11.80

New York U., N. Y.
ELECTROMAGNETIC THEORY, M. Kline. Project 5635(803A), Contract AF 19(604)-5238, CRRD; AFCRL:

Basic mathematical investigations to extend existing state of knowledge of electromagnetic theory with specific emphasis on diffraction and radiation. Specific areas currently being investigated are (1) asymptotic expansions of solutions of Maxwell's equations, (2) high frequency approximations, (3) asymptotic expansions of integrals, (4) behavior of electromagnetic fields in the vicinity of caustics, (5) surface wave phenomena, (6)inverse scattering problems, and (7) infinite matrices arising in diffraction problems.

11.81

New York U. Inst. of Mathematical Sciences, N. Y.
RADIOWAVE PROPAGATION IN VARIABLE MEDIA, M. Kline. Project 5631(803A), Contract AF 19(604)-3495; CRRK,AFCRL.

Mathematical studies on the direct and inverse interrelationships between radio field-intensity distribution and refractive-index distribution in variable media. Extension of the complex-valued ray theory, originating at New York University, for treating radio propagation problems will be pursued. Recent studies show good promise that this complex ray theory will be extremely useful for isotropic media; application of this theory to ionospheric propagation, including the geomagnetic field, will be explored. A study is being made of a class of non self-adjoint spectral problems related to the trapped modes in radiowave ducts.

11.82

Norwegian Defense Research Establishment.
STATISTICAL PROPERTIES OF RADIO WAVES REFLECTED FROM THE IONOSPHERE, T. Hagfors. Project 5631(803A), Contract AF 61(052)-500; CRRK, AFCRL.

This research will continue the study of the statistical properties of radio waves reflected from the ionosphere in terms of a correlation function R (a, Δ f, T) (where a = spatial separation, Δ f = frequency separation and T = time shift, relating received signals separated in space, in frequency and in time). The studies are to be performed at vertical or near vertical incidence near Kjeller. The results of the measurements are to be analyzed and presented in such a form that they may be used in evaluating various communication systems depending on waves reflected from the ionosphere. The observational results are to be discussed in terms of the various theoretical models available for explaining the irregularities at ionospheric heights.

11.83

Oregon U., Eugene.
MICROWAVE AND OPTICAL PROPERTIES OF CRYSTALS, J. C. Kemp. Project 9763(802A), Grant AF-AFOSR 62-180; SRPS, AFOSR.

The relationship between the electron spin resonance and optical spectra of crystals such as Al_2O_3 and MgO doped with transition metal impurities and alkali halides with F-centers will be determined by using a combination of optical and microwave techniques; including double resonance methods involving simultaneous excitation in these two frequency ranges. The objectives are: (1) to add to our knowledge of optical-excited states in these crystals, including multiplicities and Zeeman structure, lifetimes and relaxation times, and line-broadening mechanisms; and (2) to relate unequivocally the ESR spectra with certain optical bands in terms of models of the particular absorbing centers.

11.84

Oxford U. (Gt. Brit.)
WAVES AND ANISOTROPIC MEDIA, H. Mets. Project 9768(803A), Grant AF-EOAR 62-62; SRPP, AFOSR.

Research on the generation of millimeter and sub-millimeter waves by means of the undulator principle, and the propagation and absorption characteristics of such waves in solids and gases. The use of high intensity magnetic fields in connection with both cyclotron resonance experiments and paramagnetic oscillators and amplifiers is also being investigated with particular reference to high temperature plasma parameters.

11.85

Pisa U. (Italy).
ELECTROMAGNETIC PROPAGATION, U. Tiberio. Project 5631 (803A), Contract AF 61(052)-359; CRRK, AFCRL.

This will be research leading to the recovery of the information which has been transferred into phase modulation when amplitude modulated electromagnetic waves are reflected by the ionosphere. In the waves which have been reflected by the ionosphere, there are large distortions owing to selective fading and differential phase shift; these distortions are partially interpretable as due to transfer of information from amplitude to phase transfer which occurs. Analysis of the resultant data acquired will be performed to determine the principal physical phenomena involved in this transfer of amplitude to phase modulation.

11.86

Plasma Physics Research Lab., ARN, AEL, Dayton, Ohio.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZR- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZM- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

TRANSMISSIONS OF ELECTROMAGNETIC RADIATION THROUGH PLASMAS, W. Fris. Project 7073(806A), Internal.

Experiment to determine the oscillatory states of an electron plasma. An experiment is under way in which a monoenergetic electron beam crosses a cloud of electrons of known distribution function. After having crossed this cloud, this beam is analyzed in respect to energy of its constituent particles. This transformation of a monoenergetic beam into a beam containing a wider energy spread due to the interaction with this cloud represents a well defined case of relaxation from a non-equilibrium distribution. The experiment is tailored to obtain quantitative dispersion relations (w-k diagram) for several clean cut conditions.

11.87

Polytechnic Inst. of Brooklyn, N. Y.
GASEOUS ELECTRONICS, M. Ettenberg. Project 4619(760E), Contract AF 19(604)-7216; CRRC, AFCRL.

The objective of the current research is to study the interaction between a medium density plasma and a microwave beam. This aim serves a dual purpose, namely the study of the microwave diagnostic method in itself and the derivation of information concerning the plasma parameters such as electron density, electron collision frequency and temperature.

11.88

Polytechnic Inst. of Brooklyn, N. Y.
MICROWAVES, ELECTROMAGNETIC THEORY AND INFORMATION PROCESSES, N. Marcuvitz. Project 4751(803A), Grant AF-AFOSR 62-795; SRPP, AFOSR.

This program comprises six broad research areas in microwave, plasma and magnetogasdynamic phenomena; network and circuit theory; and, electromagnetic interactions.

11.89

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
RADIOMETEOROLOGICAL STUDIES, R. W. Corkum. Project 5631 (803A), Internal.

Theoretical and analytical studies are conducted to determine the inter-action of radiowaves with constituents of the earth's troposphere and correlation between meteorological parameters and received signals on tropospheric circuits. Present emphasis is on atmospheric duct meteorology and radiowave trapping.

11.90

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
RADIO WAVE PROPAGATION IN VARIABLE MEDIA, G. M. Daniels. Project 5631(803A), Internal.

The effects of fluctuations and particle motion correlations on the index of refraction and incoherent scattering properties of an ionized gas are being studied. Radio wave propagation in a medium with a smoothly varying index of refraction having one minimum is being studied. Attempts are being made to apply the work of V. A. Fok to obtain the eigenmodes for a medium of this type. At present Weber functions of complex argument and index are being studied. The zeros of these functions as a function of index will give the eigenvalues for the simplest problem, a parabolic index of refraction, falling in the above category.

11.91

Propagation Sciences Lab., CRR, AFCRL, Bedford. Mass.
EXTENDED HF-VHF PROPAGATION STUDIES EMPLOYING OBLIQUE INCIDENCE IONOSPHERIC SOUNDER TECHNIQUES, W. G. Griffin. Project 5631(803A), Internal.

A receiving station employing a receiver synchronized with the Step Frequency Sounder at Plum Island, Mass. will be installed in the vicinity of Atlanta, Georgia. Signals in the region 4 Mc to 64 Mc will be transmitted. The meteor mode of propagation will be compared with other modes on a continuous basis over this path.

11.92

Propagation Sciences Lab., CRRK, AFCRL, Bedford, Mass.
EXTENSION OF THE APPLETON-HARTREE PHASE REFRACTIVE INDEX FORMULATION CONSIDERING THE EFFECT OF ONE TYPE OF ION-COLLISIONS NEGLECTED, G. Kantor. Project 5631 (803A), Internal.

A derivation of an extension of the Appleton-Hartree phase refractive index formulation considering one type of ion with collisions neglected is considered. This extension assumes that the wave-frequency is somewhat above the ion gyromagnetic frequency and considerably below the electron gyromagnetic frequency. Expressions for the Quasi-longitudinal (QL) and Quasi-transverse (QT) approximations are obtained.

11.93

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
ELF/VLF RECIPROCITY EXPERIMENT, E. A. Lewis. Project 5631(803A), Internal.

Battery operated ELF/VLF recorders of the Kalakowsky type will be placed on the islands of Bermuda and Azores, the line joining which is essentially transverse to the geomagnetic field. The British Meteorological Office Sferics Net will provide fixes on lightning strokes in the European Area, while the D/F apparatus at Bedford, Mass. will provide fixes in the Florida area. The ratio of field strengths Azores/Bermuda will be compared for E to W and W to E propagation paths. The oceanic environment will minimize terrain effects.

11.94

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.

BACKSCATTER EXPERIMENTS, C. Malik. Project 5631(803A), Internal.

In recording backscatter vs. azimuth, the new method of alternately compressing the two coordinates is in continuous use. The characteristics of backscatter on each day are represented graphically and investigated with respect to phenomena relating to disturbances. The correlation with various disturbance parameters is studied. Backscatter from places in or beyond the auroral zone is compared with backscatter from other azimuths with the aim of understanding the varying characteristics of the northern gap and discovering differences in the behavior of the F layer in different latitudes. Also auroras and Sporadic E are investigated.

11.95

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
IONOSPHERIC PROPAGATION, H. S. Marsh. Project 5631(803A), Internal.

(1) Present study is concentrated around ionospheric shock-waves and frequently accompanying "thermal" dropouts on high frequency signals. Possible connection with solar tidal effects at the lower interface, and with solar winds at the upper ionospace interface, are being investigated. (2) Study of the Ionospheric Storm Index, now being conducted by NBS is being followed remotely; (3) Ionospheric storms are sorted into several types defined by the Concord Storm Index. Plans are to determine reliability of forecasting form and duration of various types of storms by using magnetic and solar data; also attempt is being made to classify overlapping disturbances. (4) Study of Concord anomalies by Page Engineers, Inc. appears to show predictive value of "rotation patterns" of very limited value compared to (3) above, however, apparent double-dependence of the rotation patterns on direct magnetic effects and foF_2 variation, apparently not thoroughly covered by Page, may be explored further if possible. (5) Continuous stochastimetric distribution recordings and occasional multipath delay measurements are continuing, primarily in support of (1) above. Exotic multipath patterns observed on Arctic signals when operating above the classical MUF are being studied further.

11.96

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
ELECTRON DENSITY PROFILE MEASUREMENTS, R. J. Miner. Project 5631(803A), Internal.

Electron density profiles in the ionosphere will be measured using a C-4 ionosonde operating over a frequency band of 0.25 - 20 Mcps at Reservoir Hill, AFCRL. Wherever possible, such data will be correlated with other sources of data such as vertical sounding radars, riometers, moon reflected and satellite transmitted signals.

11.97

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
EXOSPHERIC PROPAGATION STUDIES, H. Poeverlein. Project 5631(803A), Internal.

Theoretical and analytical studies of propagation of electromagnetic and hydromagnetic waves are conducted with emphasis on propagation and excitation effects in the higher atmosphere and their observation. The theoretical study in conjunction with noise observations on the ground and VLF observations on satellites or rockets is expected to lead to a better understanding of processes and conditions in the exosphere and of VLF and ELF propagation.

11.98

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
AMPLITUDE AND PHASE PATTERNS OF VLF RADIATION RECEIVED FROM SFERICS, J. E. Rasmussen. Project 5631(803A), Internal.

Using the Mt. Wachusetts facility, observations of phase pattern anomalies will be made simultaneously with the Univ. of Florida observations. The waveforms of sferics of accurately known origin will be recorded at 4 selected sites approximately 50 km from a common center, in order to determine whether previously noted anomalies in received field strengths of sferics are due to the source, the propagation medium or both.

11.99

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
ANALOGUE COMPUTER STUDIES OF RADIO PROPAGATION IN VARIABLE MEDIA, M. S. Wong. Project 5631(803A), Internal.

The large ray-tracing computer at AFCRL is being used to study radio wave propagation phenomena in non-uniform, non-isotropic media such as the ionosphere, including the geomagnetic field and disturbed ionization conditions. A study is nearing completion on the trapping of high frequency (below 30 Mc) radio waves in ducts in the exosphere.

11.100

Puerto Rico U., Mayaguez.
SPORADIC "E" LAYER IONIZATION PHENOMENA, B. Dueno. Project 9768(803A), Contract AF 49(638)-172; SRPP, AFOSR.

Investigation of the growth and motion of Sporadic E patches which occur seasonally in Puerto Rico. This study includes correlation of Sporadic E with other phenomena such as the abnormal increase of ionization of Sporadic E during hurricanes, and with star scintillation phenomena. Backscatter data at three different frequencies (21.6, 40.68 and 49.68 mc) is being recorded and analyzed, particularly in relation to the sporadic E phenomena and long range transequatorial echoes.

11.101

Purdue U., Lafayette, Ind.
PROPERTIES OF A COHERENT LIGHT SOURCE, A. K. Kamal. Project 9768(803A), Grant AF-AFOSR 62-296; SRPP, AFOSR.

AFOSR- Air Force Office of Scientific Research
- SRA- Directorate of Research Analysis
- SRC- Directorate of Chemical Sciences
- SRE- Directorate of Engineering Sciences
- SRI- Directorate of Information Sciences
- SRL- Directorate of Life Sciences
- SRM- Directorate of Mathematical Sciences
- SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
- CRR- Electronic Research Directorate
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  - CRRD- Electromagnetic Radiation Lab
  - CRRI- Astrosurveillance Sciences Lab
  - CRRK- Propagation Sciences Lab
  - CRRS- Communications Sciences Lab
  - CRRZ- Control Sciences Lab
- CRZ- Geophysics Research Directorate
  - CRZA- Photochemistry Lab
  - CRZC- Thermal Radiation Lab
  - CRZE- Research Instrumentation Lab
  - CRZG- Terrestrial Sciences Lab
  - CRZH- Meteorological Research Lab
  - CRZI- Ionospheric Physics Lab
  - CRZR- Sacramento Peak Observatory

This research covers an investigation of pulsed laser beams, especially Stark and Zeeman effects, space coherence of the wave front, and improved detection techniques. Initial research employs a ruby laser with application of Stark and Zeeman broadening in an effort to tune the laser over a broad frequency band. This work is expected to contribute to a more complete understanding of the operation of quantum-effect coherent light generators.

11.102

Purdue U., Lafayette, Ind.
SCATTERING OF WAVES BY PERFECTLY REFLECTING BODIES, F. V. Schultz. Project 5635(803A), Contract AF 19(604)-4051; CRRD, AFCRL.

An investigation of (1) the scattering of electromagnetic waves by perfectly reflecting complex shapes, and (2) the reduction of scattering cross sections by methods other than coating reflecting surface with absorbing materials such as shaping or reactive loading. Calculations have been made on the cross sections of finite cones (spherically capped) in the resonance region and Rayleigh region.

11.103

Queen Mary Coll., London U. (Gt. Brit.).
PHENOMENA IN THE IONOSPHERE AND LARGE SCALE TRANSPORT, V. C. A. Ferraro. Project 7635(770A), Contract AF 61(052)-299, Grant AF-EOAR 61-41; CRZA, AFCRL.

Solutions have been found for the equations of motion, diffusion, and charge transport under conditions appropriate to ionospheric drift and to blast-and shock-wave phenomena. Numerical values have been used for the parameters in these equations and comparison made with observed values as feasible. These studies relate closely to communication problems in the ionosphere under perturbed conditions.

11.104

Queensland U. (Australia).
TRANSEQUATORIAL, BACKSCATTER AND EXOSPHERIC-DUCTING PROPAGATION, H. C. Webster. Project 5631(803A), Contract AF 64(500)-9; CRRK, AFCRL.

Experimental observations and theoretical interpretation of transequatorial modes of radio propagation from the southern to northern hemisphere. Backscatter soundings--with antennas rotating in azimuth at 16 and 55 Mc--are made to observe reflections from field-aligned irregularities in the ionosphere, forward propagation via the F_2 layer and subsequent backscatter by the ground at the magnetic conjugate area, and forward propagation via filamentary ionization aligned along geomagnetic lines in the magnetosphere and subsequent backscatter by the ground at the conjugate area.

11.105

RCA Victor Co., Ltd. (Canada).
PHASE AND ATTENUATION FUNCTIONS OF RADIOWAVES PROPAGATED IN MAGNETO-IONIC MEDIA, M. P. Bachynski. Project 5631 (803A), Contract AF 19(604)-7432; CRRK, AFCRL.

Performs theoretical studies on the phase and attenuation functions of electromagnetic waves transmitted and reflected in an ionized medium bounded by a plane surface and containing a uniform magnetic field. Non-linear effects, effects due to charged-particle streams in the medium, effects due to differences between electron and ion temperatures, effects due to collisions among different species of ions, and special boundary-surface effects will be studied. The contractor has nearly completed a comprehensive study for the case of a plane electromagnetic wave incident upon an homogeneous, anisotropic medium bounded by a plane surface.

11.106

Rhode Island U., Kingston.
ELECTROMAGNETIC WAVES ALONG INTERFACES WITH NON-SIMPLE BOUNDARY CONDITIONS, J. Kane. Project 5635(803A), Contract AF 19(604)-7983; CRRD, AFCRL.

Contractor has calculated current distribution along surface wave antennas, in a manner that takes into account the interaction between feed and terminal discontinuity. The work will be extended to encompass boundary conditions that more accurately describe a real interface(such as that of a dielectric, artificial dielectric, or plasma layer) than the simplified Leontovich boundary condition used heretofore.

11.107

Rhode Island U., Kingston.
ELF PROPAGATION PHENOMENA, C. Polk. Project 5631 (803A), Contract AF 19(604)-7252; CRRK, AFCRL.

ELF noises are simulated at microwave frequencies by usage of scaled models of the earth and ionosphere. A plane model was investigated. A spherical model is near completion. In an observational program, ELF noises are received on two coils oriented in the NS and EW directions. Resonance noises at frequencies around 9 c/s were observed. The variation of their characteristics with ionospheric conditions is under investigation. The nature of other observed noises is not yet known. It is planned to correlate the program with measurements at other locations and to study some of the observed effects by means of the simulation technique.

11.108

Rochester U., N. Y.
EFFECTS OF IMPERFECTIONS ON THE OPTICAL AND ELECTRICAL PROPERTIES OF SOLIDS, D. Dexter. Project 9760(802A), Contracts AF 18(600)-193, AF 49(638)-432; SRPS, AFOSR.

A theoretical study of the effects of imperfections on the optical and electrical properties of solids is undertaken along the following lines: (1) investigation of the role of exchange in insulating crystals; (2)

AEL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARH- Hypersonics Research Lab
ARK- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

AED- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESER- Operational Applications Lab

Theory of concentration quenching of luminescence; (3) Measurement of the vacuum ultra-violet absorption spectrum and photoconductivity of films in rare gases; (4)"Boiling off" of incipient F-centers; (5) Edge luminescence in cadmium sulfide; and (6) Absence of luminescence in alkali halides after excitation in the F-band at liquid helium temperatures.

11.109

Rochester U., N. Y.
FUNDAMENTALS OF GEOMETRICAL OPTICS, R. E. Hopkins. Project 9768(803A), Contract AF 49(638)-668; SRPP, AFOSR.

This study concerns development of more accurate theories to support requirements for modern lens design and to define more precisely the meaning of the merit function. Study includes detailed investigation of the ray differential equation and comparisons with the finite difference equation. Methods will be developed for evaluating lens systems by means of automatic computing equipment.

11.110

Rochester U., N. Y.
EFFECTS OF COHERENCE IN EM RADIATION, E. Wolf. Project 9768(803A), Grant AF-AFOSR 62-246; SRPP, AFOSR.

This research is concerned with a better understanding of the properties of electromagnetic radiation in the optical frequency region, especially its coherence properties.

11.111

Saskatchewan U. (Canada).
EFFECTS OF THE AURORA ON THE PROPAGATION OF RADIO WAVES, P. A. Forsyth. Project 5631(803A), Contract AF 19(604)-7329; CRRK, AFCRL.

The purpose of this work is to analyse data on back scatter and forward scatter of radio energy gathered by radio systems operated by the University of Saskatchewan. A study to provide new information on the effects of the aurora on meteoric propagation mode and ionospheric scatter propagation will be made. Additional information concerning the little known nature of magnetic field aligned ionization as a potential mode of propagation particularly in the auroral regions should result from these studies. The data collected at the University of Saskatchewan will be correlated with the meteor and auroral reflection information obtained with the Prince Albert Radar.

11.112

Societa Industrie Elettroniche (Italy).
MICROWAVE INVESTIGATION OF THE DIELECTRIC WAVE GUIDE PROPAGATION BY MAGNETO-IONIC DUCTS, A. Gilardini. Project 5631 (803A), Contract AF 61(052)-145; CRRK, AFCRL.

Experimental and theoretical study of waveguide propagation in a plasma with presence of a longitudinal magnetic field. The objective is to simulate as closely as possible "whistler propagation" and to find out what other propagation effects may occur in VLF propagation through the ionosphere. The planned investigations are concerned with nonuniform plasmas, coupling between plasma ducts, group propagation, and wall effects.

11.113

South Carolina U., Columbia.
NON-WAVEGUIDE METHODS OF MILLIMETER WAVE TRANSMISSION, R. G. Fellers. Project 9768(803A), Grant AF-AFOSR 61-53; SRPP, AFOSR.

This research concerns the study of millimeter electromagnetic wave diffraction theory, design of various geometrics for transmission and reflection of these waves, design of new antenna feed systems, and the adaptation of optical frequency methods to the solution of millimeter wave problems.

11.114

Stanford Research Inst., Menlo Park, Calif.
LUMINESCENCE OF SOLIDS PRODUCED BY SURFACE RECOMBINATION OF ATOMS, H. Wise, K. M. Sancier. Project 9760(802A), Contract AF 49(638)-353; SRPS, AFOSR.

This is a study of the conversion of the heterogeneous recombination energy on free-atoms (and other unstable species) into luminescent energy of a solid surface composed of a phosphor such as calcium oxide. Luminescence of the phosphor is observed as a function of time, surface temperature, physical and chemical constitution of the phosphor, identity and pressure of the gas, and power input to the discharge. The gases being used include hydrogen and nitrogen. The basic phosphor used in the work to date has been calcium oxide.

11.115

Stanford U., Calif.
INTERACTION OF MICROWAVES WITH MATTER, M. Chodorov. Project 9768(803A), Grant AF-AFOSR 62-343; SRPP, AFOSR.

This research covers theoretical and experimental investigations on the interaction of microwaves with plasmas and with ferrites. Emphasis is placed on: an investigation of plasma properties as these affect the propagation of e.m. waves at microwave frequencies; interaction of electron beams and plasmas; plasma probing by microwave signals; plasma properties as related to the microwave energy used for producing plasma; use of ferrites as active elements for microwave generation and frequency doubling; and millimeter wave generation using plasmas and ferrites.

11.116

Stanford U., Calif.
NATURAL AND MAN-MADE VLF PHENOMENA, R. A. Helliwell. Project 9768(803A), Contract AF 49(638)-1060; SRPP, AFOSR.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

A theoretical study of the effects of imperfections on the optical and electrical properties of solids is undertaken along the following lines: (1) Investigation of the role of exchange in insulating crystals; (2) This research includes an investigation of whistlers and related low frequency radio wave phenomena, both theoretical and experimental, with emphasis on excitation and focusing aspects in terms of a new dispersion law. Measurements are also being made of the power spectrum, direction of arrival and polarization of whistlers. The origin of certain unusual whistlers such as the dawn chorus is being investigated. The experimental data will be used to provide an understanding of the generation of whistlers and related phenomena, and to develop a theory of propagation of signals in the whistler mode.

11.117

Stanford U., Calif.
RADIO INTERACTION STUDIES, A. M. Peterson. Project 7661 (770A), Contract AF 19(604)-7994; CRZI, AFCRL.

Conduct studies and experimental investigations directed to determine the effects of auroral ionization upon radio waves.

11.118

Stanford U., Calif.
OPTICAL AND IR MASERS AND COHERENT PLASMA PHENOMENA, A. Siegman, O. Buneman. Project 9768(803A), Grant AF-AFOSR 62-286; SRPP, AFOSR.

Theoretical and experimental studies of maser operation from the viewpoint of bandwidth limitations, frequency stability and inherent noise, using a quantum electrodynamics approach rather than classicial EM theory. The plasma research aims to clarify certain coherent plasma phenomena encountered in efforts to generate extreme frequencies by means of plasma oscillations.

11.119

Stanford U., Calif.
STUDIES IN TUNABLE CIRCUITS, NON-SCANNING SPECTRUM ANALYSIS, WIDE-BAND OSCILLATORS, TRAVELING WAVE PRINCIPLES, KLYSTRONS, SOLID STATE ELECTRONICS, NETWORKS, F. E. Terman. Project 4751(803A), Contract Nonr 225(24); SRPP, AFOSR.

This Joint Services program includes basic theoretical and experimental studies on electron devices such as new microwave tubes for higher frequency and higher power applications, advanced circuit-analysis and synthesis including sampled data feedback systems, transistor and related solid state electronics research, and electromagnetic wave propagation including meteor ionization studies and low frequency propagation phenomena.

11.120

St. Louis U., Mo.
THEORETICAL PROBLEMS CONNECTED WITH THE SOLID STATE RASER, W. A. Barker. Project 9763(802A), Contract AF 49(638)-612; SRPS, AFOSR.

The purpose of this research is to carry out a theoretical study of problems relating to the solid state raser, a device similar to the solid state maser proposed by N. Bloembergen. Both devices are solid state quantum mechanical amplifiers, but the raser operates in the radio frequency region whereas the maser operates in the microwave region. This research will include a study of the gain, bandwidth, and signal to noise ratio of the raser, and related questions such as the effect upon the energy band structure of various solids resulting from the type of magnetic field used in producing nuclear polarization. Another interesting related effect which will be studied more extensively is the specific heat associated with steady state "inverted" Overhauser nuclear polarization.

11.121

Sylvania Electric Systems, Waltham, Mass.
LOW FREQUENCY PROPAGATION IN UPPER IONOSPHERE, R. V. Row. Project 5631(803A), Contract AF 19(604)-7228; CRRK, AFCRL.

A theoretical study of low frequency propagation (below 1 kc) in the upper ionosphere will be conducted. The significance of the motion of ions and electrons in the presence of the earth's magnetic field and in interaction with each other will be examined. The investigation will look into the disturbances induced in the medium by a moving external charge, planar disturbances, associated dispersion relations, group velocities, attenuation, etc.

11.122

Technion Research and Development Foundation (Israel).
MEASUREMENTS OF VERY LOW FREQUENCY RADIATIONS, U. Galil. Project 5631(803A), Contract AF 61(052)-555; CRRK, AFCRL.

Instrumentation consisting of a loop antenna, preamplifier, amplifier and recorder is being installed at a noise free site near Haifa, Israel. Measurements will be made of noise bursts at five (5) kilocycles per second. These bursts apparently originate from upper atmospheric sources and are believed to be caused by interaction between auroral particle streams and the plasma of the outer atmosphere. Data will be compared with similar data taken in different parts of the world in order to study the noise source distribution in more detail.

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ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNR- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESWR- Operational Applications Lab

11.123

Technion Research and Development Foundation (Israel). OPTICAL PROPERTIES OF ATOMIC DISPERSION IN INERT MATRICES, O. Schnepp. Project 9763(802A), Contract AF 61(052)-428; SRPS, AFOSR.

Dispersions of metal atoms or ions in such matrix materials as solidified rare gases, solid ammonia, and ice will be prepared and studied. The crystal field perturbation of the metal atoms and ions will be investigated by spectroscopic methods. In the case of ionized metal atoms the electronic properties of the dispersions will be examined.

11.124

Texas U., Austin.
PROPAGATION CHARACTERISTICS OF THE ATMOSPHERE, A. W. Straiton. Project 5631(803A), Contract AF 19(604)-8038; CRRK, AFCRL.

Theoretical study on propagation through the troposphere and ionosphere, with consideration of: (a) apparent directions of departure and arrival of ray paths (b) travel time for pulsed waves and for CW waves; (c) Doppler shifts; (d) signal amplitude. The study will emphasize models of the atmosphere which are intermediate between uniform layers and homogeneous time-stationary turbulence. The study will include analysis, with regard to statistical parameters, of data from rocket, satellite and radio-astronomical experiments by other groups.

11.125

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass. SCATTERING STUDIES, P. R. Gast. Project 7670(770A), Internal.

This effort involves the measurement of scattering of radiation in the earth's atmosphere and the correlation of the results with laboratory data and theory to obtain description of the distribution, amount and effect on infrared radiation of atmospheric aerosols. The effort is primarily in the stage of constructing and testing the required measuring instrumentation and reducing preliminary data.

11.126

University Coll. of Ghana (Ghana).
EQUATORIAL STUDY OF IRREGULARITIES OF THE IONOSPHERE, R. H. Wright. Project 5631(803A), Contract AF 61(052)-421; CRRK, AFCRL.

Study irregularities in the ionosphere as observed at equatorial latitudes as follows: (a) study of semi-antipodal signal characteristics using the Freiburg Rhombic antenna; (b) observe HF Arctic signals for diurnal and seasonal amplitude and multipath variations and fading rates; (c) study semi-antipodal signals, with attention to equatorial and north-south characteristics; (d) study the morphology of equatorial Spread F and its correlation with Arctic Spread F, layer tilt and Sporadic E occurrences; and also (e) examine the backscatter from the ionosphere during Spread F and Sporadic E conditions for information regarding size, location, shape and orientation.

11.127

University of Southern California, Los Angeles. PLASMAS AND MAGNETOHYDRODYNAMICS, Z. A. Kaprielian. Project 9768(803A), Grant AF-AFOSR 62-112; SRPP, AFOSR.

This research covers broadly theoretical and experimental investigations of plasmas, especially their high frequency oscillations, amplification, influence on antenna radiation, electromagnetic scattering properties and dielectric properties when subjected to magnetic or electric fields. The research also includes magneto-hydrodynamic aspects of plasmas based on the interaction of radiation and magnetic fields with plasmas, and plasma transport properties.

11.128

University of Western Ontario (Canada).
MILLIMETER ELECTROMAGNETIC RADIATION PRODUCED BY HIGH ENERGY ELECTRON BEAMS, E. Brannen. Project 9768(803A), Grant AF-AFOSR 62-172; SRPP, AFOSR.

The object of this research is the production of useful amounts of sub-millimeter electromagnetic radiation by means of the Cerenkov effect. The electrons which produce the Cerenkov radiation will be energized in a special microton electron accelerator being constructed at the University of Western Ontario.

11.129

Utah U., Salt Lake City.
INTERACTION OF LIGHT WITH MATTER STUDIED BY EFFECT OF DIFFRACTION ON POLARIZATION, F. S. Harris. Project 9768(803A), Grant AF-AFOSR 62-226; SRPP, AFOSR.

11.130

Washington U., Seattle.
RADIATION SYNTHESIS STUDIES, D. K. Reynolds. Project 5635(803A), Contract AF 19(604)-4098; CRRD, AFCRL.

Theoretical and experimental studies on modulated spiral radiators, azimuthal pattern synthesis for circular apertures, azimuthal pattern synthesis for circular cylinders, azimuthal leaky waveguide radiation, and on surface waves over conducting plane in a plasma in the presence of a d.c. magnetic field; radiation from line sources in magnetoplasma.

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See also: 1.5, 4.4, 4.18, 4.21, 4.27, 4.42, 4.61, 6.30, 6.35, 6.45, 6.51-52, 6.121, 7.54, 7.60, 8.37, 8.39, 8.63, 9.19, 9.33, 9.41, 9.57, 10.3, 10.28, 12.1, 12.35, 12.44, 12.55, 12.78, 12.81, 12.96, 14.25, 14.68, 16.43, 17.91, 19.111, 20.14, 20.61, 20.79, 23.7, 23.54, 23.73, 23.77, 23.129

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12. PHYSICS OF CONDUCTING FLUIDS

Hydromagnetic Flow; Electron Density in Plasmas; Emission of Radiation by Plasmas; Shock Wave Characteristics in Plasmas; Particle Interactions in Plasmas; Electric Conductivity of Plasmas; Plasma Diagnostic Devices and Techniques; Explosion-generated Plasmas; Arc Discharges; Flow of Plasmas; Heat Transfer in Plasmas; Temperature Measurement in Plasmas; Ion Generation; Acceleration of Plasmas.

12.1

Advanced Kinetics, Inc., Santa Ana, Calif.
GENERATION OF MILLIMETER WAVES IN PLASMA, R. W. Waniek. Project 4619(760E), Contract AF 19 (604)-7406; CRRC, AFCRL.

The basic objective of this research project is the investigation of the radiative behavior of high energy electrons in strong magnetic fields. Trajectory studies of electrons injected into axially symmetric strong magnetic fields are performed by the incorporation of the first order Lagrangian equations of motion into a trajectory program formulated in the Fortran code for an IBM 709. The detailed effects of injecting particle bunches are studied together with other system parameters of immediate interest, such as: injection velocity and direction, bunch spread as a function of injection point and time, and injection spread in velocity and position.

12.2

Advanced Kinetic, Inc., Costa Mesa, Calif.
HIGH TEMPERATURE NON-EQUILIBRIUM PLASMA CONFIGURATIONS, R. W. Waniek. Project 5634(803A), Contract AF 19(604)-7363; CRRC, AFCRL.

This research is aimed at the observation of thermalisation processes in colliding plasmas. Strong-field geometries of two different types have been developed. In the first, the confining fields are mirror-like; this geometry is termed a Helmholtz geometry; in the second geometry, the confining fields are cusped-shaped; in such case the geometry is labeled a Counter-Helmholtz geometry.

12.3

AeroChem Research Lab., Inc., Princeton, N. J.
ATOMIC CONCENTRATIONS IN SUPERSONIC STREAMS, H. F. Calcote. Project 9752(801A), Contract AF 49(638)-300; SRE, AFOSR.

The present objectives of this work are the re-examination of current methods for determining atom concentrations in supersonic non-equilibrium streams, and the development of new techniques. Making use of a low-temperature plasma jet, the method of cooled catalytic probes is being investigated, while the previously developed method of uncooled probes is being critically studied. The titration method in which the atoms are quantitatively reacted with propylene, are being reinvestigated with titrants other than propylene, and with chromatographic as well as mass spectroscopic analysis of titration products. At the same time, recombination coefficients for nitrogen atoms on hot metallic surfaces under high velocity flow are being examined. The determination of N atoms concentration by the catalytic probe method gives a value one half as great as the one obtained by titration methods. Since the precision of this chemical method leaves much to be desired, an effort is being made to improve the technique.

12.4

AeroChem Research Lab., Inc., Princeton, N.J.
EFFECTS OF MAGNETIC FIELDS ON FLOW IN IONIZED GASES, H. F. Calcote. Project 7063(806A), Contract AF 33(616)-6717; ARN, ARL.

The aim of this essentially experimental research program is to determine the feasibility of reducing rates of heat transfer from electrically conducting gases (plasmas) to bodies in contact with them by means of the application of electric or magnetic fields.

12.5

Aerojet-General Corp., Azusa, Calif.
POSITIVE ION SURFACE EMISSION FOR PROPULSION, R. J. Sunderland, Project 9751(801A), Contract AF 49(638)-214; SRE, AFOSR.

There are in general two methods for making large quantities of ions. One is by bombardment of neutral atoms by electrons and the other is by contact ionization between suitably chosen atoms and surfaces. The relative effectiveness of the two methods of producing a high intensity beam of ions is now under investigation. Quantitative measurements on the intensity and on the purity of the beam are being made.

12.6

Aeronutronics Space Technology Operations, Newport Beach, Calif.
NON-EQUILIBRIUM PLASMA PROPERTIES, S. R. Byron. Project 9751(801A), Contract AF 49(638)-670;

SRE, AFOSR.

The present effort is redirected toward the study of plasma problems of general interest. Because of non-uniformity of the T-tube hot gas sample, an approach using a driver high enthalpy shock tube will be used which provides a constant velocity shockwave and a test gas sample having uniform and readily calculable properties. Initial experimental work is directed toward the measurement of electron-ion recombination rates, and then comparison with theory.

12.7

Allison Div., General Motors Corp., Indianapolis, Inc.
RAIL TYPE ELECTROMAGNETIC ACCELERATION, T. L. Rosebrock. Project 9752(801A), Contract AF 49(638)-864; SRE, AFOSR.

The basic problem is a quantitative description and experimental varification of the energy losses in the process of transforming electrical energy into kinetic energy of the exhaust jet. One of the theoretically tractable configurations is the rail accelerator. The effort will center on the reduction of loss mechanisms associated with a rail configuration. Basic areas currently being investigated are: (1) investigations of methods for minimizing energy and propellant mass losses associated with plasma formative dispersion; (2) evaluation of effects on accelerator performance of reduced circuit inductance and internal discharge control; and (3) establishment of criteria for the selection of electrode materials producing maximum arc velocities and minimum electrode erosion.

12.8

Armour Research Foundation, Chicago, Ill.
DETERMINATION OF PROCESSES WHICH OCCUR IN PLASMAS AND ABLATING SYSTEMS, J. Brophy. Project 7364(802A), Contract AF 33(616)-6686; ASRC, ASD.

The purpose of this program was to obtain qualitative knowledge of the energetics and chemical processes which occur in plasmas and ablating systems. A complementary goal was to examine the feasibility of using available spectrographic research tools to detect the prevailing chemical species in arc plasmas and ablating boundary layers, and to determine their states of excitation, dissociation and ionization. An incremental study was to be made both axially and radially, using the emission and the time-of-flight spectrometers to determine the relative amounts and the preferred zones of the various species present. Similar studies were to have been made concurrently of the boundary layers adjacent to various materials ablating in an air arc plasma. This program was aimed at obtaining a better understanding of the energetics and chemistry of air stabilized arc plasmas, detailed ablation mechanisms, and the composition of the boundary layers surrounding an ablating system.

12.9

Armour Research Foundation, Chicago, Ill.
THEORETICAL AND EXPERIMENTAL STUDY OF PLASMOIDS, L. C. Scholz. Project 7073(806A), Contract AF 33(616)-5791; ARH, ARL.

Improvement in the design and reliability of the equipment was made during the last year. Specific improvements included all electronic ignitron switching in the plasmoid generator permitting greater flexibility, wide working range (5-20 kilovolts), and providing accurate timing with very low jitter. A satisfactory current measuring resistor was devised and installed permitting accurate determination of the magnitude and shape of the arc current. The high speed camera circuits were improved providing faster rise time pulses (10 nanoseconds) with shorter possible exposure time (50 nanoseconds). A series of still pictures were made. This gave an instantaneous picture of the shape and position of the plasmoid. A large number of time integrated exposures were also taken showing the path of the plasma material through the field, around obstacles, and the interaction with probes. Using probe techniques the velocity has been measured as a function of field strength and capacitor voltage. The effect of the ambient pressure was also investigated. Two other interesting topics were explored; namely, the interaction of two plasmoids launched simultaneously on initially parallel paths and the problem of the generation and acceleration of the plasmoid. The generation of the plasmoid and the erosion of material from the electrodes was approached as a cold cathode arc problem and a rough study was made along these lines. Microphotographs indicated a complex arc structure at the electrodes which does not permit a simple formulation of the heat flow and other parameters. However, a very generalized idea of a "best material" was worked out.

12.10

Astrosurveillance Sciences Lab., CRRI, AFCRL, Bedford, Mass.
MHD EXCITATION MECHANISMS, M. Bruce. Project 5633(803A), Internal.

This in-house effort comprises an experimental and theoretical study of hydromagnetic waves of very low frequency. It includes investigations of devices and methods for initiating hydromagnetic waves and the determination of the percentage of transferred energy to specific modes of propagation. Plasma of a quiescent nature are utilized which

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are produced by ultraviolet radiation in cesium gas at very low pressures.

12.11

Astrosurveillance Sciences Lab., CRR, AFCRL, Bedford, Mass.
RADIATIVE PROPERTIES OF PLASMA ENGINE, R. Murphy. Project 5633(803A), Internal.

Plasma engines satisfy the need for an experimental tool to pursue research in properties of exhaust gas structures. Investigations of the radiative mechanisms of these engines will be made by considering them both on the ground and in the space environment. The initial experiment simulates a plasma engine by employing a glass container which is hemispherically surrounded by a half-turn of a large coil and is evacuated by a vacuum system capable of 10^{-7} mm Hg. The coil is energized by a bank of capacitors capable of delivering 80,000 amps within 10 microseconds. In turn the capacitors are supplied by a 60 kv power supply.

12.12

Atlantic Research Corp., Alexandria, Va.
HIGH-PRESSURE PLASMA PRODUCTION TECHNIQUE, R. Friedman, L. W. Fagg. Project 9750(801A), Contract AF 49(638)-651; SRE, AFOSR.

The present work is directed to the study of a novel and potentially convenient means of producing a concentrated high pressure plasma and to explore its properties. The basic idea is that if a powdered oxidizer such as cesium perchlorate or cesium nitrate were mixed with a metal having a high heat of combustion and pressed together to form a stick, it would burn like a propellant when suitably ignited, particularly at high ambient pressure. The combustion products would be sufficiently hot to permit high concentrations of cesium ions and free electrons. The program includes (1) the solution of thermodynamic equilibrium equations for a variety of chemical systems, (2) experimental formulation and determination of combustion characteristics of the most promising systems, and (3) the study of the properties of the plasma produced by these means.

12.13

Avco Mfg. Corp., Everett, Mass.
RESEARCH ON PLASMA PROPULSION, G. S. Janes. Project 9752(801A), Contract AF 49(638)-659; SRE, AFOSR.

The practical problem is to examine the various electromagnetic propulsion concepts, classify them according to the differences in the basic principles involved and evaluate the factors that determine the conversion of electromagnetic energy into kinetic energy of the plasma beam. The scientific problem is the formulation of a theoretical model of each of the several mechanisms for the acceleration of plasma. The theoretical model must provide the means for making quantitative estimates of the efficiency of energy conversion and propellant mass utilization. Experimental determination of the correlation between the parameters describing the model will establish the adequacy of the theory for the prediction of the behavior of the plasma.

12.14

Avco Mfg. Corp., Everett, Mass.
PROPERTIES OF COLLISIONLESS PLASMA, R. M. Patrick. Project 9751(801A), Contract AF 49(638)-1129; SREP, AFOSR.

The experiment consists of producing the plasma between concentric cylinders in a magnetically driven annular shock tube. Containing fields are furnished by external current carrying coils. The diagnostic technique is to determine shock yield and plasma density by measuring the light emitted by the shock-heated plasma. Changes in magnetic flux are measured by very small flux coils.

12.15

Avco Mfg. Corp., Wilmington, Mass.
RADIATION FROM ARC HEATED PLASMAS, C. Ultee. Project 7063(806A), Contract AF 33(616)-8390; ARN, ARL.

This study will endeavor to determine the radiation characteristics of air, argon, hydrogen, helium, and nitrogen at various pressures and enthalpies up to 100 atm and 30,000 BTU/lb. The program will emphasize the measurement of many accurate radiation data and the comparison of these data with theory.

12.16

Boston U., Mass.
COLLECTIVE MOTION IN PLASMAS, C. R. Willis. Project 4619(760E), Contract AF 19(604)-7419; CRRC, AFCRL.

It is the purpose of this contract to make a study of the relationship of the formulas of collective motion in normal gases to the more complex formulas applicable to ionized gases.

12.17

Brown U., Providence, R. I.
MAGNETOGASDYNAMICS, P. F. Maeder. Project 9781 (806A), Grant AF-AFOSR-62-111; SREM, AFOSR.

A method is proposed to measure electrical conductivity in ionized gases at extreme temperatures and moderate pressures. This method would use the

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fact that eddy currents set up in a plasma by an alternating current in a coil will cause an emf to appear on the ends of the coil. The impedance of the coil becomes a function of the plasma conductivity and the device can be used to make local measurements.

12.18

Brown U., Providence, R. I.
HYDROMAGNETIC STABILITIES, W. H. Reid. Project 8600 (804A), Contract AF 19(604)-7236; AFCRL.

Development of techniques for treating the linear stability equations that arise in problems of fluid motion when curvature, rotation and/or magnetic field is present. Investigation of the finite amplitude motion which occurs once instability has set in and the energy exchange between the velocity and magnetic fields these motions introduce.

12.19

Brandeis U., Waltham, Mass.
PLASMAS AND DEGENERATE MATTER, J. S. Goldstein. Project 8608(801A), Contract AF 19(604)-7283; CRZC, AFCRL.

To investigate theoretical wave and shock phenomenon in plasmas and degenerate matter. The scope of this study will include magneto-hydrodynamic waves, shock wave wake, and acoustic waves. The investigation of extremely dense matter in the degenerate form will include a quantum mechanical approach.

12.20

California Inst. of Tech., Pasadena.
PLASMA DYNAMICS, R. W. Gould. Project 9768(803A), Contract AF 49(638)-820; SRPP, AFOSR.

This research aims to develop and test fundamental concepts and relations involved in plasma behavior, especially plasma dynamics. It includes also the investigation of hydromagnetic phenomena, especially wave propagation in plasmas. Present emphasis covers: a theoretical study of Alfven propagation in a hot, dense cylindrical plasma; the design and construction of a plasma generator for experimental Alfven wave studies; and consideration of ion waves and oscillations from the theoretical and experimental viewpoint.

12.21

California Inst. of Tech., Pasadena.
GROWTH OF BOUNDARY LAYERS IN PLASMA ACCELERATORS, F. E. Marble. Project 9751(801A), Contract AF 49(638)-758; SRE, AFOSR.

The objective of this research effort is a detailed theoretical model of the boundary layer in plasma accelerators of steady and pulsed varieties sufficient for the prediction of their performance. The properties of the model are to be formulated in such a way as to permit experimental evaluation of the theoretical predictions. In particular, the conductivity, heat transfer, degree of ionization and momentum distribution will be calculated and measured.

12.22

California U., Berkeley.
THEORETICAL RESEARCH IN MAGNETOHYDRODYNAMICS, K. M. Watson, L. G. Hanyey. Project 9768(803A), Contract AF 49(638)-508; SRPP, AFOSR.

This theoretical research in magnetohydrodynamics includes studies of flow stability and transport of ionized fluids in magnetic fields and boundary condition effects on the stability of finite regions, experiencing gravitational acceleration. The work is also being extended to approximate transport equations in magnetic fields where binary ionized-particle collisions are not reversible and to scattering phenomena, second order corrections to adiabatic processes and to Fermi acceleration.

12.23

California U., Berkeley.
ELECTRON AND PLASMA BEAM DYNAMICS, C. Susskind. Project 5634(803A), Contract AF 19(604)-2270; CRRC, AFCRL.

The Hall effect in gases is being studied with a view to possible utilization of the effect in the measurement of intensity of an incident e.m. field and measurement of very small d.c. fields. Sinusoidal oscillations in gaseous conductors with no external circuitry except a voltage source and stabilizing resistors and plasma oscillations along magnetic field lines are being studied. Interaction of the drifting electron beam with a plasma is being investigated experimentally and theoretically.

12.24

Canadian Commercial Corp., Washington, D.C.
MODULATED ELECTRON BEAM DIAGNOSTIC TECHNIQUES OF BASIC PLASMA PARAMETERS, T. W. Johnston. Project 4619(760E), Contract AF 19(604)-7246; CRRC, AFCRL.

The object of the investigation is to devise techniques to use the predicted interaction between a plasma and a fine electron beam which has been density-modulated at a microwave frequency to yield information about the plasma.

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12.25

Case Inst. of Tech., Cleveland, Ohio.
HYDROMAGNETIC SHOCKS, O. K. Mawardi. Project 8608 (801A), Contract AF 19(604)-7287; CRZC, AFCRL.

To investigate both theoretically and experimentally hydromagnetic shocks in ionized gases. To construct apparatus to determine experimentally the interactions and behavior of a plasma beam penetrating a magnetic field. To develop a high velocity high density plasma beam gun. To investigate both theoretical and experimental hydromagnetic shocks with particular reference to ionized gases, although certain investigations will be carried on in liquids and solids. Several shock tubes will be constructed and methods of intensifying shocks in order to approach states that may be dealt with more exactly theoretical are being devised. Methods of determining both experimentally and theoretically magnetic field distribution and gas temperature inside the shock are being investigated. The role of magnetohydrodynamic wave will be considered.

12.26

Chicago U., Ill.
EFFECTS OF AN AXIAL MAGNETIC FIELD ON FLOW OF IONIZED GAS, J. Bonin. Project 7063(806A), Contract AF 33 (616)-8048; ARM, ARL.

The study is concerned with the experimental determination of the effects of strong axial or transverse magnetic fields on the flow phenomena and the heat transfer from partially ionized gases to the walls of a circular duct. Through analytical work the experimental data will be compared and correlated with theories. Special emphasis will be given to the effects of the non-uniform distribution of ionized particles across the radius of the duct on the magnetic interaction phenomena.

12.27

Chicago U., Ill.
HYDROMAGNETIC STABILITIES, S. Chandrasekhar. Project 8600(804A), Contract AF 19(604)-2046; CRZI, AFCRL.

This research covers theoretical studies on the decay of a magnetic field in a fluid conductor and other problems relating to magnetic clouds and hydromagnetic oscillations.

12.28

Chicago U., Ill.
TRANSPORT PROPERTIES OF PARTIALLY IONIZED GASES, J. P. Dickerman. Project 9781(806A), Contract AF 49(638)-1033; SREM, AFOSR.

The contractor employs a spectroscopic technique for measuring the radial temperature distribution in an arc discharge using argon, helium, and nitrogen as working gases. From the temperature distribution, the voltage-current characteristics of the arc, and computed values of ion-electron collision cross sections (which can be computed with some confidence), the atom-electron cross sections are computed. These are used to determine the transport properties.

12.29

Columbia U., New York.
HYDROMAGNETIC PLASMA RESEARCH, R. A. Gross. Project 9751(801A), Grant AF-AFOSR-62-47; SREP, AFOSR.

The main emphasis is on the study of the dynamics, kinetics and radiation associated with a hydrogen plasma. The experimental range chosen permits a study of the plasma from the conditions where it behaves as an aggregate of particles through to a continuum fluid. A new versatile hydromagnetic shock tube with several special features is being constructed to permit direct comparison between experiment and theory. Coupled with these experiments is an expansion of diagnostic techniques and of existing theory.

12.30

Columbia U., New York.
FLUID TRANSPIRATION ARC, C. Sheer. Project 9781 (806A), Grant AF-AFOSR-62-293; SREM, AFOSR.

The contractor proposes to perform diagnostic measurements of the physical properties and flow characteristics of a high temperature, high intensity electric arc which will employ a porous, transpiration cooled anode. An attempt will be made to understand the energy exchange mechanisms whereby the energy of the electric field is transferred to the gas in the region between the electrodes. Diagnostic techniques will include spectroscopic measurements and Langmuir and Hall probe measurements, all directed toward describing the voltage, charged particle, and temperature distributions in the inter-electrode region.

12.31

Dayton U., Ohio.
SPECTROSCOPIC PLASMA ANALYSIS, W. G. Rambeuske. Project 7073(806A), Contract AF 33(657)-7925; ARM, ARL.

A basic research program in high energy density plasma physics shall be conducted using experimental facilities of the ARL, such as a Bausch and Lomb

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dual grating spectrograph, d-c power supplies, etc. A high energy density plasma shall be generated by an electrical discharge of an energy storage capacitor bank through a pre-ionized discharge vessel. The plasma thus created will be analyzed by electrical and optical methods yielding the ion and electron density, the particle temperature, collision frequencies and information on the degree of the energy equilibrium.

12.32

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
EXTREME HIGH TEMPERATURE RESEARCH STUDIES, E. Rutner. Project 7367(802A), Internal.

An experimental research investigation will be conducted to determine the relative merits of the line intensity of I, II, III ionized states methods for measuring the temperature of the hot gases produced in the 200 KW plasma jet facility at ASD's Directorate of Materials and Processes. Both photographic and photomultiplier spectroscopic techniques will be applied. Various parts of the air stabilized plasma jet will be probed to determine the temperature distribution, the nature of the species and their diffusion rates to the cooler portions of the plasma jet.

12.33

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
ELECTROMAGNETIC RADIATION AND PLASMA TRANSPORT PROPERTIES, G. Meltz. Project 5635(803A), Internal.

Ionization effects on the transport properties of a laminar boundary layer are to be considered.

12.34

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
ELECTRON DENSITY MEASUREMENT, T. J. Skinner, G. Meltz. Project 5635(803A), Internal.

Two techniques for the measurement of the electronic density in ionized flow fields are being explored. The first method is a variation of a technique due to Lin, Reselet, and Kantrowitz. The second technique employs a resonant cavity -- one wall of which is an ionized plasma. Both methods possess the important advantage of requiring no external sensor in the flow field.

12.35

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
PLASMA DIAGNOSIS AND PLASMA ELECTRONICS, S. B. Harskovitz. Project 5634(803A), Internal.

Experiments continue, aimed at comparing various plasma probes using the same gas under similar conditions. These techniques are microwave cavity, microwave transmission (guided and unguided) and quenching of afterglow. The study of microwave detection continues with emphasis on identifying the factors which determine sensitivity. Studies of ionization with high power microwaves and studies of the coupling of H.F. electromagnetic energy into extended plasmas continues.

12.36

Electronics Technology Lab., ASRMT, ASD, Dayton, Ohio.
ENERGY MECHANISMS IN PLASMAS, G. K. Medicus. Project 4152(803A), Internal.

This effort deals with the determination of the properties of plasmas by means of Langmuir probes. Parts of this work are (1) automatic second derivative of probe curves, (2) theory of electron collection of spherical probes, and (3) the effect of work function on probe characteristics. Work will be extended to achieve correlation between microwave and probe analysis.

12.37

Electro-Optical Systems, Inc., Pasadena, Calif.
ELECTRICALLY EXPLODING WIRES AND FILMS, F. H. Webb. Project 9752(801A), Contract AF 49(638)-1063; SREP, AFOSR.

When a thin wire or film is subjected to rapid current discharge it evaporates into a highly ionized gas and expands with high velocity. Studies are directed at understanding the vaporization and energy exchange process, the behavior of film fragments and the overall efficiency of the acceleration process. Currently the feasibility of utilizing an image technique and special geometries for plasma confinement are being investigated analytically and experimentally. Also being conducted, are theoretical and experimental studies of a unique means of energy transfer to a neutral dense plasma by coupling magnetic pressure to the plasma.

12.38

General Electric Co., Philadelphia, Pa
FUNDAMENTALS OF MHD FLOW, G. W. Sutton. Project 9752(801A), Contract AF 49(638)-914; SRE, AFOSR.

This research concerns the motion of plasmas which are at low enough temperatures and high enough densities to be considered a continuum. At the present time, the MHD flow including the Hall effect in the end region of a channel is being analyzed. A technique is also being developed to determine

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the MHD channel for maximum power generation.

12.39

Georgia Inst. of Tech., Atlanta.
MOBILITY AND CLUSTERING OF NEGATIVE IONS, D. W. Martin. Project 9767(803A), Contract AF 18(600)-1524; SRPP, AFOSR.

This research deals with ion identification in gaseous electronics experiments involving complex initial ionisation processes which are not well understood. Present work covers precise mass spectrographic studies of ion-molecule reactions under thermal equilibrium conditions. Theoretical interpretation of the experimental results is being undertaken. In addition, studies are being initiated on the transport properties of a fully ionized gas.

12.40

Giannini Scientific Corp., Santa Ana, Calif.
THERMALLY ACCELERATED PLASMA JETS, A. C. Ducati. Project 9751(801A), Contract AF 49(638)-1161; SREP, AFOSR.

During the past years theoretical and experimental work has been conducted to analyze the possibility of space propulsion with plasma jets which are thermally accelerated. Without regeneration, efficiencies between 15 and 20 percent have been measured. The various losses that constitute the 80 - 85 percent of the total input can be grouped in three principal categories: (1) losses in the heat transfer to the propellant, (2) losses in directing and accelerating the propellant, and (3) losses in dissociation and ionization of the propellant. The scope of this research is to analyze the various losses to obtain a more accurate balance and to explain the eventual anomalies experimentally encountered.

12.41

Giannini G. M. and Co., Inc., Pasadena, Calif.
INITIAL IONIZATION PROCESS IN GASES, H. G. Loos. Project 9751(801A), Contract AF 49(638)-655; SRR, AFOSR.

The initial phases of the process by which plasma is created play a very important part in the subsequent transfer of energy from the electromagnetic field to the plasma. The efficiency of the acceleration process is directly dependent on the conductivity of the plasma. A theoretical model of the process has been formulated and can be described in the following way. A gas is suddenly subjected to a high intensity electric field with cylindrical symmetry. During the short rise time of the field the major effect is to accelerate the free electrons in the gas. The second phase during which ionization occurs is characterized by collisions between electrons and neutral atoms. The means by which the energy is transferred and the resulting ionization is presently being investigated.

12.42

Hebrew U. (Israel).
ELECTRON DENSITY, IONIZATION RATE, AND APPROACH TO EQUILIBRIUM BEHIND SHOCK WAVES, W. Low. Project 9781(806A), Contract AF 61(052)-401; SREM, AFOSR.

Using microwave absorptive techniques, the contractor will investigate the interaction of microwaves with shock waves for the general purpose of measuring the electron densities, the temperature, and the rate of ionization of the shocked gas. A microwave interferometer is to be used to measure the phase in addition to absorption so that the electron density and the collision frequencies can be obtained from the onset of ionization to recombination.

12.43

Hughes Research Lab., Malibu, Calif.
PROBE INSTRUMENTED CESIUM PLASMA TUBE, J. Y. Wada. Project 4152(803A), Contract AF 33(657)-8348; ASRNE, ASD.

The program will perform research to establish the feasibility of using Langmuir probes, based on work of G. K. Medicus, in a cesium plasma. The electron temperature will be approximately 2000°K and the density will be 10^{11} - 10^{12} ions and electron/cc.

12.44

Illinois U., Urbana.
BASIC PROPERTIES OF GASEOUS PLASMAS, L. Goldstein. Project 5634(803A), Contract AF 19(604)-7473; CRRC, AFCRL.

This research on microwave plasmas is presently concerned with the development and use of novel plasma diagnostic techniques such as electronic and nuclear resonance; plasma paramagnetics, and Hall coefficient measurements. Studies are underway on the interaction of magnetic fields with ionized gases such as the broadening of electron gyro-resonance by noise-field photons, and gyro-acoustic resonance phenomena. Refinement of certain theoretical and experimental determinations such as electron afterglow temperatures and electromagnetic radiation scattering is being carried out.

12.45

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
STELLAR ASTRONOMY, G. W. Wares. Project 8635(804A), Internal.

A program of theoretical studies of the structure of a

shock wave in a plasma in the presence of a magnetic field has been in progress. The approach is the microscopic or Boltzman approach and leads to charge separation and oscillations within the shock as were found in previous work by the continuum theory and in the absence of a magnetic field.

12.46

Johns Hopkins U., Baltimore, Md.
INSTABILITIES OF MAGNETICALLY CONFINED PLASMAS, M. Scotto. Project 5634(803A), Contract AF 19 (604)-5468; CRRC, AFCRL.

The objective of this contract is to study experimentally and theoretically, instabilities in a magnetically confined plasma considering both longitudinal and circumferential fields. Instabilities in a Philips ionization gauge have been observed by measuring the noise power spectra in a coaxial line coupled to the plasma. In the immediate future, measurements of noise power density as a function of frequency will continue over a wide band in the megacycle range.

12.47

Kiel U. (Germany).
METHOD FOR MEASURING TEMPERATURES BETWEEN 5000° and 15,000° Kelvin, W. Lochte-Holtgreven. Project 7367 (802A), Contract AF 61(052)-512; ASRC, ASD.

The investigation is directed toward research on methods for the measurement of the maximum temperatures existing in hot gases issued from an air stabilized electric arc jet. It is expected that these gas temperatures will range from 3000°K to 15,000°K depending upon the power and air input into the electric arc. A plasma generator capable of producing relatively clean hot gases having enthalpies of at least 8,000 BTU/pound of air shall be used as the source of high temperatures. The contractor shall develop at least one of the possible spectroscopic techniques into a system suitable for making rapid measurements. A proposed method involving the measurement of the relative intensities of nitrogen I, II, and III spectroscopic lines using a monochromator employing an oscillating mirror, a photomultiplier and associated electronic circuitry feeding an appropriate recorder to record the necessary information shall be investigated.

12.48

Kiel U. (Germany).
QUANTITATIVE SPECTROSCOPIC TEMPERATURE DETERMINATION OF PLASMAS UP TO 10^5 DEGREES KELVIN, L. Holtgreven. Project 7073(806A), Grant AF-EOAR-61-29; ARH, ARL.

The contractor will start the high temperature measurements at temperatures of about 3×10^4 degrees K and work gradually to establish methods for measurement of higher temperatures. The temperatures will be obtained in plasmas in electric arcs operated continuously at a current of about 100 amps. This arc will be pinched by a strong additional outer magnetic field. Special attention will be given to the investigation of whether or not thermodynamic equilibrium exists or can be obtained in the plasma. Using this approach to create a high temperature plasma, the contractor's efforts will be directed to the 10^5 degrees K. area. The investigation will be made by spectroscopically measuring line intensities, line shifts, line widths and continuous emission from the plasma.

12.49

Laboratoire Mediterraneen de Recherches Thermodynamiques (France).
RAREFIED GASDYNAMICS, F. M. Devienne. Project 9781(806A), Contract AF 61(052)-124; SREM, AFOSR.

Theoretical and experimental investigations of the phenomena produced by the displacement of a body at high speeds in an ionized gas shall be performed. A rotating arm facility, housed in a special low pressure chamber, shall be used to obtain measurements of the medium near the body, including measurements of the variation of the magnetic field. In addition, studies will be initiated on the problems of friction and momentum exchange in a rarefied atmosphere by means of projecting a molecular beam on the surface of a rotating disc. These latter investigations shall include: (1) the measurement of the momentum exchange coefficient; (2) measurement of lingering time; (3) a study of the laws of reflection of molecules relative to speed; (4) a study of the influence of temperature of the molecular beam on the reflection of molecules; (5) a determination of the recombination time of ions on the surface; and (6) a study of the influence of the speed of molecules on a chemical surface.

12.50

Litton Industries, Beverly Hills, Calif.
ELECTROMAGNETIC ACCELERATION OF PLASMAS, A. S. Penfold. Project 9752(801A), Contract AF 49 (638)-759; SREP, AFOSR.

A puff of gas that is initially ionized can have its conductivity maintained and even increased by the action of a moving magnetic field if the lines of force are allowed to cut through the plasma as is done in the armature of an induction motor. The pre-ionized puff of gas is trapped in a moving magnetic field. The slip of the plasma through the field maintains the current in it. The experimental confirmation of this concept is accomplished by injecting a puff of preionized gas into a cylindrical tube with concentric

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external coils which are energized in a programmed sequence. The plasma is then tracked down the tube with suitable instrumentation.

12.51

Maryland U., College Park.
PHENOMENA SURROUNDING HIGH SPEED FLOW, J. M. Burgers. Project 9781(806A), Contract AF 49(638)-401; SRE, AFOSR.

The group is engaged in the investigation of (a) the properties of gases at high temperatures; (b) the effects of these properties on high speed flow; (c) electro- and magneto-gasdynamics; and (d) dynamics of rarefied gases. Under (a) the investigation bears upon the effects which occur in atomic and molecular collisions, in particular in view of electronic excitation, ionization, and dissociation, while it may extend into the domain of chemical reactions. Under (b) the kinetic theory of gases, the Boltzmann equation and the transfer equations deduced from it, is applied to the analysis of flow phenomena, including effects of viscosity, diffusion, heat conduction, radiation, electric conductivity, and transfer of energy between different types of particles. Under (c) the high speed flow of electrically conductive gases is studied, under the influence of electric and magnetic fields. Finally, under (d) phenomena are considered occurring when the density of the gas is so low that collisions are of little importance in the behavior of the particles.

12.52

Maryland U., College Park.
SHOCK PROPAGATION IN A RAREFIED PLASMA, INTERACTION OF SHOCK WAVES WITH MAGNETIC FIELDS, AND BASIC LAWS OF MAGNETOGASDYNAMICS, H. Grien. Project 8606(801A), Contract AF 19(604)-4074; CRZC, AFCRL.

Research directed toward the theoretical and experimental study of shock propagation in a rarefied plasma, interaction of shock waves and turbulence with magnetic fields, and the basic laws of magnetogasdynamics. Special emphasis will be placed on measurement of the absolute spectral line intensities and the spectral line broadening from luminous shock waves as a diagnostic tool.

12.53

Maryland U., College Park.
COLOR CENTERS IN ALKALI HALIDES, W. G. Maisch. Project 9760(802A), Contract AF 49(638)-627; SRPS, AFOSR.

This research is concerned with the study of the effect of pressure and temperature on various optical absorption bands in irradiated and additively colored alkali halides. The absorption spectrum of certain colored alkali halides will be studied at pressures up to 50,000 atmospheres using recently developed high pressure apparatus. Correlation of frequency shift, band widths, bleaching, dichroism, and the appearance of new bands (K^0) with fundamental properties of the lattice will be attempted.

12.54

Maryland U., College Park.
DRAG OF CHARGED BODIES IN PLASMA, S. F. Singer. Project 9781(806A), Contract AF 49(638)-899; SRE, AFOSR.

The contractor will attempt to calculate the potential on a satellite from laboratory considerations of charging of spherical bodies moving in a plasma, will calculate drag forces resulting therefrom, and may attempt to provide direct experimental verification of the results. The charging mechanism will be studied, as will the principal "types" of electromagnetic drag: the coulomb drag due to electrical repulsive forces and the wave drag due to the energy lost by the charged body moving through a plasma.

12.55

Massachusetts Inst. of Tech., Cambridge.
INTERACTION OF HIGH POWERED RF ENERGIES & HIGH DENSITY PLASMAS, S. C. Brown. Project 5634(803A), Contract AF 19(604)-5992; CRRC, AFCRL.

The aim of this work is to study the fundamental properties of plasmas with emphasis on high density plasmas and plasmas in magnetic fields. The resonant cavity probing technique as developed and perfected at M.I.T. during the past ten years, is being used. Plasmas with high percentage ionization have been produced using cesium. In addition to microwave and spectroscopic probing, IR probing will be investigated.

12.56

Massachusetts Inst. of Tech., Cambridge.
DESIGN OF AN ELECTROMAGNETIC A-C PLASMA ACCELERATOR, E. E. Covert. Project 7065(806A), Contract AF 33 (657)-7975; ARF, ARL.

The purpose of the work is to provide information leading to design requirements for a high Mach number a-c plasma accelerator which will provide the proper environment for re-entry flow simulation. The desired altitude range is from 300,000 to 400,000 feet, and Mach number range from 10 to 40. The study is to further develop and extend the concept of the traveling wave pump, the operating principles of which were demonstrated in a circuit having a three-inch diameter test section. The traveling wave pump is an electromagnetic accelerating

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apparatus which adds both heat and kinetic energy to a previously ionized gas confined in a tube by the application of a moving electromagnetic field.

12.57

Massachusetts Inst. of Tech., Cambridge.
PLASMA STUDIES USING ELECTROLYTIC ANALOGIES, E. E. Covert. Project 9781(806A), Contract AF 49(638)-900; SRE, AFOSR.

The complexity of a plasma makes it difficult to predict the gross behavior as well as the microscopic phenomena. Considerable effort is directed toward a better understanding of reaction mechanisms (ionization and recombination processes, chemical effects).

12.58

Massachusetts Inst. of Tech., Cambridge.
HEAT TRANSFER IN DISSOCIATED GASES, J. A. Fay. Project 9781(806A), Contract AF 49(638)-643; SREM, AFOSR.

This research continues to be aimed at a furtherance of our knowledge of the phenomena associated with heat transfer in ionized gases.

12.59

Massachusetts Inst. of Tech., Cambridge.
HYDROMAGNETIC SHOCKS, J. A. Fay. Project 8608(801A), Contract AF 19(604)-4551; CRZC, AFCRL.

To investigate both theoretical and experimental hydromagnetic shocks with particular reference to ionized gases, although certain investigations will be carried on in liquids and solids. Several shock tubes will be constructed and methods of intensifying shocks in order to approach states that may be dealt with more exactly theoretical are being devised. Methods of determining both experimentally and theoretically magnetic field distribution and gas temperature inside the shock are being investigated.

12.60

Massachusetts Inst. of Tech., Cambridge.
CONDUCTION IN IONIZED GAS-SURFACE INTERACTIONS, J. L. Kerrebrock. Project 9751(801A), Grant AF-AFOSR-62-306; SREP, AFOSR.

For conducting gases with rather large deviation from thermal equilibrium and the degree of ionization not large enough to render the fully ionized gas theory valid, much additional theoretical and experimental work is needed before the electrical conductivity and other properties can be predicted with engineering accuracy. Kerrebrock has developed a simple theory to treat one type of deviation from thermal equilibrium. The first objective is to provide additional experimental verification as well as further analytical development of this theory. The second objective is to study, both analytically and experimentally, the interaction between ionized gases and surfaces. These experimental studies are carried out in a continuous flow plasma apparatus.

12.61

Massachusetts Inst. of Tech., Cambridge.
PLANE SHOCKS AND HIGH SPEED PLASMA IN MAGNETIC FIELDS, C. Moffatt. Project 8608(801A), Contract AF 19(628)-221; CRZC, AFCRL.

To investigate both theoretical and experimental hydromagnetic shocks with particular reference to ionized gases, although certain investigations will be carried on in liquids and solids. Several shock tubes will be constructed and methods of intensifying shocks in order to approach states that may be dealt with more exactly theoretically are being devised. Methods of determining both experimentally and theoretically magnetic field distribution and gas temperature inside the shock are being investigated. The role of magnetohydrodynamic wave will be considered. Special attention will be given to boundary layer flow.

12.62

Massachusetts Inst. of Tech., Cambridge.
PHYSICS OF HIGH SPEED RAREFIED GAS AND PLASMA MOTIONS, L. Trilling. Project 9781(806A), Grant AF-AFOSR-62-84; SREM, AFOSR.

The research done under this contract includes an investigation of rarefied gas flows by a new statistical technique based on the Monte Carlo method. The research also includes an investigation of the stability of plasmas under certain classes of small disturbances. Finally, it includes the construction of a molecular beam apparatus for the purpose of measuring accommodation coefficients and scattering cross-sections in the 1 ev energy range.

12.63

Miami U., Coral Gables, Fla.
PROCESSES IN PLASMAS, B. Kursunoglu. Project 6694(750F), Contract AF 19(604)-8082; CRZA, AFCRL.

Experimental and theoretical studies are being performed on transport processes and their relationship to cooperative phenomena in a steady-state plasma in an axial magnetic field. Measurements of diffusion coefficients, viscosity and

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electrical and thermal conductivity are being compared with theoretical results and with calculations from measured distribution functions. Data are being obtained from a variety of instrumentation, including Langmuir probes, velocity analysers, and photoelectric detectors. In addition, an attempt will be made to measure viscosity and torque transfer mechanically.

12.64

Michigan U., Ann Arbor.
MAGNETIC PROBLEMS OF GASES AND SOLIDS, W. Dow. Project 8608(801A), Contract AF 19(604)-4557; CRZC, AFCRL.

To investigate theoretically and experimentally the acceleration of a plasma by magnetic fields. This study will include not only the usual electrical engineering concept of the plasma as a projectile interacting with the magnetic field or electric gun, but also a detailed description of the plasma on a single particle basis. Measurements will be taken of a solenoidal type accelerator to verify theoretical prediction.

12.65

Michigan U., Ann Arbor.
CORONA DISCHARGE PHENOMENA IN FLOWING GASES, H. C. Early, D. B. Miller. Project 7116(801A), Contract AF 33(616)-7243; ARM, ARL.

This study is concerned with the investigation of non-arc diffused electrical discharge phenomena in a flowing gas. It will include theoretical and experimental investigations of the phenomena of arrested field breakdown employing pulsed discharges. The effects on arrested field breakdown of voltage, duration of pulsed discharge, cycle duration, alternating polarity for a given electrode configuration as well as flow velocity, nature and condition of the gas will be determined. Determinations are to be made on the energy input and the state of the discharge gas.

12.66

Minnesota U., Minneapolis.
HEAT TRANSFER IN DISSOCIATED AND IONIZED FLOW, E.R.G. Eckert. Project 7064(806A), Contract AF 33(616)-5528; ARF, ARL.

Heat transfer measurements will be made in a system of high temperature partially ionized gas flow along cooled solid surfaces of simple geometrical shape. For these investigations a jet of high temperature gas will be generated by means of an arc discharge heater. Feasibility studies will be made on a possible reduction of heat losses in the electrode system by transpiration cooling.

12.67

Minnesota U., Minneapolis.
HEAT TRANSFER IN PLASMA STREAMS, E.R.G. Eckert. Project 7063(806A), Contract AF 33(657)-7380; ARM, AFOSR.

Investigations of arc-heated high temperature gas streams are to be conducted. Emphasis is to be placed on (1) studies to obtain a basic understanding of the heat transfer process at a transpiration or water cooled anode, (2) a study of the basic physical processes determining heat transfer, and possibly mass transfer, on a transpiration cooled wall, and (3) development of a computer program and calculations of thermodynamic and transport properties for a plasma in thermodynamic equilibrium as a means of constructing Mollier charts for the study of heat and mass transfer processes in a plasma.

12.68

Minnesota U., Minneapolis.
DYNAMICS OF PLASMA RINGS, T. S. Lundgren. Project 7071(806A), Contract AF 33(616)-7877; ARM, ARL.

This contract covers a theoretical investigation of the dynamic behavior of a plasma ring when the ring is moving in a uniform magnetic field. Initially the ring axis will be taken parallel to the magnetic field. Finally, the plasmoid moving in a time-dependent magnetic field will be considered. Later investigations will include the case for a plasma ring moving in a space-dependent magnetic field, and will consider the stability of the ring under these conditions. Lastly, two plasma rings moving toward each other along their common axis, which is in the direction of a uniform magnetic field, will be investigated. The contractor has considered several theoretical models for a plasma ring and has begun an investigation of the compression of the plasma in an infinite cylinder by a suddenly applied magnetic field.

12.69

Minnesota U., Minneapolis.
GASEOUS ELECTRONICS, M. J. Oakam. Project 9768 (803A), Grant AF-AFOSR-62-103; SRPP, AFOSR.

This work includes a detailed study of various basic processes occurring in gaseous discharge plasmas with emphasis on processes that determine the properties of decaying plasmas. Various measuring techniques, such as microwave, drift-velocity spectrometer, mass-spectrometer and light-spectrometer diagnostics will be applied simultaneously. The gases to be studied by the various methods are helium-neon mixtures; neon, argon and hydrogen, deuterium and their mixtures

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with the rare gases.

12.70

Minnesota U., Minneapolis.
THERMIONIC PROCESSES, H. J. Oskam. Project 6694(750W), Contract AF 19(604)-8072; CRZA, AFCRL.

The work of this contract involves the following interrelated studies: (1) theoretical and experimental study of space-charge limited currents in gas-filled tubes; (2) study of the quantities determining the occurrence of a plasma c[illegible]arter discharge; (3) study of the properties of the plasma converter discharge. Using the data obtained in these studies, an attempt is being made to develop a refined physical mechanism for the fundamental collision phenomena associated with the motion of charge carriers in alkali vapors.

12.71

Minnesota U., Minneapolis.
TRANSIENT BEHAVIOR OF PLASMA, H. J. Oskam. Project 4152(803A), Contract AF 33(657)-8687; ASRMM, ASD.

The behavior of low temperature plasmas under transient conditions will be determined. The first step is the examination of the behavior of pulsed Langmuir probes. Correlation with the data from unpulsed Langmuir probes will then be effected. Subsequently, an evaluation of probes in pulsed plasmas and various excitation conditions will be made.

12.72

Minnesota U., Minneapolis.
NOISE PROPERTIES OF GAS DISCHARGES, A. Van der Ziel. Project 4152(803A), Contract AF 33(616)-7731; ASRMM, ASD.

The general objective of this work is a better understanding of the physics of plasmas by studying the noise produced in the plasma. Techniques and apparatus for picking up noise from plasmas and for analyzing the noise spectrum have been developed. There are four principle lines of investigation: Probe Noise in DC Discharges, Noise in Electrodeless Discharges, Electromagnetic Radiation of a Plasma, and Transient Behavior of Noise Temperatures.

12.73

New Hampshire U., Durham.
CONDUCTION THEORIES IN GASEOUS PLASMAS AND SOLIDS, L. Mower. Project 9768(803A), Grant AF-AFOSR-62-105; SRPP, AFOSR.

This research involves a theoretical investigation of transport phenomena and the general mechanism of conduction in gaseous plasmas and in solids.

12.74

New York U., N. Y.
MACROSCOPIC MAGNETO-FLUID-DYNAMICS, J. Berkowitz, H. Grad. Project 9781(804A), Grant AF-AFOSR-62-266; SRRM, AFOSR.

The contractor is performing theoretical studies of a perfectly conducting fluid to understand: (a) one dimensional flows in which the magnetic field guides the flow, (b) two dimensional simple waves which arise in the flow, and (c) flow around bends and corners. In order to treat these problems effectively, new mathematical methods will be developed as appropriate.

12.75

New York U., N. Y.
HYDROMAGNETIC TURBULENCE, M. Kline, R. Kraichnan. Project 9768(803A), Contract AF 49(638)-1065; SRPP, AFOSR.

An analytical approach to the solution of the hydromagnetic turbulence problem is being made. This includes derivation of the equations of motion for velocity and magnetic fields in an incompressible, highly conducting fluid. Using these equations, the distribution of the energy of excitation of velocity and magnetic fields over the wave vector and overfrequency will be determined. Resulting expressions for the nonlinear energy exchange between low and high wave number modes will then be used to determine equilibrium spectra and decay rates for hydromagnetic turbulence.

12.76

New York U., N. Y.
MAGNETIC HYDRODYNAMICS WITH APPLICATION TO PHENOMENA APPEARING IN THE VICINITY OF OUR PLANET AND IN SPACE, M. Kline. Project 8600 (804A), Contract AF 19(604)-6144; CRZI, AFCRL.

The study and mathematical investigations of the motions of charged particles of an ionized fluid in the presence of external magnetic field with particular application to motion in the ionized layers of the atmosphere and to the influence such motions have on the geomagnetic field at and near the earth's surface.

12.77

North Carolina State Coll., Raleigh.
PLASMA HEAT TRANSFER RESEARCH, J. T. Yen. Project 7116(801A), Contract AF 33(657)-8068; ARM, AEL.

This is a theoretical study of magnetohydrodynamic

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heat transfer problems in continuous and plasma flows having as its goal the determination of the influence of various phenomena such as electrical conductivity of the confining surfaces, Hall and ion slip currents, etc. on the flow and thermal fields subject to magnetic fields.

12.78

Northeastern U., Boston, Mass.
THEORY OF PLASMA OSCILLATIONS, G. Lenna. Project 9768 (803A), Contract AF 49(638)-555; SRPP, AFOSR.

This research program has included the theoretical analysis of instabilities in plasma pinches, and the study of characteristics of magnetohydrodynamic shock waves. Further studies are being made on the propagation of electromagnetic and hydromagnetic waves in an ionized gas. In particular, the coupling between the two modes of propagation produced by the presence of an external magnetic field will be examined. The main purpose is to show that plasma oscillations in the presence of a magnetic field radiate electromagnetic waves at the boundary between ionized and non-ionized gas. This study attempts to establish agreement between the experimental spectrum of cosmic noise and theory.

12.79

Northrop Corp., Hawthorne, Calif.
MEASUREMENT OF PLASMA PROPERTIES BY MOMENTUM CHANGE TECHNIQUES, S. T. Demetriades. Project 9752(804A), Contract AF 49(638)-1160; SREP, AFOSR.

This research is to investigate the possibility of measuring plasma properties (e.g., collision frequencies) by observing momentum changes of a plasma stream due to applied elvetric and magnetic fields.

12.80

Northwestern U., Evanston, Ill.
PLASMA PROPERTIES, A. B. Cambel. Project 8951(806A), Contract AF 40(600)-972; AEOR, AEDC.

Based upon improved techniques of terminating the infinite series representing the electronic partition function, the thermodynamic properties of high temperature oxygen and nitrogen will be determined. The electrical conductivity of seeded atmospheric gases will be measured and the pertinent collision cross-sections determined. The radiation from high temperature atmospheric gases, with and without alkali seeding material, will be measured.

12.81

Northwestern U., Evanston, Ill.
THERMOSPHERICAL PROPERTIES OF PLASMAS, A. B. Cambel. Project 9751(801A), Contract AF 49(638)-879; SREE, AFOSR.

Current research is concerned with determining (1) the kinetic coefficients for the recombination of ions and electrons, and the effect of radiative transfer to high Mach number shock waves, (2) the effect of electron-neutral particle collision on the transmission and reflection of microwaves incident on the plasmas, and the tensor electrical conductivity of the plasma, and (3) the velocity distribution and thermal conductivity of a conventional plasma jet, and the electrical conductivity, thermal conductivity and viscosity of a plasma as a function of its thermodynamic state.

12.82

Observatoire de Meudon (France).
THEORY OF MAGNETOGASDYNAMICS, J. F. Denisse. Project 8608(801A), Grant AF-EOAR-60-224; CRZC, AFCRL.

Extend the Boltzmann theory to magneto fluid dynamics. Attempt to bring together the hydrodynamic and the kinetic approaches in magnetogas-dynamics. Determine the behavior of disturbances in a low density gas in a magnetic field. The objective of this research is to attempt to tie together the continuum and kinetic theory approaches for a better understanding of magnetogasdynamics and correspondingly a more fruitful approach to the utilization of an ionized gas for the generation of energy.

12.83

Ohio State U., Columbus.
SHOCK-TUBE ASTROPHYSICS, A. Slettebak. Project 8635(804A), Contract AF 19(604)-4055; CRZI, AFCRL.

The contractor has designed and fabricated a luminous shock tube to act as an optical source at the temperatures of stellar atmospheres, but under precisely measured conditions of temperature, pressure, and density. He will use shock-tube and auxiliary research equipment to determine the optical properties of high temperature gases (plasmas). Now that initial experiments are virtually complete, a systematic program will be undertaken to determine the transition probabilities (f-values) for various atoms and molecules of astrophysical interest. These f-values constitute one of the outstanding needs of modern astrophysics. The shock-tube will also be used to facilitate identification of certain unidentified lines and bands in stellar spectra. Experiments relating to line broadening in certain gases will also be attempted; in any case the recent theory of

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ARE- Solid State Physics Research Lab
ARS- Metallurgy & Ceramics Research Lab
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ASRMM- Electronics Technology Lab
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RAEM- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAE- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AERR- Research Division
AFWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
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hydrogen line broadening by Alan Kolb and Hans Griem will be used as a diagnostic tool to determine ion densities from the measured broadening of lines of hydrogen introduced as a tracer.

12.84

Oregon State Coll., Corvallis.
LINEAR EMISSION CHARACTERISTICS DURING EARLY STAGES OF MICROWAVE PLASMA FORMULATION, J. Brady. Project 5634 (800A), Contract AF 19(604)-5962; CRRC, AFCRL.

The object of this research is to obtain a better understanding of the details of the formation of microwave plasmas through study of the light emission occurring during the early stages of the plasma formation.

12.85

Oxford U. (Gt. Brit.).
PRODUCTION OF HOT PLASMA GASES AND MEASUREMENTS OF GAS TEMPERATURES BETWEEN 4000 AND 12,000°K NEAR SOLID SURFACES, A. Von Engel. Project 7367(802A), Contract AF 61(052)-405; AERC, AED.

This investigation is directed toward research on the properties of hot plasma gases and methods for measuring the temperature distribution in air in the range from 4000°K to 25,000°K and at pressures from 0.01 to 10 atmospheres as produced in the tail flames of air stabilized plasma jets.

12.86

Pennsylvania State U., University Park.
ELECTRODYNAMICS OF PLASMA, H. Li. Project 9751(801A), Contract AF 49(638)-647; SRE, AFOSR.

The macroscopic equations of magnetogasdynamics and the expressions for the transport properties must be determined for the various gas models proposed. This study approaches the problem from the point of view of individual particles to predict overall behavior for the ionized gas model assumed. The equations of state of a plasma in an electromagnetic field as well as the generalized Ohm's law for the plasma is under investigation. Transport coefficients such as diffusion, conductivity are being sought for a fully ionized gas to be later treated as a gas having finite conductivity. These theoretical investigations are being extended to the structure of a shock wave in an ionized gas subjected to an external field. The model assumed is that of a two component continuum consisting of ions and electrons in quasi equilibrium. The gasdynamics of plasmas with chemical reaction is being initiated.

12.87

Physics, Engineering and Chemistry (P.E.C.) Corp., Boulder, Colo.
QUANTUM MECHANICAL STUDY OF PLASMAS, M. Ashby. Project 7071(806A), Contract AF 33(616)-7972; ARM, AEL.

This contract sets out a program to establish the relation between the particle picture used in most theoretical descriptions of plasma physics and the formulation in terms of quantum mechanics, which is the basic physical form of such problems. The fundamental tool in this endeavor will be the utilization of Green's function of quantum field theory as basic quantities describing properties of many particle systems.

12.88

Physics, Engineering and Chemistry (P.E.C.) Corp., Boulder, Colo.
DYNAMICS OF IONIZED MEDIA (PLASMAS), W. Britton. Project 7071(806A), Contract AF 33(657)-8131; ARM, AEL.

Methods of non-equilibrium statistical mechanics will be applied to the problem of transport phenomena in a system made up of charge particles interacting via the electromagnetic fields. An attempt will be made to generalize the methods developed by Prigogine to include the electromagnetic field.

12.89

Plasmadyne Corp., Santa Ana, Calif.
HIGH INTENSITY IONIC JETS, A. C. Ducati. Project 9752(801A), Contract AF 49(638)-766; SRE, AFOSR.

The electrical energy supplied to a pressurized arc is transformed to thermal energy of the gas by collisions with electrons and ions created by the arc discharge. This energy must be distributed over the whole volume of the gas by mixing and then converted to beam kinetic energy by nozzles. The experiment to evaluate the effectiveness of this method for high exhaust velocities is one in which the measured thrust together with the mass flow rate is used as a criterion.

12.90

Plasmadyne Corp., Santa Ana, Calif.
INTERACTIONS BETWEEN AN ELECTRIC FIELD AND A GAS FLOW CARRYING AN EXCESS ELECTRICAL CHARGE, M. Gourdine. Project 7116(801A), Contract AF 33 (616)-8220; ARM, AEL.

A theoretical and experimental investigation is being conducted of one-dimensional steady electrogasdynamics where emphasis will include: (a) charge seeding and neutralization; (b) electrical

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characteristics of the system; (c) effect of gas state; (d) effect of massive charge carriers; and (e) secondary electrode effects.

12.91

Plasmadyne Corp., Santa Ana, Calif.
ROTARY MAGNETO FLUID DYNAMICS, C. Gourdine. Project 9752(801A), Contract AF 49(638)-1149; SREP, AFOSR.

An electrically conducting fluid subjected to the action of an axial magnetic field and a radial electric field will rotate. The objective of this research is a theoretical and experimental study of this phenomenon in two phases: (1) a mercury dynamics phase in which an ionized gas serves as the working fluid and compressibility is unimportant, and (2) a plasma dynamics phase in which an ionized gas serves as the working fluid and compressibility is very important. These phases run consecutively. The initial research concerns the steady and transient dynamics of mercury. A theoretical and experimental investigation of the homopolar device without mass flow, and considering transient and steady flows, is being undertaken. Also, a theoretical and experimental investigation of the homopolar device with radial and axial mass flows is being conducted.

12.92

Plasmadyne Corp., Santa Ana, Calif.
BASIC STUDY OF ENERGY EXCHANGE PROCESS BETWEEN AN ELECTRIC ARC AND A GAS FLOW, P. Thiene. Project 9781(806A), Contract AF 49(638)-334; SRE, AFOSR.

Initial experimental studies are being made using a vortex-stabilized spark; rather than an arc, in order to avoid the problems of heating and electrode erosion which are associated with arcs. The principal types of measurement which have been made are: (1) Kerr cell and rotating mirror photography of the spark, and (2) determination of pressure distribution throughout the vortex. In addition, a new technique for the measurement of conductivity of a plasma has been developed. This technique consists of measuring the change of inductance of a coil surrounding the plasma column. The study of sparks should be completed in the near future, and the study of continuous arcs initiated.

12.93

Plasma Physics Research Lab., ARH, ARL, Dayton, Ohio.
SHUTTER CHARACTERISTICS OF AN IMAGE CONVERTER DIODE, P. Bletzinger. Project 7073(806A), Internal.

The investigation of the behavior of the image diode is necessary before such diodes can be used properly for the recording of ultra short events. The present experimental setup uses a very high speed rotating mirror to deflect a light spot across the photocathode of the image diode with a speed of up to 4.10^4 m/sec. Primary illumination is supplied by a Xenon flashtube in a special arrangement to achieve extreme brightness and good synchronization. The recording of the light trace with the pulsed image diode and auxiliary devices will allow reconstruction of a complete time history of the light trace as seen by the diode and as it actually took place. Comparison of the two histories will point out limitations of the image diode as a recording device.

12.94

Plasma Physics Research Lab., ARH, ARL, Dayton, Ohio.
GALVANIC GUARD RING PROBE, R. Palmer. Project 7073(806A), Internal.

Voltage-current characteristics of galvanic probes are a means for determining plasma quantities such as carrier densities and temperature. The potential field created by the probe in the plasma is preferably one-dimensional, i.e., depends only on the distance from the probe surface. This condition can be approximated by the use of a guard ring around the probe extending in the plane of the probe surface. Probe and guard ring are held at the same potential but only the current to the probe-surface is considered for evaluation. Isolation must be achieved by a deep but very narrow gap; this requirement complicates the technology on the guard ring. Several very small guard ring probes have been built. To minimize discharge oscillations a barium hot cathode was introduced and a deep cylindrical anode was incorporated to minimize anode feedback oscillations encountered by Pekarek and Emeleus.

12.95

Plasma Physics Research Lab., ARH, ARL, Dayton, Ohio.
ELECTRIC ARC DISCHARGE UNDER ZERO GRAVITY CONDITIONS, R. Rautio. Project 7073(806A), Internal.

The heat of an electric arc in the gravitational field generates a flow field which deflects and cools the discharge. If, under zero gravity condition, the convective cooling flow is eliminated, the discharge should assume rotational symmetry and follow the electric field lines between the electrodes. The flight experiments offer much longer zero gravity intervals and also permit almost unlimited instrumentation space as compared to the loading capacity of the drop sled. The recordings of the arc parameters caused difficulties

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RAUA- Advanced Development Lab
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and further improvement of the recording devices is necessary.

12.96

Polytechnic Inst. of Brooklyn, N. Y.
PROBING OF PLASMAS, M. Ettenberg. Project 6694(750F), Contract AF 19(604)-8070; CRZA, AFCRL.

Research activity under this contract is directed toward the study of plasmas by means of microwave probing. Attempts are being made to correlate angular microwave scattering with the density distribution of a plasma column and to develop techniques of microwave probing of plasmas which do not depend on the transparency of the plasma.

12.97

Polytechnic Inst. of Brooklyn, N. Y.
PLASMAS AND HIGH DENSITY BEAMS, N. Marcuvitz. Project 9768(803A), Grant AF-AFOSR-62-274; SRPP, AFOSR.

Theoretical and experimental studies are being made of the various transport processes that take place in plasmas and high current density beams. These studies also include investigation of noise and plasma waves arising from electron emitting surfaces, as well as thermal velocity and boundary effects, plasma oscillations, and the influence of static magnetic fields. Increases in the power output and frequency of microwave sources necessitate increases in the density of the electron beams, causing these to approach an electron gas condition.

12.98

Queen's U., Belfast (Gt. Brit.).
ELECTRON BEAM SCATTERING AND OSCILLATIONS IN PLASMAS, K. G. Emeleus. Project 7073(806A), Contract AF 61 (052)-132; ARH, ARL.

Studies of the oscillations in the meniscus region of a low energy discharge were made by Langmuir probes and by spectroscopic means to investigate longitudinal and transverse oscillations, diffraction of wave beams and occurrence of and significance of harmonics and subharmonics. Experiments were conducted with increased cathode fall in order to complete the linkup of the Merrill-Webb type tubes and standing wave oscillators of Wehner, Monney and S. C. Brown. The "winging" of the discharge behind the meniscus region was studied. To avoid the interference caused by the Langmuir probes, spectroscopic means were used during the past year.

12.99

Radiation Dynamics Corp., Westbury, N. Y.
ION BEAM SOURCES FOR BOMBARDMENT STUDIES, K. Eklund. Project 4152(803A), Contract AF 33(616)-8063; ASRN, ASD.

Research is progressing on techniques required to devise a high intensity ion beam with variable but controllable energy down to a level of 10 electron volts under extremely clean vacuum conditions. The goals are to create an ion current density of the order of 0.5 ma/cm^2 on the target. The beam will be parallel and monoenergetic with a diameter on target of 3 to 5 millimeters. The energy will be variable between 10 electron volts and 50 kiloelectron volts. Emphasis is presently on deceleration techniques, analysis of current density, and the ionic energy distribution in the beam.

12.100

Radio Corp. of America, Princeton, N. J.
SIMULTANEOUS PROBE, MICROWAVE, AND SPECTRA PLASMA INVESTIGATION, M. Glicksman. Project 4152(803A), Contract AF 33(657)-7814; ASRNE, ASD.

The program will simultaneously evaluate a plasma in a microwave cavity by spherical Langmuir probes, microwaves, and spectral emission. Correlation between the methods will be effected. The work will allow the comparison of similar plasma experiments that are performed using the different diagnostic methods. The correlation will also allow the implication from data obtained by one method of those factors obtainable only by the other two methods.

12.101

Ramo-Wooldridge Corp., Los Angeles, Calif.
ION BEAM NEUTRALIZATION, D. Langmuir. Project 9752(801A), Contract AF 49(638)-886; SRE, AFOSR.

For ion propulsion space systems a basic problem is to determine quantitatively the effect of the field due to space charge outside the vehicle on the field inside the accelerating electrodes. Elimination of this field must be accomplished by injecting negative particles and creating a homogeneous plasma. The extent to which the outside field is eliminated can be measured by the behavior of charged particles shot through it, by detecting recombination radiation and by measuring the velocity of the ions. Research is now directed on a quantitative investigation of the properties of the plasma ejected from the ion engine. The properties are those of a pulsed, in-flight, plasma beam in order to establish the plasma behavior under conditions as nearly as possible those of the vehicular environment. Also, the effect of the geometry of the neutraliser will be analyzed.

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12.102

RCA Labs. Div., Radio Corp. of America, Princeton, N. J.
PLASMA ACCELERATION BY ELECTRIC FIELD GRADIENT, E. C. Hutter. Project 9752(801A), Contract AF 49(638)-658; SRE, AFOSR.

A new concept of plasma acceleration for use in satellite and space-vehicle propulsion and control is being investigated. A radio frequency alternating electric field gradient acceleration of plasma is employed to avoid both the neutralization problem of ion rockets and the plasma rocket requirement for heavy magnetic field equipment. The current work is continuing the investigation of plasma accelerators in non-uniform fields and extending it to a continuous mode of operation. An experimental program is being conducted to better demonstrate thrust feasibility and the results will be compared with theory.

12.103

Republic Aviation Corp., Farmingdale, N. Y.
REPETITIVE PINCH ACCELERATION, A. E. Kunen. Project 9752(801A), Contract MIPR 60-19; SRE, AFOSR.

The problem under consideration is the production of a series of successive electromagnetically induced pressure pulses to accelerate plasma. The concept is to form at each pulse a highly ionized cylindrical shell through which a large current is allowed to flow. The cylinder will pinch radially, compressing and accelerating the gas within and ejecting it through a suitably designed nozzle. The successive cycling requires that the gas swept out by the discharge be replenished. Two methods of repetitive pulsing are being investigated: (1) gas dynamical, which depends on the lowering of pressure following the ejection of a puff of plasma; and (2) electromagnetic pinching, in which the negative overshoot of a condenser discharge is used to interrupt the gas flow.

12.104

Royal Coll. of Science and Tech., Glasgow (Gt. Brit.).
STEADY AND UNSTEADY MOTION IN MAGNETO-FLUIDYNAMICS, D. C. Pack. Project 9783(806A), Grant AF-EOAR-61-49; SREM, AFOSR.

Theoretical research will be performed on the effect of a magnetic field upon the steady and unsteady motion of a conducting fluid. In addition, electrostatic and diffraction theory problems will be formulated in terms of singular integral equations and direct methods are to be developed for the numerical solution of these equations.

12.105

Sperry Rand Corp., Ford Instrument Co., Long Island City, N. Y.
METASTABLE SPECIES, T. Jarvis. Project 6694 (750F), Contract AF 19(604)-8486; CRZA, AFCRL.

Research directed toward the investigation of the volume ionization concept of space charge neutralization in a plasma diode thermionic energy converter. The work is theoretical as well as experimental. An attempt is being made to develop a better understanding of the physical mechanisms involved the arc process and in the volume ionizati effect.

12.106

Stanford U., Palo Alto, Calif.
PLASMA BOUNDARY STUDIES, M. Chodorow. Project 7073(806A), Contract AF 33(616)-8121; ARH, ARL.

The purpose of this contract is to study the plasma sheath and to develop theories and techniques suitable for determining the microscopic details pertinent to the plasma sheath. The structure of the sheath, e.g., particle distribution, potential distribution, oscillatory states, energy economy, particle balance and electron temperature, will be investigated in detail. The investigation will include the dependence of the parameters on the type of plasma excitation, DC field, and RF fields of various frequencies under simultaneous influence of a DC magnetic field of variable direction and intensity. The research will include the design and construction of an apparatus for production of a versatile, well instrumented moderate temperature plasma from which an ion beam can be extracted and its parameters measured.

12.107

Stanford U., Palo Alto, Calif.
CURRENT FLOW IN PLASMAS, H. Derfler. Project 5634(803A), Contract AF 19(604)-5480; CRRC, AFCRL.

Theoretical study of interparticle r.f. interaction processes in which coherent particle energies are rapidly converted to random energies. This involves the theoretical and experimental investigation of non-collisional interactions between plasma electrons and ions when they drift through each other to form a current.

12.108

Stevens Inst. of Tech., Hoboken, N. J.
MECHANISM AND DYNAMICS OF COAXIAL PLASMA ACCELERATION, W. H. Bostick. Project 9752(801A), Grant AF-AFOSR-62-225; SREP, AFOSR.

In the present configuration, the plasma is formed

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by vaporising a metallic wire by the rapid discharge of a capacitor. A study of pulsed metal arcs (lithium and copper) is being made by investigating mass flow, temperature and pressure of the arc and correlated with the vapor jet mechanism theory. An effort will be made to improve the pulsed plasma motor efficiency, velocity and energy handling capability, by studies of the acceleration processes. The solar wind type of plasma interaction with a two dimensional magnetic dipole will be studied. Also, development and refinement of related instrumentation will continue.

12.109

Stevens Inst. of Tech., Hoboken, N. J.
STABILITY OF HYDROMAGNETIC PLASMAS, W. H. Bostick. Project 8608(801A), Contract AF 19(604)-4086; CRZC, AFCRL.

This research will study the stability of the interaction of a so-called plasmoid with a magnetic field and these studies will be extended to similar interactions of accelerated or hypervelocity plasma "blobs" in their interaction with a magnetic field. Attempts will be made to transform the kinetic energy of such plasmoids, plasma jets, or other sources of directed energy in an ionized gas into an electric energy pulse through their interaction with a magnetic field.

12.110

Sylvania Electronic Systems, Waltham, Mass.
HYDROMAGNETIC WAVE PROPAGATION, Carstoiu. Project 5631(803A), Contract AF 19(604)-7487; CRRK, AFCRL.

Theoretical research on hydromagnetic wave propagation and related topics in magneto-fluid dynamics. Work will include a critical review of existing literature on the subject of small amplitude hydromagnetic waves. Investigation will be based on work dealing with hydromagnetic waves in a compressible fluid conductor. The one dimensional propagation considered presents a transport of energy that is not, theoretically, radially attenuated and may lead to some insight regarding geomagnetic pulsation and the phenomenon of whistlers.

12.111

Sylvania Electronic Systems, Waltham, Mass.
RF RADIATION FROM FLAME EXCITED PLASMAS, J. H. Joshi. Project 5631(803A), Contract AF 19(604)-7305; CRRIC, AFCRL.

The contractor will conduct a theoretical study of the physical mechanisms involved in the generation of RF radiation in flame excited plasmas. Particular consideration will be given to the case of a rocket exhaust, physically describable as a drifting plasma and which serves as a propagating medium which might amplify signals by interacting with slow electromagnetic waves which might exist in the flame. Attention will be concentrated on the existence and nature of the cyclotron-space charge spectrum.

12.112

Syracuse U. Research Inst., N.Y.
ENERGY DISTRIBUTION OF THE ELECTRONS PRODUCED BY IONIZING COLLISIONS OF HEAVY PARTICLES, H. W. Berry. Project 7073(806A), Contract AF 33(616)-5741; ARH, ARL.

The efforts under this contract were directed to analyzing the mechanism of ionization in collisions of heavy particles. Experimental apparatus consists of an ion source, serving also as mass spectrograph, a particle accelerator and focusing device, an electron analyser and a current detector. The introduction of a secondary electron multiplier in the electron current measuring circuit improved the sensitivity of the system greatly so that measurements could be extended to the much smaller yields occurring at higher electron energies. This permitted the study of collisions of ion-atom systems in which the yield is very small.

12.113

Systems Research Lab., Dayton, Ohio.
HEAT TRANSFER IN AN ARC DISCHARGE, P. Bunce. Project 7063(806A), Contract AF 33(616)-8098; ARN, ARL.

The contractor is conducting basic studies of the behavior of arc discharges using plasmajet apparatus and related instrumentation located at the Aeronautical Research Laboratory. Experimental investigations have included the following: (1) determination of the arc diameter, voltage drop along the arc, and conductivity across the arc at various power inputs and mass flows; (2) the use of high speed photography to determine the behavior of the arc discharge along the positive column and at the electrodes; and (3) studies of electrode ablation for various electrode configurations to determine optimum electrode design parameters.

12.114

Systems Research Lab., Dayton, Ohio.
SPATIAL ION-ELECTRON DISTRIBUTION IN EVACUATED HOT CAVITIES, R. W. Vest. Project 7073(806A), Contract AF 33(616)-8186; ARH, ARL.

Experimental and theoretical studies will be performed on spatial ion and electron distribution in evacuated hot cavities at temperatures ranging from 800°C up to 2000°C utilising the facilities of the Plasma Physics Research Branch. This research work

will be concerned with: (a) the determination of the spatial density distribution in the evacuated hot cavity by means of probe measurements or other suitable methods; (b) the measurement of this distribution at different cavity temperatures; (c) investigation of the influence of additional magnetic and electric fields; (d) the design and construction of the necessary apparatus for heating the cavity; and (e) the design and construction of the equipment necessary for measuring the particle distribution in the cavity.

12.115

Technion Research and Development Foundation (Israel). MICROSTRUCTURE OF THE MAGNETIC FIELD IN A PLASMA. G Kalman. Project 7073(806A), Contract AF 61(052)-177; ARH, ARL.

The distribution of the static magnetic field due to randomly distributed charged particles in phase space has been investigated. Furthermore, a perturbation analysis of the energy loss suffered by a test particle traveling through a plasma was considered. The action of the systems on the particle was described as a combined result due to the polarization of the medium and the correlated fluctuations of the electric microfield.

12.116

Technische Hochschule, Stuttgart (Germany). MEAN EFFECTIVE TEMPERATURE IN A FULLY IONIZED PLASMA USING SHOCK WAVE MEASUREMENTS, K. H. Hoecker. Project 7073(806A), Contract AF 61(052)-199: ARH, ARL.

Using shock wave measurements, (a) mean effective temperatures, and (b) temperature profiles of fully ionized gases were investigated during the past year. A detailed treatment of the basic properties of hydromagnetic shock waves was prepared and extensive experimental work done in developing the electronics for measurement of (a) above. Other work was concerned with fundamental problems of the kinetic theory, hydromechanic shock waves, azimuthal pinch, and electromagnetic waves in a plasma.

12.117

Technische Hochschule Hannover (Germany). RELATION OF PLASMA OSCILLATIONS TO ELECTROMAGNETIC RADIATION AND TO IONOSPHERIC EFFECTS, R. W. Larenz. Project 5631(803A), Contract AF 61(052)-161; CRRK, AFCRL.

The theoretical study is concerned with the structure of a shock wave in a plasma and with the radio noise emissions originating from shock waves. The aim is the explanation of noises produced in the solar and terrestrial plasmas. The various approaches used in this study are based on electromagnetic and hydrodynamic principles, on Boltzmann equations, and on considerations of coupling effects.

12.118

Technische Hochschule, Stuttgart (Germany). WHIRL-STABILIZED HYDROGEN ARC, E. Pfender. Project 7073(806A), Grant AF-EOAR-61-25; ARH, ARL.

An experimental investigation is underway using a capacitor-pulsed electric arc to determine the temperature profile in a standard and pulsed hydrogen arc as accurately as possible. Several arc chambers consisting of water cooled electrodes separated by a quartz glass cylinder have been built and tested. These chambers are used for the hydrogen arc which is to be pulsed. A vertical arrangement has been built to use the arc in combination with a Bausch and Lomb grating spectrograph and an attached sensitive photomultiplier. A rotating mirror device and a phototube for triggering the oscilloscope are used to measure the intensity profile of the arc channel at a given wavelength. At present tungsten plated electrodes are being tested. As soon as the arc is operative for longer periods the arc will be pulsed by a capacitor and the influence of the pulse on the arc temperature will be studied by spectrographic temperature analysis. A comparison plasma was therefore generated by means of a 200 kw R.F. power supply under atmospheric pressure.

12.119

Temple U., Philadelphia, Pa. ATTAINMENT AND UTILIZATION OF HIGH TEMPERATURE, J. L. Bohn. Project 8608(801A), Contract AF 19 (604)-3076; CRZC, AFCRL.

To carry out exploding wire experiments under conditions other than atmospheric where the effect of pressure and of ambient gas can be controlled. A part of the instrumentation phase of this contract will be to refine and perfect the ultra-high-speed camera and the microsecond thermometer as important research tools.

12.120

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass. EXPLODING WIRE STUDIES, W. G. Chace. Project 8608 (801A), Internal.

To study the behavior of solids under high pressure high temperature conditions and to obtain information on the transition of solids into liquids, and solids to vapors in metals. Exploding wires will be used as a tool to conduct experimental investigations of these phenomena. In addition, the change in conductivity of the wire as it passes to the vapor stage will be investigated. The use of exploding wires as a source of high density plasma will be considered

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RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
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APGC- Air Proving Ground Center
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and its interaction with the magnetic field in the exploding wire phenomenon will be noted.

12.121

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
PLASMA CONTAINMENT AND STABILITY, L. S. Combes.
Project 8608(801A), Internal.

Studies of hydromagnetic stability in a low pressure gas will be conducted for several field geometries. Microwave and optic interferometer measurements will be made to determine plasma densities and temperature. Apparatus utilising the so-called "cusped" eometries with a crossed magnetic field at strengths f over 100,000 gauss will be studied. Methods of heating this gas to high temperatures will be investigated and the degree of thermal equilibrium measured.

12.122

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
PLASMA HEATING AND ACCELERATION, M. A. Levine.
Project 8608(801A), Internal.

Studies of hydromagnetic flow in non-equilibrium configurations will be carried out. Plasma will be stored in gradient magnetic fields in unstable configurations, and studies will be made of the nature of the turbulent flow. The problem of the turbulent shock as developed above will be considered.

12.123

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
MAGNETO-SHOCK-DYNAMICS, H. K. Sen. Project 8608 (801A), Internal.

A theoretical investigation of energy transfer mechanisms in a magnetoionic gas. Calculations include the investigation of magnetic shocks in a conducting gas and those parameters of the gas such as viscosity, heat conduction, electrical conductivity, and other effects, which bear on shock propagation. Consideration is given to the propagation and development of turbulences in magnetohydrodynamic atmospheres.

12.124

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
PHYSICS OF IONIZED GASES, H. K. Sen. Project 8647 (806A), Internal.

A theoretical investigation of the propagation of intense shocks and other energy transfer mechanisms in conducting atmospheres. Calculations are based on the Boltzmann model and/or the hydrodynamic model and do not include the influence of magnetic fields. Recently a hydrodynamical two-fluid shock structure model was formulated to account simultaneously for the effects of viscosity and diffusion in a magnetic field-free plasma. This model is now being subjected to rigorous mathematical analysis in an effort to predict shock wave structures as they actually occur in nature.

12.125

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
SPECTROSCOPY OF HOT GASES, H. K. Sen. Project 8647 (806A), Internal.

Collection and analysis of spectroscopic results as applied to shock waves in a conducting gas with and without a magnetic field. Determination of temperature, field intensity, densities and other parameters of conducting gases in motion through the analysis and interpretation of spectral lines.

12.126

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
THEORETICAL MHD, H. K. Sen. Project 8647(806A), Internal.

A theoretical investigation of energy transfer mechanisms in a magnetoionic gas. Calculations include the investigation of magnetic shocks in a conducting gas and those parameters of the gas such as viscosity, heat conduction, electrical conductivity, and other effects, which bear on shock propagation. Consideration is given to the propagation and development of turbulences in magnetohydrodynamic atmospheres.

12.127

Thermomechanics Research Lab., ARN, ARL, Dayton, Ohio.
MAGNETO-HYDRODYNAMIC INVESTIGATIONS, K. R. Cramer.
Project 7116(801A), Internal.

This effort was established to conduct theoretical investigations of general magneto-hydrodynamic flow and heat transfer phenomena. The investigations to date have considered the influence of transverse magnetic fields on the velocity and temperature fields of free convection flows over a variable temperature flat plate, between constant and variable temperature parallel plates and through a constant temperature vertical pipe. An investigation is currently being conducted to determine the influence of Joule heating on the velocity and temperature fields of flow between constant temperature parallel plates.

12.128

Thermomechanics Research Lab., ARN, ARL, Dayton, Ohio.
HEAT TRANSFER RESEARCH, E. E. Soehngen. Project 7063 (806A), Internal.

AFOSR- Air Force Office of Scientific Research
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SRI- Directorate of Information Sciences
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SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
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CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZM- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

Studies are to be performed on parameters which affect heat transfer phenomena but have generally been neglected or are insufficiently known, such as: flow fluctuations, surface vibrations, sound effects, flow separation surface geometries, chemical reactions and very high temperature effects.

12.129

Toronto U. (Canada).
MAGNETOGASDYNAMICS, J. H. De Leeuw. Project 9781 (806A), Grant AF-AFOSR-62-100; SREM, AFOSR.

The basic objective of the current research under this contract is to study various aspects of the influence of magnetic and electric fields on the flow of ionized gases. In particular, some of our immediate goals are the study of magnetically driven transient flows, the interaction of a plane shock wave with a magnetic field, the influence of a magnetic field on the properties of the boundary layer that exists behind a strong shock wave in a shock tube and the influence on the heat transfer at the stagnation point of a blunt body. In addition, a significant amount of effort has been directed towards the understanding and development of diagnostic tools in plasma flows. The experiment on the magnetic influence on heat transfer at the stagnation point of a blunt body will be performed in the UTIA 1" shock tube.

12.130

United Aircraft Corp., East Hartford, Conn.
ELECTROSTATIC ACCELERATION OF A PLASMA, R. Meyerand. Project 7116(801A), Contract AF 33(616)-7448; AEM, ARL.

This program is for the investigation of various influencing parameters on a cavity anode type plasma generator and accelerator. The acceleration is accomplished by an electrostatic field with a magnetic field employed for columniation. The accelerated plasma issues forth from the anode as a space charge free monoenergetic beam. The experimental research will determine effects of electric and magnetic field and particle interaction phenomena within the cavity anode as well as diagnostic information on the beam issuing from the anode.

12.131

University of Southern California, Los Angeles.
RAREFIED GASDYNAMICS, R. L. Chuan. Project 9783 (806A), Contract AF 18(603)-95; SRE, AFOSR.

A two phase wind tunnel, based on a new concept, was constructed for conducting research in rarefied gas flows for Reynolds Numbers .02 to 100,000 and in a Mach number range of 1 - 12. The program included studies to increase the research capability of the facility, mainly by plasma heating of the nozzle flow to increase the Mach number. Studies were performed in plasma physics relating to rarefied high temperature gas flows. Theoretical and experimental investigations were performed in the basic characteristics of the dynamics of plasma flows and their interaction with solid boundaries.

12.132

University of Southern California, Los Angeles.
SHOCKWAVE IONIZATION PHENOMENA, R. S. Macmillan. Project 9768(803A), Contract AF 49(638)-893; SRPP, AFOSR.

This research covers a theoretical and experimental investigation of shockwave induced ionization phenomena with special emphasis on the physical processes associated with a vehicle's plasma sheath and ionized trail. Such processes include: thermal and collisional ionization accompanying the shock wave; electron and particle density distribution behind the shock front, in the ionized sheath, and in the trail. Related information concerns the nature of the radiation from the shock-induced plasma, and the possible presence of suprathermal particles in the ionized sheath and trail.

12.133

Uppsala U. (Sweden).
HIGH TEMPERATURE PLASMA PHYSICS, K. Siegbahn, P. Ohlin. Project 7073(806A), Contract AF 61(052)-170; ARH, ARL.

The research work under this contract can be grouped as follows: Large scale pinch experiments with a toroidal plasma; investigations of plasmoids; and spectroscopic probing. The large toroidal plasma pinch experiment employs a toroidal discharge vessel. The preionized gas in the torus forms the secondary winding of a transformer, the primary of which is the inductance of a ringing circuit. The induced circular discharge is stabilized by a weak axial field parallel to the circular center line of the discharge tube. An increasing axial field is used to compress the ring discharge. The discharge is probed by pick-up coils shielded with quartz tubes. The observed values of the field distribution have been used to study the instabilities of this geometry. Experiments on runaway phenomena have been started. New types of probes used for detection of X-rays and fast electrons are being tested. New experiments will be conducted with a setup consisting of two plasma guns with pulsed gas inlets, but with increased stored energy. The guns are placed opposite to each other at the end of a 2.5 cm long Pyrex tube with 6 cm bore. A "guiding" longitudinal magnetic field can be applied over the tube. In the central region where the plasma bursts from the two guns collide a magnetic mirror field can be applied. The construction of the experimental apparatus is underway. Spectrographic work is being carried on with a Hilger medium quartz prism

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spectrograph, a 2 meter Ebert grating spectrograph, and a 3 meter grazing incidence vacuum spectrograph. The work is concerned with (1) stigmatic survey spectrograms for analysing the impurities in the systems and deciding from which part of the discharge they originate and (2) time-resolved and internal spectrograms. These studies give information on the electron temperatures and the times when impurities are released from the walls, on detailed time records of line intensities from photomultipliers for the same purpose as mentioned above, and on the velocities of ordered motion by measuring the Doppler shifts.

12.134

Utah U., Salt Lake City.
ELECTRICAL AND PLASMA PHENOMENA ACCOMPANYING DETONATIONS, M. A. Cook. Project 9751(801A), Contract AF 49(638)-1061; SRPP, AFOSR.

Studies concern the determination of plasma length versus reaction zone length or explosive particle size in external detonation-generated plasmas. Reaction times determined from these results are compared with independently determined values of reaction times. Studies will continue of electrical conductivity and electron density in such plasmas when propagated through different types of gases at various pressures. Experiments are also planned on methods of manipulating these plasmas by both mechanical and magnetic means.

12.135

Vidya, Inc., Palo Alto, Calif.
ANALYTICAL STUDIES OF PLASMAJET TECHNIQUES, J. R. Stalder. Project 7063(806A), Contract AF 33(616)-8338; ARM, ARL.

A critical analysis is being made of the capabilities and shortcomings of the plasmajet technique as a research tool for the investigation of the interaction phenomena between highly ionized gas jets and their environments.

12.136

Vitro Labs., West Orange, N. J.
ENERGY EXCHANGE IN HIGH INTENSITY ARC PLASMA, C. Sheer. Project 9781(806A), Contract AF 49(638)-477; SREM, AFOSR.

The contractor investigated the physical properties of and the flow field associated with a high intensity electric arc utilizing a fluid transpiration cooled, porous anode. The objective was to learn enough about these basic problems to determine in what manner the arc might be modified to generate high temperatures in a test facility where large volumes of gas must be heated.

12.137

Vitro Labs., West Orange, N. J.
PHYSICAL PROPERTIES OF HIGH INTENSITY ARCS, C. Sheer. Project 9752(801A), Contract AF 49(638)-329; SRE, AFOSR.

The "high intensity" or Beck arc can provide a plasma from solid electrodes. This arc is characterized by the fact that most of the arc voltage drop occurs at the anode. Under such conditions most of the energy in the arc current is transferred to the anode, vaporizing it. The basic problem is to determine the physical properties of the resulting plasma jet. The physical properties of interest are the conductivity, or ion concentration, the particle velocity, the species and the temperature. Velocity is detectable by interrupting the arc for a very short time. The velocity of the discontinuity is the particle velocity. Some measure of conductivity can be derived by measuring the bending of the beam by a magnetic field. The other parameters can be evaluated roughly by spectroscopy.

12.138

Warner and Swasey Research Corp., New York.
INFRARED RADIATION OF PLASMAS WITH APPLICATION TO TEMPERATURE MEASUREMENTS, R. H. Tourin. Project 7063(806A), Contract AF 33(616)-8057; ARM, ARL.

The measurement of temperatures in plasmajets is being investigated by means of infrared radiation measurements. The purpose of the present investigation is to further develop an infrared technique in order to measure radial temperature distributions in the plasmajet with a reasonable degree of accuracy. Experimental comparison of the infrared technique with other methods now employed in plasma temperature measurements will be made. With the knowledge of the temperature of these plasmas, a tabulation of the spectral emissivities of the various gases at high temperature levels will be compiled.

12.139

Warner and Swasey Research Corp., New York.
INFRARED TECHNIQUES FOR AIR TEMPERATURE MEASUREMENTS IN A HYPERSONIC WIND TUNNEL, R. H. Tourin. Project 7065(806A), Contract AF 33(616)-8319; ARF, ARL.

Conditions are being investigated under which infrared monochromatic radiation can be used to study temperature phenomena in gases, with high time resolution, up to 9000°R. The principles and the technique are being perfected, and instrument components which are capable of microsecond recording of temperature phenomena are being constructed. Basic factors pertaining to this technique will be investigated in order to (1) provide

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more detailed interpretation of the measurements obtained with the High Speed Infrared Pyrometer, (2) determine the limitations of the infrared method in measuring transient phenomena, and (3) elucidate the procedures for using the instrument in practice. This additional research will serve to determine more precisely the range of application of the instrument. Application of the infrared technique to the measurement of air temperatures at selected points in a hypersonic wind tunnel will be investigated.

12.140

Yale U., New Haven, Conn.
INTERMOLECULAR FORCES AND SPECTRAL LINE BROADENING, H. Margenau. Project 9751(801A), Contract AF 18(603)-15; SRPP, AFOSR.

This project is a study of spectral line widths emitted at high temperature, and in ionized gases; of intermolecular forces between similar atoms in the excited states; doublet lines of alkali atoms; and the distribution of ion states at high ion densities with particular emphasis on applications to plasma diagnostics.

12.141

Yale U., New Haven, Conn.
INTERACTION OF RADIATION AND MATTER IN A PLASMA, L. Oster. Project 7073(806A), Contract AF 33(657)-7271; ARH, ARL.

Efforts will be made to develop a combined theory of the emission of radiation in a plasma compatible with the mechanism of bremsstrahlung and cyclotron radiation as opposed to the customary theories which are based upon either concept. The theory will consider the effect of a magnetic field, the influence of the statistically fluctuating Coulomb fields of the ions, and, if significant and possible, the influence of mutual interactions between the free electrons. The radiation of a plasma in the radio frequency range will be investigated to include the frequency range close to the cut-off frequency where the refractive index differs from unity.

See also: 1.27, 4.6, 4.67, 7.20, 7.74, 8.9, 8.23, 8.77, 10.29, 11.40, 11.69, 11.77, 11.87, 11.115, 14.112, 16.1, 16.19, 16.39-40, 16.46, 16.81, 16.85, 16.95, 16.100, 16.104, 16.110, 16.112, 16.118, 16.121, 19.20, 20.6, 20.16, 20.23-24, 20.75, 22.17, 23.126, 24.16, 24.33

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- CREM- Meteorological Research Lab
- CREI- Ionospheric Physics Lab
- CRER- Sacramento Peak Observatory

13. INFORMATION AND CONTROL SYSTEMS

Communications Theory; Systems Performance; Adaptive Systems; Systems Theory; Codes; Pattern Recognition; Natural Languages; Machine Languages; Information Storage and Retrieval.

13.1

Aeronca Mfg. Corp., Baltimore, Md.
OPTIMAL CONTROL THEORY, R. W. Bass. Project 9761 (802A), Contract AF 49(638)-1003; SRPP, AFOSR.

This is a modern functional analysis approach to the optimal control of physical systems of arbitrary order. Included in the investigation are: (1) deeper correlation of Bellman's optimality principle with Pontrjagin's maximum principle; (2) correlation of the remaining approaches of Krasovski, Kulikowski, Letov, Lerner, Feldbaum, Kalman, Kurzweil, Oldenburger, Flugge-Lots, Schmidt, etc.; (3) development of Bass' adjoint system synthesis concept; (4) extension of preceding results to (a) non-autonomous systems; (b) systems with adjustable parameters and additional nonlinear constraints; (c) self-adaptive systems; (5) development of Bass' method of optimization of explicit solution of a partial differential equation derived from Liapunov's stability theory, including (a) topological-dynamical characterization of the optimal transition time; (b) derivation from this, and the Malkin-Persidskii theory of continually acting perturbations, of the allowable parameter-uncertainties to achieve given final error; and (6) an attempt to derive an entirely new approach to the subject via direct methods of calculus of variations, including approximations of Rayleigh-Ritz-Galerkin and steepest-descent iterations of Hadamard.

13.2

Arizona U., Tucson.
MATHEMATICAL FORMULATION AND COMPUTER SIMULATION OF DOCUMENTATION METHODS AND SYSTEMS, J. W. Perry. Project 9769(803A), Grant AF-AFOSR-62-289; SRIR, AFOSR.

This is a fundamental investigation into the problems of information storage and retrieval, from the standpoint of how knowledge is generated and used. Postulates will be formulated, for the generation and use of knowledge. These will be used to develop a mathematical formulation for the operation of information storage and retrieval systems. These formulations can then be used to develop computer techniques for the computer simulation of possible storage and retrieval systems for evaluating their performance.

13.3

Astrosurveillance Sciences Lab., CRR, AFCRL, Bedford, Mass.
SYSTEM THEORY, C. M. Jones. Project 5632(803A), Internal.

This work involves studies of the fundamental principles and basic characteristics of systems in the broad, general sense. An attempt will be made to define a system (or different categories of systems, e.g., a unit system) and its elements by their functional relationship in terms of a mathematical expression and/or literal statements. Fundamental characteristics common to all systems will be derived and evaluated; e.g., the basic nature of internal inter-relationships among system elements, as well as functional relationships with other systems or the outside world. The generalized system will be studied from a theoretical viewpoint in order to obtain a better understanding of the roles of feedback, decision theory, game theory, utility theory, statistical processing, etc., in the behavior of complex systems. Efforts will be made to develop generalized theories applicable to system behavior.

13.4

Astrosurveillance Sciences Lab., CRR, AFCRL, Bedford, Mass.
MATHEMATICAL MODELING METHODS, J. F. Kallaher. Project 5632(803A), Internal.

In this work, the goal will be the formulation of better system modeling methodology to permit more realistic system simulation and synthesis. Intermediate to this goal is the evolution of a system theory, theories for better measuring overall performance as related to subsystem performance, and a logic for constructing a large efficient configuration with the most economical, reliable, and efficient components.

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RAE- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESRR- Operational Applications Lab

13.5

Bolt, Beranek and Newman, Inc., Cambridge, Mass.
SYSTEM SIMPLIFICATION, T. Marill. Project 5632 (803A), Contract AF 19(604)-7290; CRRI, AFCRL.

The objective of this research is to derive mathematical techniques for the simplification of complex systems. This work consists of a literature review to uncover promising ideas and techniques, consultation with specialists in pertinent areas, simulation of promising concepts on a general purpose computer, and a report on the most promising areas. The approach is to consider abstractly several small presumably well understood systems. Initially, attention has been given to switching circuits, passive networks and computer programs. In the future, emphasis will be placed on the simplification of information-manipulative systems, as exemplified by digital computer programs.

13.6

California U., Berkeley.
RESEARCH ON CORRUPTED DATA PROCESSING SYSTEMS, A. Bergen. Project 5632(803A), Contract AF 19(604)-5466; CRRB, AFCRL.

Research on the description, analysis, and synthesis of stochastically self-adaptive nonlinear systems operating on non-deterministic dynamical data, and on criteria for evaluating the performance of such systems. This work is orientated toward analytical approach involving approximation techniques which looks extremely promising as a means for characterizing wide classes of self-adaptive systems.

13.7

California U., Berkeley.
GENERALIZED ALGOL 60 COMPUTING SYSTEM, H. D. Huskey, W. H. Wattenburg. Project 9769(803A), Grant AF-AFOSR-62-156; SRI, AFOSR.

The existence of a multiplicity of machines creates the requirement for a compiler for each which is to be used by a non-programmer. The object of this project is to design a general compiling system which can be readily adapted to the needs of any specific computer. The algorithmic language to be employed as the source language is Algol 60, a language for scientific data processing, which appears likely to become a standard in the field.

13.8

California U., Berkeley.
SAMPLED DATA CONTROL SYSTEMS, E. I. Jury. Project 9768(803A), Grant AF-AFOSR-62-70; SRPP, AFOSR.

The general objective of this research is the continuation of study and investigation of sampled-data, digital control systems as well as computer-controlled adaptive systems. In particular, problems arising in the study of non-linear, time-varying discrete and digital control systems are being studied. Identification and adaptive control of the process in a mixed digital-analogue system is the major effort of this process. Of particular significance, the phase plane (space) trajectories, Lyapunov method of asymptotic stability, and the variational transfer method (minimization techniques) are to be further developed and investigated in the study of sampled-data systems.

13.9

California U., Berkeley.
BASIC RESEARCH IN ELECTRONICS, D. Pederson, J. Whinnery. Project 4751(803A), Grant AF-AFOSR-340; SRPP, AFOSR.

This research comprises twenty-seven separate topics in the fields of circuitry, microwave propagation, electromagnetic waves, solid state electronics, systems theory, and electrophysiology.

13.10

California U., Los Angeles.
CONTROL SYSTEM THEORY AND SYNTHESIS, C. T. Leondes. Project 9783(806A), Grant AF-AFOSR-62-68; SREM, AFOSR.

This program of research will investigate and extend the following control system research areas: (a) adaptive control system theory; (b) nonlinear control system theory; (c) multiple control systems with random processes as inputs; (d) synthesis of linear time variable control systems with non-stationary random processes as inputs; and (e) synthesis of linear time variable systems with deterministic inputs.

13.11

Cambridge Language Research Unit (Gt. Brit.).
INFORMATION STRUCTURES, E. Bastin. Project 9769 (803A), Contract AF 61(052)-331; SRI, AFOSR.

This research represents a novel, deductive approach to the structuring of information, having particular reference to the problems of information handling, information retrieval and self-organizing systems. In any set of statements conveying information, words and symbols exist at various levels, but there is as yet no fully satisfactory theoretical formalism treating the problem of relating structures to information in a unified manner. The object of this

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AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRE- Geophysics Research Directorate
CREA- Photochemistry Lab
CREC- Thermal Radiation Lab
CREE- Research Instrumentation Lab
CREG- Terrestrial Sciences Lab
CREM- Meteorological Research Lab
CREI- Ionospheric Physics Lab
CRER- Sacramento Peak Observatory

research is to attempt to develop such theoretical understanding, and to develop appropriate mathematical techniques which can be tested experimentally by digital or analog simulation of certain information structure models.

13.12

Columbia U., New York.
ANALYSIS OF SPEECH SOUNDS, C. M. Harris. Project 9769(803A), Contract AF-AFOSR-62-251; SRI, AFOSR.

Techniques being sought for the accurate analysis of speech have significance in the development of speech compression systems, in solution of the speech segmentation problem, and in the design of automatic speech recognition devices. Results have applicability in the general sphere of automatic pattern recognition. The characteristics of speech in American English being studied in the present effort include the spectral energy distribution of selected speech sounds as a function of time, and time-varying influences between consonant sounds and adjacent vowel sounds. Speech analysis, which is being conducted with a novel analyzer containing 54 parallel bandpass filters of the Gaussian type, will provide the opportunity of evaluating characteristics obtainable by a new technique.

13.13

Columbia U., New York.
CONTROL SYSTEMS, G. Kranc. Project 9768(803A), Grant AF-AFOSR-62-144; SRPP, AFOSR.

Research will cover the investigation of the methods applicable to the study of optimum control problems, adaptive control systems, the optimum control of sample data systems, the optimization of contour control systems, and the optimization of non-linear plants. In particular the application of functional analysis to optimal systems will be investigated.

13.14

Columbia U., New York.
RESEARCH ON NON-LINEAR FILTERS, R. Schwarz. Project 5632(803A), Contract AF 19(604)-4140; CRRB, AFCRL.

The purpose of this contract is to conduct research on the analysis and synthesis of time varying nonlinear filters and predictors operating on stochastic signals imbedded in additive noise. The application of non-parametric statistical methods is being made to the design of filters which must operate on data whose statistical characteristics cannot be conveniently specified in terms of a small number of parameters.

13.15

Communications Sciences Lab., CRRI, AFCRL, Bedford, Mass.
LINGUISTIC PARAMETRIC SPEECH PROCESSING, P. Lieberman. Project 5628(803A), Internal.

Investigate problems involved in analysing speech in such a way as to yield a set or sets of necessary and sufficient descriptive parameters which correlate explicitly with linguistic units in the signal. Study super segmental aspects of linguistic structure which are meaningful for perception and recognition.

13.16

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
DECISION THEORY, D. Middleton. Project 5628(803A), Internal.

Decision criteria and suitable mathematical models with which communication systems can, in principle, be designed are investigated. The payoff of various sophisticated techniques in terms of improved communications are sought together with an estimate of the "cost" in order to appropriately weigh the practicability of these techniques. Work now in progress has as one of its aims, to provide a generalized and integrated theory for both coherent and incoherent FSK reception in slow fading under very general conditions, based on the principal investigator's treatment of communication theory by statistical decision methods.

13.17

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
MODULATION AND DETECTION STUDIES, J. N. Pierce. Project 5628(803A), Internal.

Object is to determine theoretical capabilities of communicating information from various sources through various transmission environments, and to determine optimum modulation-detection configurations which will permit attaining these ultimate capabilities. Work during coming year will be concentrated in two areas: optimization of zero-memory transmission of analog data under a mean-square-error criterion (including studies of FM and PFM as a subtopic), and optimization of digital data transmission over the Gaussian multiplicative channel. Effort will be subsequently expanded to include optimization of strategy for multiple asynchronous common channel occupancy.

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ARR- Hypersonics Research Lab
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ARZ- Metallurgy & Ceramics Research Lab

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ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAAW- Intelligence & Electronic Warfare Div.
RACH- Advanced Studies Office
RAS- Directorate of Engineering
RAVA- Advanced Development Lab
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AEGR- Research Division
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SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
RED- Electronics Systems Division
RSER- Operational Applications Lab

13.18

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
PROPERTIES OF FILTERED NOISE, J. N. Pierce. Project 5632(803A), Internal.

Object is to obtain basic understanding of statistical properties of filtered thermal noise and other random processes derived from it, such as zero crossing rate, first passage times, properties of filtered envelopes of bandpass signals.

13.19

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
CODING THEORY, E. Prange. Project 5628(803A), Internal.

This research concerns the theory of error-correcting codes, with emphasis on decoding methods. For example, a general decoding method for cyclic codes is being studied. This method involves the construction of less than n^2 words to be compared with the work to be decoded.

13.20

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING, A. L. Bastian. Project 5632(803A), Internal.

Conduct investigation of machine learning and artificial intelligence by the study of game playing machines. Effort will be chiefly directed toward the finding of what constitutes an intelligent move. This is to be analyzed as: (a) the conception of possible decisions having both short and long range possibilities; (b) the rapid elimination of bad decisions and intelligent selection of a final decision; and (c) the changing of criteria in both (a) and (b) by the machine as a result of its study of past moves and their effect.

13.21

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
NON-COMPUTER COGNITIVE MACHINES, M. Blum. Project 5632(803A), Internal.

Investigation of cognitive machines with the aim of broadening the conceptual foundations to include machines with primitive notions better able to develop "heuristic" approaches and deal with unordered events of high dimensionality. Abstractions from insights of the bio- and psychological fields will be used since such systems exist there.

13.22

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
COMPUTER RESEARCH IN PATTERN RECOGNITION, S. R. Patrick. Project 5632(803A), Internal.

To perform research in the pattern recognition area of artificial intelligence using speech pattern recognition as a research vehicle. Previously considered speech recognition procedures will be tested on a large scale computer to determine their effectiveness on large vocabularies. Several more sophisticated classification transformations and metrics will be examined in order to improve recognition in already treated areas, and to permit recognition in areas not now amenable to present methods.

13.23

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
MATHEMATICAL MODEL FOR NATURAL LANGUAGE, M. E. Sherry. Project 5632(803A), Internal.

Investigate the mathematical structure of language and devise a mathematical model of natural language that is valid for one or a group of natural languages (e.g., Indo-European). The model should contain the essential elements of language whose knowledge is essential for the automatic translation of languages.

13.24

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
METHODOLOGY OF DYNAMIC DATA PROCESSING, C. M. Walter. Project 5632(803A), Internal.

Research in the methodology of description and of extraction of dynamical properties from data obtained from measurement devices and self-adaptive data processors which interact with the processes under investigation in a non-deterministic manner. Problems associated with the extraction and measurement of the magnitude and significance of a one parameter process have been extensively investigated and the effort is now being extended to multiple parameter processes. Considerable use is being made of simulation involving combined analog-digital data processing devices in evaluating various dynamical property extraction techniques.

13.25

Cook Research Labs., Morton Grove, Ill.

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CRRR- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRD- Geophysics Research Directorate
CRDA- Photochemistry Lab
CRDC- Thermal Radiation Lab
CRDE- Research Instrumentation Lab
CRDO- Terrestrial Sciences Lab
CRDR- Meteorological Research Lab
CRDI- Ionospheric Physics Lab
CRDR- Sacramento Peak Observatory

FORMULATION OF MATHEMATICAL EFFECTIVENESS CRITERIA FOR SYSTEM OPTIMIZATION, T. J. Horrigan. Project 5632(803A), Contract AF 19 (604)-7497; CERI, AFCRL.

This research is a study in the mathematical formulation of criteria for the effectiveness of complex systems. Its principal objective is the clear formulation of a realistically broad notion of effectiveness in a format which ensures logical and precise definition, and an investigation into rigorous rules for determining and measuring this effectiveness. This study, which is based on the areas of probability, and measure theory, seeks to develop an axiomatic mathematical context in terms of which the portion of the effectiveness notion common to a very large class of systems can be given exact expression. The means for testing the generality, adequacy and credibility of the effectiveness criteria will also be developed. A second objective of the program is the construction of effectiveness functions for some special families of simple systems. The third objective is to proceed toward a rigorous and workable definition of the terms "system" and "subsystem," and toward relating the effectiveness criteria of subsystems to the effectiveness of the system of which they are a part.

13.26

Delaware U., Newark.
QUANTUM LIMITATIONS ON EM SIGNAL MEASUREMENT, L. P. Bolgiano. Project 9768(803A), Grant AF-AFOSR-62-253; SRPP, AFOSR.

This research covers theoretical aspects of the limitations which quantum mechanics imposes on the measurement of em signals. This has an important bearing on information transmission.

13.27

Directorate of Engineering, RAS, RADC, Rome, N.Y.
RELATIONSHIPS BETWEEN RELIABILITY AND EFFECTIVENESS, A. Copola. Project 8505(803A), Internal.

If the input to a system is controlled by probability, measures (such as expectations or a set of probabilities on a set of events) at the output(s) can be used as system performance measures. If the parameters of the components are controlled by probability, there will be a statistical influence on effectiveness directly related to component value changes (failures etc.). This investigation will attempt to relate the interaction of these probabilistic measures for certain system classes.

13.28

Directorate of Engineering, RAS, RADC, Rome, N.Y.

APPLICATION OF STATISTICAL INFERENCE ON SYSTEM STATE FROM OBSERVATIONAL PERFORMANCE DATA, J. Klion. Project 8505(803A), Internal.

Observation of decision theory applications to probabilistic detection of state of systems whose network parameters descriptions are controlled by probability. Emphasis will be initially placed upon electronic systems composed of elements whose probabilistic behavior can be described by the states of "open," "normal," or "short" circuit between terminal pairs. Observation of system response to prescribed probing excitations will be used to determine conditional probabilities of state given a set of observations. The set of conditional probabilities will be one input to the decision process of estimation of system state.

13.29

Documentation, Incorporated, Washington, D. C.
MULTIPURPOSE INFORMATION SYSTEM DESIGN WITH SIMULATION, M. Tauba. Project 9769(803A), Contract AF 49 (638)-1109; SRIR, AFOSR.

Scientific manpower at the research administration level requires an information system capable of providing a complex of management and scientific data. The basic objectives of this research are to identify and define elements of an information system to satisfy these multipurpose needs, and to explore approaches to the construction of such a system through system simulation. The experience and data accumulated previously in conjunction with the design, construction, and evolution of Project ECHO (Experimental Contract Highlight Operation) will be applied in the conduct of the present research.

13.30

Duke U., Durham, N. C.
MECHANICAL LANGUAGE ANALYSIS AND SYNTHESIS, T. M. Gallie. Project 9769(803A), Grant AF-AFOSR-62-164; SRIR, AFOSR.

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. Mathematical description of mechanical languages and new methods for introducing semantic content into mechanical languages are sought.

13.31

Electronic Technology Lab., ASD, Dayton, Ohio.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
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ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARZ- Hypersonics Research Lab
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ARE- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
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MOLECULAR GROUPING STORAGE STUDIES, G. B. Kidd. Project 7031(803A), Internal.

The final objective of this in-house effort is to determine techniques which will permit the storage and recovery of electronic information at a density which is mainly dependent on the molecular size of the storage media. Since this is a new effort the initial work is directed towards the selection of the more promising areas of research. The general area to be examined is that on methods of determining storage locations in continuous media with sufficient accuracy and precision as to develop the storage capabilities of the media.

13.32

Electronic Warfare Lab., RADC, Rome, N. Y.
ANALYSIS TECHNIQUES FOR PROBABILISTIC SYSTEMS, H. E. Webb. Project 8505(803A), Internal.

To formulate analysis and synthesis procedures for some classes of probabilistic systems. To establish theory and predict combinatorial behavior. This work will be primarily analytical. It will involve some aspects of theory of games, decision theory, statistical inference, information theory, and combinatorial topology. Two selected problems have been under investigation: (1) given a wide sense stochastic process which is exciting a parallel bank of N frequency selective filters. The totality of the individual filter power spectra covers the power spectra of the input process. A second bank filters whose outputs are added is available. This second bank also covers the power spectra of the input. The N terminal pairs of the first filter bank are not labeled; those of the second bank are. The problem is to investigate the decision theoretical behavior of a matching process which results with the two sets of terminal pairs connected so as to maximize the zero delay cross-correlation coefficient between the input and the output. A set of analytical experiments based on the finite time quasi-correlation matrix of the signals contained at the terminal pairs of the unlabeled box is being investigated; and (2) the second, and more fundamental problem is methods of characterizing stochastic processes such that the system response process can be characterized. Methods of transforming characterizations from one to another, and questions of sufficiency are being explored. In particular, present efforts are investigating sets of orthonormal functions where the probability measure is assigned to the time invariant coefficients of the orthonormal expansions.

13.33

Harmer and Co., Washington, D. C.

NON-MANIPULATIVE CORRELATIVE INDEXING SYSTEMS, S. Harmer. Project 9769(803A), Contract AF 49-(638)-903; SRIR, AFOSR.

This investigation concerns the use of a non-manipulative correlative indexing system to index a corpus of scientific information, set forth in a collection of R & D Project Cards covering OAR basic research contracts. This study includes an analysis of differences involved in creating an index designed for human operators and one designed for machine operation, here a contractor-designed magnetic-tape storage and retrieval device.

13.34

Illinois U., Urbana.
HIGH POWER MICROWAVES, PLASMAS, PARTICLES, BEAMS, CONTROL SYSTEMS AND HIGH VACUUM ELECTROPHYSICS, D. Alpert. Project 4751(803A), Contract DA 36-039-sc-85122; SRPP, AFOSR.

This program covers a broad investigation in the area of microwave physics, especially high power microwaves and plasmas, high energy particle beams, and related areas of physics and electronics. It also covers basic research in control systems, especially the adaptive and non-linear aspects of such systems, and information processes. In addition, emphasis is being placed on physical electronics including the interaction of radiation with fields and with matter, optical pumping, photon properties, and high vacuum electrophysics and technology. A new area receiving attention is the application of computer and computer techniques in basic research investigations and investigation of problems involved in "teaching" by means of computers.

13.35

Institut National des Techniques de la Documentation (France).
MODERN LINGUISTICS IN INFORMATION RETRIEVAL SYSTEMS; E. de Grolier. Project 9769(803A), Contract AF 61 (052)-505; SRI, AFOSR.

The research involves an examination of present trends in modern linguistics, especially structural linguistics and semantics, from the point of view of their use in the better design of information retrieval systems. The principal investigator will use as a starting point his UNESCO report on "General Categories To Be Applied to Classification and Codifications for Documentation," and evaluate and review the work now being carried out in the United States, Free Europe and Russia. There is at least a putative connection between mechanical translation and information storage and retrieval which

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CREI- Ionospheric Physics Lab
CREK- Sacramento Peak Observatory

will critically be examined in this study.

13.36

International Business Machines Corp., Yorktown Heights, N. Y.
HYPOTHESIS-FORMATION BY COMPUTER, M. Kochen. Project 5632(803A), Contract AF 19(604)-8446; CRRB, AFCRL.

To investigate the possibility of simulating that aspect of human cognitive behavior known as inference or hypothesis-formation by means of a general purpose digital computer. To contribute to research in heuristics by selecting most promising strategies from a set of many alternative solution paths. Rules of plausible inference are to be investigated by analyzing and comparing various schemes for programming a computer to solve certain large combinational searching problems without exhaustive logical enumeration.

13.37

ITEK Corp., Waltham, Mass.
INFORMATION RETRIEVAL RESEARCH, B. Lipets. Project 5632(803A), Contract AF 19(604)-8438; CRR, AFCRL.

Conduct research on the indexing problem and its relation to machine retrieval. This work to include deep indexing, descriptor evaluation, and thesaurus mechanization. Conduct research on the factors affecting integrated system design for automatic information retrieval taking into account the complex problems of input, abstracting, index preparation, retrieval machinable data interchange and the selective dissemination of information. This research to include both theoretical and background studies and the experimental evaluation of techniques applicable to the basic aim of the program. Research on boundary identification, encoding of data in machine retrievable form, and the process of automatically and programmatically controlling or modifying format for later processing, information retrieval, selective dissemination, or production of permuted indexes.

13.38

Johns Hopkins U., Baltimore, Md.
REPRESENTATION AND ANALYSIS OF SIGNALS, W. H. Huggins. Project 5632(803A), Contract AF 19(604)-1941; CRRS, AFCRL.

This research is a theoretical and experimental investigation into the generation of wave forms which are orthogonal to each other, i.e., whose cross correlation functions are zero.

13.39

Jonker Business Machines, Inc., Gaithersburg, Md.
INDEX TERMINOLOGY, F. Jonker. Project 9783(806A), Contract AF 49-(638)-961; SRI, AFOSR.

This project seeks for a general theory by which presently available solutions to the indexing and language aspects of information retrieval problems can be evaluated. The postulate is being studied that all forms of index terminology differ only in degree and all are based on the same basic principles. Mechanisms by which terminology is generated, possibilities of terminology standardization, and metalanguages are being investigated.

13.40

Librascope, Inc., Glendale, Calif.
ASSOCIATION THEORY IN DATA PROCESSING, R. F. Reiss. Project 9769(803A), Contract AF 49(638)-1039; SRI, AFOSR.

The purpose of the study is to examine classical association psychology insofar as it can be related to computers, and to draw conclusions concerning the problems that will be met in attempting to use such machines for the mechanization of thought processes.

13.41

Litton Industries Electronic Equipment Division, Waltham, Mass.
PATTERN RECOGNITION RESEARCH, G. Sebestyen. Project 5632(803A), Contract AF 19(604)-8024; CRRB, AFCRL.

To investigate class separating transformations which lead to recognition of membership in classes known only from a set of their examples. To conduct studies in machine learning by using previously learned concepts to facilitate the recognition of more complex class memberships. To enlarge the base upon which present pattern recognition theory is founded by performing various theoretical studies and experimentally verifying them through the use of representative practical pattern recognition problems.

13.42

Michigan U., Ann Arbor.
SPEECH ANALYSIS, G. E. Peterson. Project 9769 (803A), Contract AF 49(638)-492; SRIR, AFOSR.

This research involves reducing a speech signal to its basic information bearing parameters (time

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ARX- Solid State Physics Research Lab
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function of over-all power level of the signal, fundamental voice frequency, frequency spectrum of the quasi-periodic, i.e., vowel and semi-vowel parts, and the spectral properties of voiced and semi-voiced consonants) and coding these parameters in digital form for computer processing. Information about the various structural characteristics of the language is organized and stored for reference in a computer. The computer programs are needed to compare the incoming information from the various speech analyzers with the stored information about the language in order to make the logical decisions required to code the speech into a sequence of symbols.

13.43

Michigan U., Ann Arbor.
PATTERN RECOGNITION, W. P. Tanner. Project 9769 (803A), Contract AF 49(638)-884; SRI, AFOSR.

This investigation extends previous research on signal detection to the field of pattern recognition. The initial phase will be theoretical, directed toward a general mathematical model of pattern recognition. A modest experimental program, either with simple mock-ups of electronic devices, or of experiments conducted on an IBM 704, will be undertaken to determine the feasibility of implementing a device designed within the framework of the general mathematical model. It is hoped to develop general theorems stating fundamental relationships between such factors as: the energy of the displayed pattern, size of the ensemble of patterns which might have been displayed, the capacity of the memory recording the ensemble, and functions weighting the decisions. It is expected that it may be possible to place limits of performance, a given device is subjected to, in a given pattern recognition.

13.44

National Academy of Sciences, Washington, D. C.
SCIENTIFIC INFORMATION PROBLEMS IN RESEARCH, K. F. Hausman. Project 9769(803A), Grant AF-AFOSR-62-272; SRIR, AFOSR.

This program is aimed at revealing: (1) the present theoretical situation in this field; (2) prospects for improvement in abstracting and indexing of scientific information; (3) search and retrieval techniques of current and future interest; (4) the place of machines such as computers in dealing with information; and (5) what can be expected for the immediate future.

13.45

New York U., N. Y.
CONTROL SYSTEMS, S. S. L. Chang, J. R. Ragazzini. Project 9768(803A), Grant AF-AFOSR-62-321; SRPP, AFOSR.

The research includes work on three closely related major areas as follows: digital filtering and control, adaptive and self-optimizing systems, and the maximum principle and bang-bang control. The emphasis is on optimum control of systems which are nonlinear, or having unknown variations of parameters, or having stochastic inputs or having any combination of these three attributes.

13.46

New York U., N. Y.
PATTERN ANALYSIS OF PLANAR GEOMETRIC CONFIGURATIONS; H. Freeman. Project 9769(803A), Grant AF-AFOSR-62-152; SRI, AFOSR.

This project aims to develop efficient techniques of encoding geometric information and to develop algorithms for the recognition, analysis, and classification of geometric patterns. Three tasks to be studied are: (1) an investigation of the quantization error associated with the encoding of geometric configurations; (2) a comparison study of criteria for classifying geometric patterns; and (3) the development of algorithms for computer analysis of specific properties of geometric curves.

13.47

Northeastern U., Boston, Mass.
MATHEMATICAL DESIGN TECHNIQUES FOR COMPLEX SYSTEMS; L. O. Dolansky. Project 5632(803A), Contract AF 19(604)-4573; CRRI, AFCRL.

The objective of this research is to advance the state-of-the-art in the application of new mathematical techniques to the synthesis, analysis and evaluation of complex dynamic systems. This investigation includes: (a) the application of statistics, probability theory and numerical analysis to complex dynamic systems; (b) the use of game theory, decision theory and utility theory to systems analysis. Hypothetical system configurations are used to test the validity of the concepts and techniques. Future investigations will be made chiefly in the areas of queueing theory, Markov processes and adaptive systems.

13.48

Parke Mathematical Labs, Inc., Carlisle, Mass.
NEW CODING TECHNIQUES, L. Calabi. Project 5628 (803A), Contract AF 19(604)-7493; CRRS, AFCRL.

Conduct theoretical research on advanced mathematical theories likely to find application in the

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solution of important communication problems. An important start has been made on the error correcting properties of codes which are generated by summing or multiplying two or more codes together. Product codes appear particularly interesting because the error correcting properties of one code are multiplied by another. Thus two codes which will correct all e_1 and e_2 random errors respectively when multiplied together result in a code which will correct all $e_1 \times e_2$ random errors. On the other hand a sum code made up of the same two component codes gives positive correction of the smallest of e_1 or e_2 random errors.

13.49

Pennsylvania U., Philadelphia.
USE OF A TAPED ENGLISH WORD LIST IN PHONOLOGICAL AND MORPHOLOGICAL STUDIES, A. F. Brown. Project 9769(803A), Contract AF 49(638)-1042; SRIR, AFOSR.

An important problem of linguistics is determining the derivation of classes of words, such as those ending in -ful or -ous. These studies are now carried out using comparatively small rhyming dictionaries. This project is intended to aid in these studies by producing a list of all single words in a standard unabridged English-language dictionary and several specialized dictionaries, alphabetized from the right. A by-product of this effort will be a magnetic tape holding essentially [illegible] words in the English language. Copies of both the word list and the tape are to be made available to scholars and libraries at the cost of computer time for printing them out, once the initial tape and punched card set is prepared.

13.50

Pennsylvania U., Philadelphia.
MECHANICAL LANGUAGES, S. Gorn. Project 9769(803A), Contract AF 49(638)-951; SRMM, AFOSR.

There have been recent attempts to produce universal languages for machines, such as Algol, a universal algebraic language. This program will attempt to develop a general theory for such languages, thus making it possible to specify a universal language for specific purposes.

13.51

Pennsylvania U., Philadelphia.
INFORMATION RETRIEVAL, J. J. O'Conner. Project 9769(803A), Grant AF-AFOSR-62-257; SRIR, AFOSR.

This program is intended to devise rules for indexing documents, based on the text, and compare the results of these rules with the results obtained by competent human indexers. In particular, the retrieval system of the Merck, Sharp and Dohme Research Laboratory library was selected as the point for departure.

13.52

Polytechnic Inst. of Brooklyn, N. Y.
ACTIVE TIME-VARYING SYSTEMS AND LINEAR NETWORKS, J. G. Truxal. Project 9768(803A), Grant AF-AFOSR-62-280; SRPP, AFOSR.

This work includes the following studies: (1) the short term stability and use of the sensitivity function in investigation of time-varying active systems; (2) complex feedback systems in terms of the stability-analysis of multi-loop and multi-dimensional systems and in terms of system design in the presence of the multi-parameter problem; (3) the design of optimum and improved feedback systems involving varying parameters with design on the basis of high-speed computational models of the controlled process with the possible implementation of learning controllers; (4) linear active networks; and (5) nonreciprocal network techniques.

13.53

Princeton U., N. J.
INFORMATION PROCESSING IN ADAPTIVE CONTROL, W. H. Surber. Project 9768(803A), Grant AF-AFOSR-62-312; SRPP, AFOSR.

Objective of the study is the investigation of mathematical techniques necessary for the synthesis of an adaptive control system for a nonlinear time-varying process. The problem of identifying the significant parameters of a time-varying system in the presence of noise will be considered and general mathematical methods for handling the identification and command problems for adaptive systems and the basic limitations on obtainable system performance will be explored.

13.54

Remington Rand Univac Div., Sperry Rand Corp., Philadelphia, Pa.
MONTE CARLO METHODS FOR SIMULATING CORRELATED STOCHASTIC DATA, G. Kaskey. Project 5632(803A), Contract AF 19(604)-4941; CRRB, AFCRL.

The use of sophisticated Monte Carlo techniques for economically generating large samples of correlated stochastic signals embedded in correlated and uncorrelated additive noise is being investigated.

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13.55

Remington Rand Univac Division, Sperry Rand Corp., Blue Bell, Pa.
MAGNETIC LOGIC CIRCUITRY OF THE AFCRL MAGNETIC COMPUTER, G. V. Zagars. Project 5632(803A), Contract AF 19(604)-8477; CRRB, AFCRL.

Study and anlysis of design and operation of AFCRL Magnetic Computer and associated equipments with the objective of improving its accuracy, reliability and methods of operation.

13.56

Rensselaer Polytechnic Inst., Troy, N. Y.
CONTINUOUS FORCING OF ON-OFF CONTROL SYSTEMS, B. Fleishman. Project 9783(806A), Contract AF 49(638)-514; SREM, AFOSR.

A theoretical study will be made of the performance of an on-off control system subjected to continuous forcing. Subharmonic and low-frequency combination harmonic solutions will be investigated, particularly from the standpoint of the stability of the solutions. The study will also investigate the effect of incorporating a damping term in the equation.

13.57

Rutgers U., New Brunswick, N. J.
COMPARATIVE EFFICIENCIES OF INFORMATION RETRIEVAL MODES, R. M. Dougherty. Project 9769(803A), Grant AF-AFOSR-62-55; SRI, AFOSR.

The Chemical Biological Coordination Center, sponsored by the National Academy of Sciences, with assistance of many experts as consultants, developed a system for the retrieval of information on chemical agents and their biological effects. This system was never put to use, although it was considered an important contribution to the field. The CBCC approach is now proposed for some present systems, including those of intelligence services. This effort will evaluate the CBCC approach which is a data storage approach and compare it with the presently more widely used document storage approach.

13.58

Rutgers U., New Brunswick, N. J.
STORAGE, RETRIEVAL AND INDEXING OF SCIENTIFIC INFORMATION, R. R. Shaw. Project 9769(803A), Grant AF-AFOSR-62-9; SRI, AFOSR.

Fields to be explored include automatic indexing; meaningful automatically produced keyword-in-context indexes; theoretical systems studies of various types of information handling devices; and methods for handling government documents to maximize their usefulness.

13.59

Stanford Research Inst., Menlo Park, Calif.
STRUCTURING COMPLEX MAN-MACHINE SYSTEMS, K. H. Schaeffer, C. J. Erickson. Project 9769(803A), Contract AF 49(638)-1020; SRIR, AFOSR.

There are two current approaches to analysis of man-machine systems. One is the mathematical model approach. The only alternative is an intuitive analysis by someone who knows the system thoroughly. It is the object of this research program to obtain an approach intermediate between these two, which will provide a more quantitative result than the intuitive analysis, without requiring the full rigor of the mathematical model.

13.60

Stanford U., Calif.
THIRD ORDER AND HIGHER CONTACTOR CONTROL SYSTEMS, I. Flugge-Lotz. Project 9783(806A), Contract AF 49(638)-513; SREM, AFOSR.

This theoretical research is directed toward achieving a fuller understanding of the significance of optimum contactor control systems of higher than second order. In particular the contractor will: (a) investigate the theory and operation of optimum contactor control (switching) systems of higher than second order whose transfer functions have real and complex roots; (b) develop, insofar as may be practicable, general criteria for the stability of solutions obtained for the operation of generalized contactor systems; (c) establish broad physical and mathematical definitions for optimum control of performance of contactor systems.

13.61

Sylvania Electronic Systems, Waltham, Mass.
WEIGHT DISTRIBUTION IN ERROR-CORRECTING CODES, H. Matson. Project 5628(803A), Contract AF 19(604)-8516; CRRS, AFCRL.

This research concerns the theory of error-correcting codes with emphasis on the weight distribution in cyclic codes.

13.62

Syracuse U. Research Inst., N. Y.
CONCEPTS OF INFORMATION THEORY, F. Raza. Project 5628(803A), Contract AF 19(604)-6169; CRRS, AFCRL.

Perform fundamental research on concepts of

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information theory with emphasis on the probabilistic studies of networks and information theoretic research. Areas to be investigated include: (a) stochastic matrices and their effect on channel capacity; (b) mathematical theory of probabilistic networks along lines indicated by Von Neuman and Shannon-Moore; (c) relations between reliability of transmission of information source and channel parameters; and (d) implications to coding of recent results on the structure of the fundamental theorems of information theory.

13.63

Thompson Ramo Wooldridge, Inc., Canoga Park, Calif.
INDUCTIVE METHODS IN SEMANTIC ANALYSIS, P. L. Garvin. Project 9769(803A), AF 49(638)-1128; SRI, AFOSR.

This research is to develop formal inductive methods for semantic analysis which may be employed to achieve reliability in the compilation of semantic codes for use in information retrieval, automatic abstracting, and related activities. The study involves adaptation of linguistic methods to the study of semantic systems. The research, to be conducted in two phases, will be concerned with (1) semantic classification of verbal elements by a form-meaning technique, and (2) semantic classification of nominal elements by a distributional technique.

13.64

University of Southern California, Los Angeles.
COMPUTER DECISION PROCESSES, G. Young. Project 9768(803A), Grant AF-AFOSR-62-69; SRPP, AFOSR.

Research covers the investigation of of self-optimizing systems and computer decision processes. It is a basic theoretical investigation of the mathematical techniques which permit a computer to perform experiments and make decisions that alter the configuration of a real or simulated control system. The research represents a broadening of the point of view of adaptive systems to include computer synthesis and learning systems. Specific items to be included are optimization of systems involving random nonlinearities, the implementation of the Weiner theory of nonlinear systems, and applications of statistical decision theory to control

13.65

Seattle U., Washington.
MAN-COMPUTER INTERFACE STUDY, D. L. Johnson. Project 9769(803A), Contract AF 49(638)-1070; SRIR, AFOSR.

It appears that an interface exists beyond which the human can more efficiently perform than can the computer. This effort seeks to determine the existence of an ultimate interface position in various categories of problems coupled with an evaluation of the various parameters which fix the limit.

13.66

Western Reserve U., Cleveland, Ohio.
A GENERALIZED THEORY OF DOCUMENTATION AND SEARCHING STRATEGY, W. Goffman. Project 9769(803A), Grant AF-AFOSR-62-35; SRIR, AFOSR.

Studies concern mathematical formulations of documentation procedures (probabilistic models for the design of information retrieval systems), the fundamental nature of computers in relation to information retrieval problems, the applicability of word-association tests for predicting the value of thesaurus like and other cross-reference aids, and linguistic analyses.

See also: 8.62, 10.11, 10.28, 13.22, 17.111, 20.82, 21.49-50, 21.83, 22.145

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14. ENERGY CONVERSION, TRANSFER AND RELEASE

Combustion; Detonation; Energy Conversion; Energy Transfer; Flames; Free Radicals; Properties and Reactions of High-Temperature Gases, Ignition; Kinetics of Combustion and Detonation; Propellants.

14.1

Aero Chem Research Lab., Princeton, N. J. INFLUENCE OF COMBUSTION ON HEAT TRANSFER IN ROCKET (TYPE) COMBUSTION CHAMBERS, D. E. Rosner. Project 7013(801A), Contract AF 33(616)6216; ARZ, ARL.

This experimental research is directed toward the determination of the effects of combustion on rocket chamber heat transfer. Steady state heat fluxes from subatmospheric (15-45 mm Hg) carbon monoxide oxygen flame gases to platinized mercury-cooled tubes are being compared to corresponding heat fluxes when the tube is coated with a silicone resin. A cylindrical reaction vessel used as an explosion cavity is being used to obtain heat transfer data at typical rocket chamber pressures. Simultaneous heat transfer and pressure records are obtained.

14.2

Aerojet General Corp., Azusa, Calif. CHARGED COLLOID FOR PROPULSION SYSTEMS, R. B. Edmonson. Project 9752(801A), Contract AF 49(638)656; SRE, AFOSR.

One of the major problems in electrical propulsion is to maximize the available thrust for any given power supply. This can be accomplished by using a propellant with a very low charge-to-mass ratio compared to even the heaviest ions. Charged colloids offer such a propellant if the particles can be produced with a uniform charge-to-mass ratio. The mechanism of colloid formation and the process by which the charge is acquired by the particles must be understood before even the roughest feasibility estimates can be made. In the present experiment a low vapor pressure oil was supplied to a needle point either internally through a capillary or externally by letting the oil flow over the surface. The needle is connected to the positive terminal of a high voltage supply. This system produces charged droplets as long as the ambient air pressure is not too low. Effective spraying of Octoil with an additive of tetra-n-butyl ammonium has been attained at pressures of 10^{-6} mm Hg. The determination of charge-to-mass ratio is underway.

14.3

Aerojet-General Corp., Azusa, Calif. TANGENTIAL INSTABILITIES IN ROCKET CHAMBERS, R.S. Pickford. Project 9751(801A), Contract AF 49 (638)178; SRE, AFOSR.

Combustion instability in rocket motors has been described as an interaction between the pressure sensitive portion of the chemical reaction and a local disturbance, i.e. a pressure fluctuation or a shock wave. This research is primarily concerned with the growth mechanism which leads to tangential combustion instability. The rate of energy release from the propellant combination as well as the amount of energy released varies along the combustion chamber. A periodic pressure disturbance can be sustained only if sufficient energy is available at the time of wave passage to be released in phase with the wave. In addition, the replenishing of this available energy must be consistent with some characteristic travel time of the wave. The theoretical analysis shows that the amount of available energy is related to the evolution rate of combustion products and that the energy consumed is a function of the perturbation strength and pressure sensitivity. Experimental results should indicate the adequacy of the model assumed.

14.4

Aerojet-General Corp., Azusa, Calif. KINETICS OF FORMATION OF BORON NITRIDE FROM PENTABORANE AND HYDRAZINE, W. P. Knight. Project 9751(801A), Contract AF 49(638)1122; SREP, AFOSR.

The combustion of pentaborane with hydrazine yields low combustion efficiency, accompanied by the formation of products not predicted by theoretical performance calculations. Very little is known about the intermediate products formed and how they react to form stable end products. One approach to obtaining complete combustion is to select a known reaction path which leads to boron nitride, then study the kinetics and mechanism of the reactions involved. Knowing the kinetic behavior of the chemical processes which can form boron nitride attempts to adapt the process to combustion conditions can then be made through a study of selected catalysts. This approach is being undertaken. The mechanism under study involves the formation of an adduct of hydrazine and pentaborane followed by the decomposition of this adduct. Controlled experiments will be conducted, to measure both gas phase and liquid phase kinetics of adduct formation

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reaction and the adduct decomposition reaction. The effect of selected catalysts on these experiments will be studied.

14.5

Aerojet-General Corp., Azusa, Calif.
ION-ELECTRON RECOMBINATION RATES, C. B. Kretschmer. Project 9751(801A), Contract AF 49(638)540; SRE, AFOSR.

The program has followed three lines: (1) an investigation of the possibility of using the atomic oxygen in the upper atmosphere as a source of energy for propulsion (the atomic-oxygen ramjet), (2) the kinetics of atomic reactions important in the upper atmosphere, and (3) kinetics of ion-electron recombinations. Analysis of the atomic-oxygen ramjet indicates that propulsion dependent on gas-phase recombination without additional fuel is at best marginal. Addition of NO_2 as fuel makes possible flights of only a few hours. Heterogeneous recombination appears to be ruled out because the heat released at the walls cannot be transferred through the boundary layer into the stream to produce thrust. The work on recombination kinetics of the upper atmosphere has also been concluded, in that rate constants for all of the important atomic reactions possible in the N-O system have been determined. Excellent experimental results have been obtained from the method of after-glows in d-c discharge tubes. During the past year, the same experimental apparatus, with the addition of Langmuir probes, has been used to determine the recombination kinetics of ionized rare gases. Rate constants for argon and helium have been measured.

14.6

Aerojet-General Corp., Azusa, Calif.
KINETICS OF ENERGETIC SPECIES AT LOW TEMPERATURES, S. Skolnik, Project 9750(801A), Contract AF 18(603)110; SRE, AFOSR.

The work on this contract is now directed primarily toward studies of the basic nature of radical reactions important in combustion processes. In particular, studies are being carried out at various low temperatures to determine rates and mechanisms of disappearance of light radicals in solids. The effects of chemical environment, temperature, and the physical nature of the solid matrix are being investigated. The concentration measurements, as well as other information, are obtained from electron paramagnetic resonance spectra. Production of radicals by γ-irradiation (Cobalt 60) and by ultraviolet is being studied. The temperature range has been extended down to liquid helium. During the previous year, an extensive study was made of the formation and disappearance of OH radicals in γ-irradiated ice in the temperature range 77° to 110°K. In the past year, studies have been nearly completed on the kinetics of H atoms in ice down to 4°K, and much effort has been devoted to looking for NF_2 radicals in frozen irradiated N_2F_4.

14.7

Aeronutronics Space Technology Operations, Newport Beach, Calif.
REFLECTION AND SCATTERING OF SOUND BY GASEOUS FLAMES, H. M. Wight. Project 9751(801A), Contract AF 49(638)1106; SREP, AFOSR.

The fundamental issue concerns whether or not a sound wave incident upon a combusting propellant is reflected with increasing or decreasing energy. It is proposed to make an experimental study of the reflection and scattering of relatively low intensity traveling acoustic waves by the surface of combustion systems. Ultrasonic pulsed waves will be emitted and the reflected and transmitted waves received by suitable transducers. The flame system to be used in scattering and reflecting the ultrasonic energy will be constructed of premixed gas-air, double-base solid propellants and composite solid propellants. The basic parameters are expected to be the ultrasonic frequency, amplitude and scattering direction. There are a number of theories that have been advanced to describe the major features of the behavior of sound interacting with a flame. The experiment proposed here, has been designed to provide criteria for the applicability of any of the existing theories.

14.8

Amoco Chemical Corp., Whiting, Ind.
NEW HIGH ENERGY PROPELLANT, E. F. Marrello. Project 9750(801A), Contract AF 49(638)1105; SREP, AFOSR.

Among the newly-conceived compounds which offer considerable potential as a future high energy propellant boron perchlorate ranks high. However, data on the compound is practically nonexistent. In order to unlock these potentials, a scientific study will be made to synthesize boron perchlorate, following which, the chemical and physical properties will be investigated along with the ammonium and the hydrazine adducts of boron perchlorate. Supplementing this work, thermochemical calculations will be carried out using an IBM 704 machine.

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14.9

Atlantic Research Corp., Alexandria, Va.
REACTIONS OF ALKYL RADICALS, J. B. Levy. Project 9763(802A), Contract AF 49(638)483; SRC, AFOSR.

Free t-butyl radicals were generated by passage of the vapor of 2,2'- azoisobutane, either pure or in a carrier gas stream, through a heated tube. Studies were carried out on the material obtained by quickly condensing the stream on a cold finger cooled with liquid nitrogen. These studies included thermochemical analyses for the estimation of the radicals present, reaction of the radicals with nitric oxide and evaporation of the radicals from the solid state. Attempts were made to isolate and characterize, as above, benzyl radicals. Colored deposits were obtained by pyrolysis of dibenzyl ketone and although the presence of radicals was confirmed, the constitution of the colored deposit is unknown.

14.10

Atlantic Research Corp., Alexandria, Va.
SOLID PROPELLANT COMBUSTION, R. Friedman, Project 9750(801A), Contract AF 49(638)813; SRE, AFOSR.

The program includes: (a) measurement of burning rates of pure solid ammonium perchlorate, (b) study of the effects of pressure, radiant energy, and various catalysts on the deflagration rate, (c) sampling and analysis of the gas phase decomposition products, (d) study of the kinetics of decomposition of gaseous perchloric acid, (e) experiments on deflagration of pressed ammonium perchlorate in contact with organic fuels, and (f) interpretation of all of the data obtained in terms of likely theoretical models. Much work has been accomplished under (a) and (b), work is going forward on (c), (d), (e) and (f), with emphasis during the past year on the perchloric acid vapor studies and on burning of ammonium perchlorate in contact with methane.

14.11

Boston U., Mass.
CRYSTAL STRUCTURES OF POTENTIAL SOLAR ENERGY CONVERTERS, K. Eriks. Project 6694(750A), Contract AF 19(604)5995; CRZA, AFCRL.

A structure program is being developed for the analysis of solid materials of interest as possible solar energy converters. Such materials include intermetallic compounds, carbides, silicides, III-V compounds as well as organic materials. Theoretical correlations between crystal or molecular structure and photo-electrical phenomena are to be developed.

14.12

Brown U., Providence, R. I.
FLAME PROPAGATION THEORY, B. T. Chu. Project 9751(801A), Contract AF 49(638)646; SRE, AFOSR.

Because of the importance of non-linear phenomena in combustion even the simplest formulation of the process requires the description to be in terms of non-linear differential equations. The usual procedures for obtaining integrated functional relationships between the variables describing the process has been in the form of permissible linearizations. A somewhat different approach is to investigate known non-linear vibrating systems which have been successfully solved and attempt to select one which most nearly describes the combustion process. In accordance with this, a non-linear vibrating system which is unstable to small disturbances, will be formulated and the solutions examined to determine the behavior of the major parameters as functions of time and space. Another inadequacy in the existing theories of flame stability is the inadequate treatment of the effects of viscosity and preferential diffusion and conduction. The usual idealization of a flame front as a discontinuity conceals the details of the processes by which the change in the physical state of the combustible mixture is changed into the combustion products. The general features of the effects of viscosity, conduction, and diffusion can perhaps be elucidated by using a model for the flame front somewhat similar to the one used in Prandtl's boundary layer theory.

14.13

Brown U., Providence, R. I.
CHEMICAL REACTIONS BEHIND SHOCK WAVES, E. F. Greene. Project 9751(801A), Contract AF 49(638)167; SRE, AFOSR.

The mechanism of decomposition of gaseous hydrocarbons and some other materials, at low pressures and high temperatures, is an important area of study in combustion. More understanding in this area is needed in order to give more detailed description and prediction of combustion processes. Much of the previous work has been difficult to interpret, partly because heating times have been difficult to interpret, partly because heating times have been comparable to, or even longer than, the reaction times of interest. By supplying the required energy in a shock wave to a gaseous sample under study, one obtains rapid and homogeneous heating and subsequent cooling of the sample. The work is concerned with (1) the development of shock tubes for such studies of mechanism, and (2) the use of shock tube experiments along with actual analyses of the reaction

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products to elucidate mechanisms of various reactions. Under (1), four shock tubes have been built, instrumented and evaluated for kinetic studies. One of these has been used for deducing the effect of tube diameter on shock velocities. Under (2) work has been completed on pyrolysis of acetylene in the range 1400 - 2500°K, on the pyrolysis of BrCN, and on the ionization of inert gases. Studies of the hydrogen-bromine reaction, and of the relaxation of hydrogen iodide, are in progress.

14.14

Brussels U., Belgium
EROSIVE BURNING OF SOLID PROPELLANTS, J. Vandenkerckhove. Project 9751(801A), Contract AF 61(052)354; SRE, AFOSR.

The acceleration of burning rate which occurs when gas flows at a high velocity past the burning surface, is known as erosive burning. The existing theories on the subject, such as those of Corner (1947) and Robillard (1956), neglect some important considerations for the sake of simplicity, and also depend on experimental observation of erosion for numerical values of some of the parameters. The present work is an attempt to establish in detail, a theoretical model which takes into account the effect of turbulence in the chemically reacting gases closest to the surface. This objective has been partially achieved, and it is felt that the presently available data are too limited to justify much further refinement.

14.15

Bureau of Mines, Washington, D. C.
THERMODYNAMICS OF ORGANIC DERIVATIVES OF LIGHTER ELEMENTS, J. P. McCullough. Project 9750(801A), Contract CSO 59-9; SRE.

This program, being conducted in one of the best thermodynamic laboratories in the country, is a long-term effort to obtain complete and accurate data on selected compounds which may have importance in new propellant programs. The properties being studied are (1) heat capacity, entrophy, enthalpy, and free energy of condensed phases and the gas phase, (2) vapor pressures, (3) temperatures and heats of transitions, (4) state data for gases, and (5) heats of formation and thermochemical bond energies. The methods used to obtain these properties include, on the experimental side, low-temperature adiabatic calorimetry, vapor flow calorimetry, combustion and reaction calorimetry, vapor-pressure and compressibility measurements, and infra-red and Raman spectroscopy. Theoretical work is being performed in statistical mechanics, molecular structure, and bond energies.

14.16

California U., Berkeley.
DEVELOPMENT AND STABILITY OF DETONATIONS, A. K. Oppenheim. Project 9751(801A), Contract AF 49(638)166; SRE, AFOSR.

Detonative combustion is important because the chemical reactions rates associated with them are among the highest for spontaneously generated reactions, and controlled detonation may some day be incorporated in air breathing propulsive systems as a means for attaining hypersonic flight speeds. The basic problem is to determine the process by which the combustible mixture reaches the thermodynamic state required for detonations. A familiar phenomenon is the development of a detonation in a tube filled with a combustible mixture ignited at one end. This is supposed to occur as a result of the compression waves that are generated by the accelerating flame. The gas ahead of the flame is heated by the compression waves until the detonation temperature is reached. This theory is being put to the test by measuring several important variables. The phenomenon is being photographed by schlieren and direct techniques which give the details of the pressure waves and particle velocities. Ionization probes give information about the conductivity in the flame front. These are being supplemented by pressure and temperature measurements. To date considerable success has been attained in correlating their analytical model of detonation buildup with experimental results.

14.17

California U., Los Angeles.
PHOTOGALVANIC THIONINE IRON SYSTEM, R. Hardwick. Project 6694(750F), Contract AF 19(604)6643; CRZA, AFCRL.

The thionine-iron system is a process where solar energy may be converted into electrical energy with no net chemical change of the electrodes or the electrolyte. The project is a study of the basic mechanism of the system. This research includes a study of the efficiency of current production as a function of viscosity, light intensity, temperature, stirring, electrode design, and concentration of the various substances present. The data obtained under this contract has shown that little is known about the association state of thionine in water solutions at various pH's. The research is continuing on the line to determine the extent and mechanism of association of the thionine ions in aqueous solutions.

14.18

California U., Los Angeles.
KINETICS OF HIGH TEMPERATURES PRODUCED BY SHOCK WAVES, E. R. Hardwick. Project 9751(801A), Grant AF AFOSR 62-240; SREP, AFOSR.

Shock tube techniques are used in this work to study the mechanism of decomposition of nitric acid, nitryl chloride, and other selected molecules. Temperature ranges not studied by other investigators are covered in this work. The time-composition relationships are determined by fast-response optical instrumentation of the shock tube. Papers on the shock-wave decomposition of nitryl chloride and chlorine gas have been published during the past year. The work on chlorine has been particularly significant in that experimental data for unimolecular decomposition have been obtained in a temperature range far beyond that previously available, and this has led to new conclusions about the deactivation of excited molecules.

14.19

California U., Los Angeles.
DETAILED STUDY OF LIGHT EMITTED BY ATOMIC FLAMES, K. D. Bayes. Project 9760(802A), Grant AF-AFOSR-62-62; SRC, AFOSR.

Study of the free radical reactions is a necessary foundation for understanding the more complex mechanisms which take place at the high temperatures and pressures of combustion processes. This study should provide information on how the energy provided by the chemical change is utilized; how it is distributed to electronic, vibrational and rotational energies.

14.20

Callery Chemical Company, Pa.
EVALUATION OF N-F COMPOUNDS AS CALORIMETRIC OXIDIZERS, W. J. Cooper. Project 9750(801A), Contract AF 49(638)1052; SREP, AFOSR.

This program has the objective of evaluating the thermochemical technique of using nitrogen-fluorine compounds as oxidizers. The chemistry of reaction of such oxidizers with high energy propellant ingredients is being studied from the point of view of products formed, side reactions, and completeness. Precise calorimetric measurements will be made of energy released by these reactions. The heats of formation of boron compounds (and many aluminum and silicon compounds) have not been obtainable by combustion calorimetry because they are not sufficiently reactive with oxygen, and, on the other hand, elemental fluorine presents many experimental difficulties. Nitrogen-fluorine compounds especially NF_3, may provide a technique which eliminates the objections of both oxygen and fluorine. Some of the more important fundamental quantities to chemical propulsion are uncertain and are being worked on by some of the outstanding laboratories in the country. Examples are (1) the enthalpy difference between crystalline and amorphous boron, (2) the B-F bond energy and (3) heats of formation and bond energies of boron-carbon compounds. All of these will be provided with answers if this program uncovers a new thermochemical technique.

14.21

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
BURNING VELOCITY OF SPECIAL FUEL SYSTEMS, K. Scheller. Project 7013(801A), Internal.

The burning velocity of unconventional fuel systems is being investigated in a constant pressure spherical bomb for the purpose of exploring chemical combustion mechanisms. The apparatus has recently been modified by the addition of a schlieren observation system in order to obtain more reliable observations of spatial flame speeds and density ratios, particularly for slower flames. An investigation has been initiated of the minimum ignition energies of cyanogen mixtures in an attempt to obtain more information on the insensitivity of their burning velocity to cyanogen content. Preparations are being made to measure the burning velocity of certain binary fuel systems in order to elucidate their combustion kinetics.

14.22

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
ENERGY TRANSPORT IN A REACTING GAS, K. Scheller. Project 7013(801A), Internal.

Two analytical studies on heat transfer in reacting gases have recently been completed. One of these treated the case of convective heat transfer through a dissociating gas confined between two semi-infinite parallel plates. Numerical calculations, based on N_2O_4 as the gaseous heat transfer medium, indicated that both the heat transfer through the gas and its convective velocity would be increased by a factor of approximately 5 as compared with expected values if the gas were chemically inert. The calculated increase in heat transfer arises from the diffusive transport of enthalpy by the dissociated species while the increase in convective velocity is attributable to the increase

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ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
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ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
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in the number of moles of gas due to dissociation, which leads to a greater buoyant force. In the second theoretical investigation, heat transfer to a fluid in laminar flow in a circular duct was examined. An exact solution was obtained to the conservation equation governing the flow. Calculations made for N_2O_4 gas revealed that the heat transfer and effective heat transfer coefficients were increased by factors of from 5 to 8 for the range of conditions considered. An experimental investigation is being made to verify the results of the parallel plate study. Apparatus is being designed and constructed for this purpose.

14.23

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
KINETIC MECHANISMS IN FLAMES AND DETONATIONS, K. Scheller. Project 7013(801A), Internal.

Two distinct, though related, lines of research are being followed in this effort. In one of these, the temperature and composition in the reaction zone of a cyanogen flame are being measured experimentally in an effort to determine some quantitative aspects of the nature of the coupling between the two stages of this flame. Construction of apparatus for this purpose is now complete and the equipment is being checked out with methane flames to compare the results with reported data in the literature. This apparatus will also be used for binary fuel studies to complement the constant pressure bomb work. In the other research activity, the kinetics of detonation waves are under study. Detonation tubes and associated velocity and pressure measuring instrumentation have now been assembled for this effort. Pressure measurements have been made on a variety of combustible gaseous mixtures in order to perfect experimental techniques for determining the pressure in the reaction zone of a detonation wave. Consideration is also being given to techniques for measuring reaction temperatures in the wave and the necessary components are being obtained to construct apparatus for this purpose. In the first of the detonation investigations, the effect of reaction inhibitors on the kinetics of the methane-oxygen detonation is to be explored.

14.24

Chemistry Research Lab., ARC, ARL, Dayton, Ohio.
ENERGY TRANSFER IN THE GAS PHASE BY THE FLUORESCENCE TECHNIQUE, J. T. Dubois. Project 7013(801A), Internal.

Intra- and inter-molecular energy transfer processes in gaseous polyatomic molecules are being studied with the help of luminescence and photochemical techniques. The information obtained therefrom is applied to general photochemical theory, to radiation chemistry and to other areas of interest. Typical experiments involve the measurements of sensitized fluorescence, phosphorescence, the theoretical investigation of vibrational temperatures of electronically excited molecules and the products of photochemical experiments.

14.25

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
RADIATIVE TRANSFER, P. Schweitzer. Project 5628(803A), Internal.

The purpose of this effort is theoretically and experimentally to study a wide range of problems concerning the transport of radiation in media not covered in existing radiative transfer theory. Prominent cases are media not having a positive temperature, bounded media, media whose index of refraction does not behave simply. Such problems arise, for instance, in connection with both man-made and natural plasmas and with lasers, and are of central importance in the study and understanding of the behavior of such entities. Included in this effort is the study, when pertinent, of the microscopic radiative interactions which give rise to microscopic parameters such as absorption or index of refraction. Therefore, work included under this effort ranges, e.g., from study of modes in a laser cavity to determination of unknown collision cross-sections.

14.26

Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
MOLECULAR INTERACTIONS AT HIGH TEMPERATURES, C. Treanor. Project 9783(806A), Contract AF 49(638)793; SREM, AFOSR.

Utilizing a molecular-beam apparatus, capable of producing neutral molecular beams in the energy range 1 to 10 ev, experiments will be made to measure the scattering cross sections for those gases which make up high temperature air. These measurements will be used, along with related theoretical work to define the transport properties of air up to 10,000°K. Preliminary studies will also be made of the interactions of high-speed atoms with solid surfaces. The molecular beam apparatus, already developed, utilizes a shock tube to heat the gas under study. Rapid expansion of the gas then produces a jet flow of very nearly mono-energetic particles. This jet is then collimated to produce an intense high energy beam of neutral atoms or molecules.

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SRP- Directorate of Physical Sciences

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CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZM- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

14.27

Cornell U., Ithaca, N. Y.
KINETICS OF PHYSICOCHEMICAL REACTIONS, E. L. Resler, S. H. Bauer. Project 9781(806A). Contract AF 49(638)716; SRE, AFOSR.

The objectives of this effort are to investigate those problems in gas dynamics which arise primarily from the chemical reactions which occur in the gas; such problems require concurrent treatment via gas dynamics and chemical kinetic principles. In particular, the contractor is studying the fundamental factors which control the rates of dissociation of small molecules and the limitations on these rates due to the system not being in thermodynamic equilibrium. Secondly, he is concerned with the production of free radicals in the gas phase generated by the decomposition of selected large molecules, and will attempt to establish the spectroscopic properties of these free radicals, so that their structures can be explored and their chemical reactivities recorded. Thirdly, he is investigating the general spectroscopic properties of a variety of gases at high temperatures. Here also he is concerned with the finite rates of attainment of an equilibrium distribution among the excited states. Finally, he will attempt to measure the rates of condensation of solids and liquids when systems at high temperature are suddenly quenched. Utilizing the data obtained, a comprehensive theory of chemical-kinetics which can be applied to hypersonic flight, or combustion problems, will be formulated.

14.28

College of Aeronautics, Cranfield, Great Britain.
COMBUSTION OF LAMINAR SOLID PROPELLANTS, A. G. Smith. Project 9751(801A), Contract AF 61(052) 267; SREP, AFOSR.

The combustion characteristics of a solid propellant-model consisting of alternate layers of fuel and oxidizer are being investigated both analytically and experimentally. The model to be studied resembles a can of pineapple rings where the rings are alternately fuel and oxidizer. Both the theoretical and experimental studies are aimed at determining the mathematical formulation of the mixing properties of the gas arising from the inside of one of these rings, with the turbulent flow down the central well. Four different calculational approaches have been tried, yielding different shapes of the concentration-distance curves. The experiments consist in measuring the concentration of CO_2 downstream from a porous cylindrical section which is injecting this gas into a turbulent air stream.

14.29

Dayton U., Ohio.
PRESSURE ENERGY EXCHANGE PRINCIPLE, J. Minardi. Project 7116(801A), Contract AF 33(616)6417; ARN, ARL.

Pressure energy exchange principles and associated problem areas are being investigated. This research is directed toward achieving temperatures of the order of 10,000°R in substantial amounts of uncontaminated, high pressure air, as well as high temperatures in small amounts of gas. Both gas and liquid driver energy exchange principles are being investigated. An approach has been made for the solution of the stability problem in the planer interface between driver liquid and the gas being compressed during the deceleration of the driver fluid. Experimental investigations are being performed in a high pressure gas driver rig as well as in a liquid low pressure driver rig.

14.30

Denver Research Inst., Colo.
EXPLOSIVE SHAPED CHARGE MECHANISMS AND EXPLOSIVE WAVE SHAPING, A. M. Krill. Project 2858(801A), Contract AF 08(635)486; ASD.

The objective of this research is to analyze explosive energy projection trends as they vary with modifications in experimental charge configurations in order to better understand the explosive process, high energy wave shaping, and wave energy transfer. Work undertaken includes; (1) a literature survey on explosive charge configuration concepts, followed by the design of unconventional shaped charges; (2) an analysis of the parameters involved in the action of shaped charges; (3) the derivation of a mathematical model of collapse mechanics for unconventional shaped charges; and (4) an experimental study of various initiation and wave shaping techniques.

14.31

Denver Research Inst., Colo.
EFFECT OF TEMPERATURE CYCLING ON HE, D. N. Gray. Project 7353(802A), Contract AF 29(601)2671; SWR, AFSWC.

This research study is to obtain data on the effects of temperature cycling on pertinent military explosives. After correlating this data, it is anticipated that a theory will be be developed to explain the resultant processes. Also as a result of the testing, realistic limits should be established within which presently conceived chemical explosive systems may be employed. The contractor will conduct a short concise literature survey of all the latest developments in

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RACR- Advanced Studies Office
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RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

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AEOR- Research Division
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explosive research with special interest in high temperature applications. From this survey, it will be jointly determined by the AFSWC and the contractor which explosives will actually be tested. The high explosives to be examined will be exposed to temperature cycling at temperatures expected in new weapon systems. The contractor will examine the explosives to determine the changes in (a) sensitivity, (b) impact sensitivity, (c) thermal sensitivity, and (d) detonation velocity. It is the ultimate goal of this research to determine the reasons an explosive is altered by heat.

14.32

Directorate of Life Sciences, SRL, AFOSR, Washington, D. C.
RADIATIVE EXCHANGE AT THE FOCAL SPOT OF RADIANT ENERGY CONCENTRATORS, B. I. Davis. Project 6886(802A), Internal.

The quantitative understanding of radiative exchange which occurs at the focal spot of an image furnace is of paramount importance to the feasibility of experimental methods for obtaining such thermodynamic parameters such as temperature, absorpitivity and emissivity at the surface of the specimen. Contractual work on the temperature measurement problem indicates the need for in-house assessment of the theoretical and experimental aspects of the problem.

14.33

Directorate of Research Analysis, SRAS, AFOSR, Washington, D. C.
EFFECT OF SPACE CONDITIONS ON ENERGY CONVERSION SYSTEMS, F. G. Pensig. Project 3827(801A), Internal.

This research is a study of high vacuum systems suitable for approximative simulation of space conditions in the laboratory regarding pressure and temperature. The work includes experimental research in the behavior of solid and liquid propellants and investigation of friction and wear of components of energy conversion systems under simulated space conditions.

14.34

Dynamic Sciences Corp., South Pasadena, Calif.
PROPELLANT SPRAYS IN LIQUID ROCKET ENGINES, M. Gerstein. Project 9751(801A), Contract 49(638)1151; SREP, AFOSR.

The proposed work is a new approach to the problem of liquid rocket combustion instability in that: (1) the space-phase relationship is emphasized rather than the time-phase relationship, (2) the events which amplify the random disturbances early in the history of the development of instability are considered as well as those which drive the instability once established, and (3) the model directly relates stability to propellant properties and injector design. The initial phase of investigation will consist of research pertaining to propellant sprays in liquid propellant rocket engines for purposes of relating combustion instability to propellant properties and injector design. The research will be primarily of an analytical nature, and a simple model will be studied to determine the relationship between the motion of the propellant droplets and the stability of the combustion system in an oscillating flow.

14.35

Electro-Optical Systems, Inc., Pasadena, Calif.
SPECTRALLY SELECTIVE MATERIALS AND SURFACES, J. Fisher. Project 7116(801A), Contract AF 33 (616)6549; ARN, ARL.

Theoretical and experimental studies are being made of spectrally selective properties of materials. An analysis is in progress of radiant energy conversion characteristics of multi-layer surfaces. Applicable equations are formulated of the interaction of radiant energy and materials. The investigation includes the determination of desirable spectral qualities of materials and surfaces based upon projected application and practical considerations.

14.36

Electro-Optical Systems, Inc., Pasadena, Calif.
SOLAR ENERGY PROPULSION DEVICES, J. H. Fisher. Project 7116(801A), Contract AF 33(616)5977; ARN, ARL.

This program will provide the required research problem areas of low Reynolds number aerodynamics and thermodynamics, and ultra-light weight collector systems in order to support studies on solar energy utilization. Low Reynolds number aerodynamics will be studied in the useful operating range. Solar radiation collector systems will be studied both theoretically and experimentally in an effort to achieve efficient operation at high receiver temperature levels. The aspects of low Reynolds number heat transfer will be studied theoretically and experimentally insofar as is applicable to solar energy utilization.

14.37

Experiment Inc., Alexandria, Va.
PROPERTIES OF IONS IN FLAMES, I. R. King. Project

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9751(801A), Contract AF 49(638)650; SRE, AFOSR.

During the past year extensive measurements have been made of electron attachment to neutral atoms to form negative ions in flames. Both mobility studies and electromagnetic attenuation have been used. Similar studies are now being conducted in flames containing alkali metal ions. By the end of this period, sufficient data should be available to afford a thorough check of the proposed mechanism of recombination in hydrocarbon-air flames. In addition, similar results for flames containing alkali metal salts should be complete.

14.38

Fairfield University of St. Robert Bellarmine, Conn.
HIGH ENERGY FREE RADICALS, R. E. Varnerin. Project 6694(750F), Contract AF 19(604)8806; CRZA, AFCRL.

The objective of the contract is an investigation of the "hot" radicals produced when an organic compound absorbs a quantum of energy in excess of the energy required to break the bond. Various methyl radical sources are photolyzed at various wavelengths in the presence of a transparent substrate molecule such as propane. The study is being carried out at widely varying conditions of temperature, concentration, and pressure in order to find conditions under which the methyl radicals are not totally equilibrated thermally before reaction with the substrate. The presence of "hot" radicals is indicated by the low activation energy determined for the systems.

14.39

Florida State U., Tallahassee.
PREPARATION AND PROPERTIES OF REACTIVE INTERMEDIATES, D. F. DeTar. Project 9760(802A), Grant AF-AFOSR-62-279; SRC, AFOSR.

The proposed research embraces two separate areas. The first is an investigation of the elementary steps of important free radical reactions in solution and a quantitative evaluation of radical reactivities. The second is the preparation and study of peptide polymers containing repeating sequences, a new type of polymer.

14.40

General Applied Sciences Lab., Hempstead, N.Y.
HYPERSONIC COMBUSTION, A. Ferri. Project 9751 (801A), Contract AF 49(638)991; SRE, AFOSR.

The initial effort consisted of analytical studies in order to obtain an understanding of the phenomena connected with the reaction of a hydrogen fuel jet in a high enthalpy supersonic stream. The experimental effort consisted of utilizing a single fuel jet placed in the center of a shock tunnel nozzle, injecting fuel in the nozzle and analyzing the flow downstream of the injection region to obtain data on mixing and reaction rates. The extended work will entail the continuation of analytical and experimental studies of flow mixing with chemical reactions in order to obtain detailed information on the mixing and reaction phenomena. The work will be extended to include determination of the stability of the flames due to multiple injectors.

14.41

General Electric Co., Cincinnati, Ohio.
RADIATION IN ROCKET MOTORS, D. E. Robison. Project 9751(801A), Contract AF 49(638)413; SRE, AFOSR.

This research is to show the relative importance of radiant heat transfer as well as the radiation mechanism of high temperature combustion products. The three most important variables at a given temperature which affect the radiant energy emitted by rocket combustion gases are the composition of the products, the combustion pressure and the geometry of the combustion chamber. At combustion temperatures of the order of 5,000° R the actual amount of energy transferred by radiating H_2O gas (products of N_2O_4 - N_2H_4 and others) is being measured by a thermopile. The spectral region in which this energy is being transferred is recorded on a spectrophometer. In addition to measuring the radiant energy emitted by water, the component of radiant energy emitted by CO_2 will be considered. Aluminum oxide will also be introduced to study the effect of incandescent particles on the radiant heat transfer characteristics.

14.42

General Electric Co., Schenectady, N.Y.
TURBULENCE IN GASEOUS DETONATIONS, D. R. White. Project 7013(801A), Contract AF 33(657)7945; ARC, ARL.

This is an experimental study of gaseous detonation in shock tubes to explore the relationship of the turbulent structure behind a detonation wave to the low pressure and duct diameter limits of propagation and to the origin and stability of spin phenomena. An effort is also to be made to determine the nature of the processes which generate turbulence in the reaction zone. Related theoretical analyses designed to elucidate the

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effects of turbulence on the behavior of detonation waves are to accompany the experimental studies.

14.43

Goettingen U., Germany
FLAME KINETICS, W. Jost. Project 7013(801A), Contract AF 61(514)1142; ARC, ARL.

An investigation is being made of the structure of the reaction zone in detonation waves and of decomposition reactions in shock waves. The thermal decomposition of hydrazine has been under study. Shock tube conditions were controlled to give temperatures ranging from about 1100° - 1350° K at a reaction pressure of 7.5 atm. Extinction coefficients of hydrazine and ammonia were determined at an appropriate wave length over the range of test temperatures. Under the experimental conditions (0.03 - 0.3% N_2H_4 in argon), hydrazine was found to decompose into NH_3, N_2 and H_2 in a reaction of the 3/2 order with an apparent activation energy of 43 kcal per gm mol. Evidence was detected for an increase in reaction order with increase in concentration for mixtures containing more than 0.3% hydrazine. In further work, the influence of oxygen on the decomposition reaction is to be explored.

14.44

Harvard U., Cambridge, Mass.
DYNAMICS AND ENERGETICS IN COMBUSTION, H. W. Emmons. Project 9751(801A), Contract AF 49(638)29; SRE, AFOSR.

The process by which oxygen in the ambient atmosphere is introduced into the combustible material is visualized as convection induced by the action of the hot produce gases. The rate of air convection at different heights above the flame is included in the formulation. Three mechanisms for heat transfer to the unburned fuel are recognized in the model: conduction, convection and radiation. The relative importance of each is related to the size of the fire. The solution of the equations gives a reasonable profile for the temperature and velocity of the column of gas above a fire. The model of the heat transfer mechanism indicates that conduction is important in small fires, convection in somewhat larger fires and radiation is important only in the very large fires. In addition, a more exact investigation is being made of the configuration of a flame around a drop in a high velocity stream of oxidizer. Both the combustion rate and the stability of the flame at these high velocities are significantly different from those usually assumed. The mechanism of pool burning is being investigated by considering the energy transfer from the diffusion flame back to the evaporating liquid surface.

14.45

Hebrew U., Israel
SOLID STATE CHEMICAL REACTIONS, S. Patai. Project 7013(801A), Contract AF 61(052)575; ARC, ARL.

The contractor shall extend his experimental investigation of heterogeneous oxidation reactions between solid oxidants and solid organic substrates to high melting polymers other than polydivinyl benzene and high melting organic compounds of known structure. The work shall involve various studies including kinetics of the reaction of the substrate-oxidant pairs selected for investigation; the influence of additive catalysts and inhibitors on the reaction rate; influence of physical factors on the reaction rate; influence of irradiation on reaction mechanism; labeled isotope studies to follow material transfer processes in the reacting system; and a complementary analysis to attempt to correlate the action of additives with their chemical and physical properties.

14.46

Hull U., Gt. Brit.
KINETICS OF HYDROGEN-OXYGEN AND HYDROCARBON-OXYGEN REACTIONS, R. R. Baldwin. Project 9751(801A), Grant AF-EOAR-62-25; SREP, AFOSR.

This contract is for fundamental study of (1) the effect of hydrocarbon additives on the explosion limits of H_2-O_2 mixtures, (2) the effect of an aged boric acid surface on the kinetics and mechanism of the H_2-O_2 "slow" reaction, (3) the effect of CO in combination with the boric acid surface, (4) the effect of various surfaces on the reactions between simple aldahydes and oxygen in the 500°C region, where no work has previously been done, and (5) the effect of the aged boric acid surface on the kinetics and mechanism of decomposition of hydrogen peroxide. In work so far it has been found that methane shows a far different effect than ethane or propane on the H_2-O_2 reaction, and this is being studied further. A satisfactory mechanism has been worked out to explain the data obtained for H_2-O_2 in aged boric acid-coated vessels.

14.47

Illinois U., Urbana.
MATRIX ISOLATION AND MASS SPECTROMETRIC STUDIES OF SPECIES PRODUCED IN A SHOCK TUBE, R. L. Belford, A. Kuppermann. Project 9763(802A), Grant AF-AFOSR-62-245; SRC, AFOSR.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
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SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

It is proposed to study high temperature gas phase kinetic and high temperature molecular species with the use of a shock tube, a mass spectrometer and a matrix isolation apparatus. A three-inch diameter shock tube is being set up for the production of high temperature gas kinetics. Two methods for study of the molecules, which emerge from a port in the end of the tube, are to be employed; matrix isolation trapping followed by optical spectrophotometry, and mass spectrometry. The role of the shock tube is to generate a homogeneous high temperature gas. The shock tube is capable of heating a test gas to over 8000° K. The reason they have chosen shock heating is that no other method now known generating these high temperatures and also yield a homogeneous mixture with uniform properties throughout.

14.48

Imperial Coll. of Science and Tech., London, Gt. Brit.
INFRARED STUDY OF FLAME STRUCTURE, F. J. Weinberg. Project 7013(801A), Contract AF 61(052)146; ARC, ARL.

Utilizing a flat flame burner, infrared spectroscopic techniques are to be employed to determine the spatial distribution across a flame front of stable combustion species. Initial efforts will be devoted to determining the local rates of generation of CO_2 in a suitable flame and comparing these values with sampling technique results and with those deduced from heat release rates calculated from optically determined temperature profiles. All activity to date under this contract has centered upon the construction, assembly, and calibration of the necessary experimental equipment. Numerous minor problems have arisen regarding the details of the design and operation of the gas flow control and metering systems and the alignment of the optical system. Solutions to these problems have been gained through the dint of straight-forward but time-consuming efforts. The apparatus is now apparently in a ready condition and is to be applied to an examination of ethylene-air flames.

14.49

Imperial Coll. of Science and Tech., London, Gt. Brit.
FLAME STRUCTURE, F. J. Weinberg. Project 7013 (801A), Contract AF 61(514)1013; ARC, ARL.

The entire contractual effort is being concentrated upon the application of optical methods to the study of fast and turbulent flames. Optical systems have been developed using ray deflection techniques to measure the randomness of orientation of the fluctuating flame front, to delineate the instantaneous flame front surface, and to determine the time-mean distribution of optical paths throughout the flame. Methods of analysis have been established to utilize the results obtained by these optical techniques to determine local burning velocities in turbulent flame fronts and to attempt to correlate turbulent transport properties with turbulent burning velocities. Some experimental confirmation has been obtained for one widely accepted model of a turbulent flame, which considers it to consist of a fluctuating, continuous, highly wrinkled front. In this view, the increase of turbulent over laminar burning velocity is due primarily to the increased surface area of the turbulent flame front. Experiments with a stoichiometric propane-air flame have thrown doubt on this premise. Results indicate that the intrinsic burning velocity of a turbulent flame is apparently greater than the laminar burning velocity. Efforts are now underway to test the wrinkled laminar flame front hypothesis in other ways.

14.50

Institute Nacional de Technica Aeronautica (Inta), Madrid, Spain.
SUB- AND SUPERSONIC DIFFUSION FLAMES, I. Da Riva. Project 9751(801A), Contract AF 61(052)221; SREP, AFOSR.

Theoretical and experimental research is being carried out on the following: (1) burning rates, flame size and ignition properties of liquid propellant systems including combustion of droplets considering transient as well as steady state conditions, (2) the internal structure and properties of premixed laminar flames with chemical reactions, with heat losses (important in the analysis of the existence of flammability limits), and with lateral diffusion, and non-steady laminar flames which occur during ignition. This work will be extended to the analysis of the properties of gaseous detonation waves, (3) flame size, thickness and temperature of both premixed and diffusion laminar-stationary spherically symmetric flames and wave. Included will be a study of a model based on a point source emitting by diffusion, fuel in a supersonic uniform fluid flow of oxidizer. For these studies use will be made of a previously developed technique for studying spherically symmetric flames for which the theoretical models are much more complete and are free of many artificial boundary conditions which are necessary for flame waves, and (4) combustion of solid propellants in spherical pellet form, including the influence on the process of the temperature and pressure of the surrounding atmosphere.

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ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
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ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

14.51

Ionics, Inc., Cambridge, Mass.
ION EXCHANGE MEMBRANE FUEL CELLS, R. M. Lurie. Project 6694(750F), Contract AF 19(604)8508; CRZA, AFCRL.

Conducts detailed studies and investigations preliminary to the development of an efficient fuel cell which operates on hydrogen and bromine. The electrolyte of the fuel cell is a cationic exchange membrane resin. The studies include an investigation of the bromine solution composition in order to reduce the bromine diffusion for optimum cell performance. A study of the different parameters of the ion exchange membranes will be made in order to achieve maximum cell performance. A material study will be made on the various components of the fuel cell. New electrodes have been constructed which improve the efficiencies of the fuel cell.

14.52

Iowa State Coll., Ames.
DIRECTIVE EFFECTS IN ALIPHATIC SUBSTITUTION, G. A. Russell. Project 9760(802A), Contract AF 49(638)678; SRC, AFOSR.

The research is an investigation into the factors that control the reactivity of free radicals and atoms. Major emphasis will be placed upon correlating the rate of reaction with the structure of the radicals. Relative reactivities toward the chlorine atom will be obtained by competitive chlorination at various concentrations of the aromatic material and their extrapolation of the results to an infinite dilution of the aromatic material. This extrapolation is necessary because of the pronounced solvent effect which aromatic materials exert upon the reactivity of chlorine atoms. The effects of heavy metal ions and solvents upon the reactivity and selectivity of free radicals and atoms will be investigated by unambiguously generating the free radicals or atoms in the presence or absence of the solvent or metal ion and observing if the solvent or metal ion has any effect on the products of the reaction.

14.53

Linfield Research Inst., McMinnville, Oreg.
NON-AQUEOUS FUEL CELL, R. Hamby. Project 5635(803A), Contract AF 19(604)7395; CRR, AFCRL.

An investigation into a high temperature fuel cell utilizing a fused molten electrolyte with the added feature that the membrane separating the fused electrolytes contain ions of the type to pass from the positive electrode.

14.54

Princeton U., N. J.
LIQUID PROPELLANT ROCKET MOTOR COMBUSTION PROCESSES, I. Glassman, L. Crocco. Project 9750(801A), Grant AF-AFOSR-62-90; SREP, AFOSR.

(1) A method has been developed analytically and experimentally, for characterizing the droplet size distribution in a spray, by a photographic measurement of light-scattering. Difficulties have been encountered in adapting the method to the conditions of a combustion chamber, where high pressure, high temperature gases also scatter light. By the use of infrared, and other ingenious refinements, the difficulties are being overcome. Soon these measurements will be used to study the details of high pressure droplet combustion in selected atmospheres. (2) A low-pressure, high-temperature flow reactor is being used to investigate the activation energies and rate constants of certain reactions. Hydrogen-oxygen combustion and ethylene-oxide decomposition were previously studied. Using a rebuilt reactor with quartz tubing at all important points, the decomposition of unsymdimethyl hydrazine has now been studied, and measurements on hydrazine are beginning. (3) A "gas rocket" is being used to assess the relative importance of chemical kinetics and heat transfer in combustion instability. In the experiments, premixed gases with known reaction rates are fed through a flat plate into a combustion chamber and the limits of longitudinal stability are measured. Series of measurements made thus far with methane-oxygen and hydrogen-oxygen are not entirely explainable, but indicate that heat transfer may be much more important than chemical reaction rate.

14.55

Little, Arthur D., Inc., Cambridge, Mass.
RECIRCULATION IN LIQUID ROCKET ENGINES, A. C. Tobey. Project 9751(801A), Contract AF 49(638)1120; SREP, AFOSR.

The proposed work represents another approach to the problem. The emphasis in this concept is on the recirculation zone at the liquid propellant injector. This is not an entirely new idea but the proposed study presents a way of quantitatively determining the behavior of the reactants in the recirculation zone when the flow is disturbed by a pressure wave. The way

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in which the mixture ratio of the reactants in this zone is affected by disturbances is expected to be the primary factor in instability. This will be evaluated by measurements of the composition and the flow pattern. Both of these can be individually controlled by the injection of inert diluents. If instability is indeed related to these properties of the recirculation zone then a quantitative theory of the phenomenon should be possible. In any case this study will introduce an additional technique for studying instability in other systems.

14.56

Lockheed Aircraft Corp., Sunnyvale, Calif.
STEADY AND UNSTEADY COMBUSTION OF SOLIDS, W. Nachbar. Project 9751(801A), Contract AF 49(638)412; SREP, AFOSR.

The objective of this work has been a mathematical (theoretical) description of the combustion process for composite propellants. Two lines of approach have been used: (1) the simplest models were first chosen and evaluated, then complexities were inserted as deemed possible, with a view toward approaching a model which nearly represents actual burning, (2) experimental results obtained from other sources were studied with a view to mathematical interpretation and understanding. Since the usefulness of continuing the theoretical studies on composite propellants has become questionable because of the scarcity of experimental data, two new directions have been taken during the past year. On the one hand, the most rigorous general equations for the combustion of a monopropellant (solid) are being derived, treating fully the formulation of radiative energy exchange. On the other hand, the mathematical problem of the spherically-symmetric combustion of metal spheres is being analyzed.

14.57

Louvain U., Belgium.
CHEMICAL KINETICS AND FLAME PROPAGATION, A. V. Tiggelen. Project 9751(801A), Grant AF-AFOSR-61-23; SREP, AFOSR.

In the premixed flames, methane-oxygen flames were studied at initial temperatures up to 450° C, and methane-nitrous oxide and acetylene-oxygen up to 250° C. Equations relating flame velocity, reaction order, and the initial and flame temperatures have been obtained. Work is nearly complete on a comparison of the vinyl chloride-oxygen and methane-hydrogen chloride-oxygen flames, and has been started on the methane-oxygen-nitrous oxide system.

14.58

Louvain U., Belgium.
IONIZATION PHENOMENA IN FLAMES, A. Van Tiggelen. Project 7013(801A), Contract AF 61(052)398; ARC, ARL.

A mass spectrographic method has been developed for the extraction and identification of individual ions present in flames. A technique has also been devised for the determination of total ion concentrations in flames by means of non-probe conductivity measurements on a special coaxial cylindrical burner. Present research embraces two general lines of investigation; a study of the correlation between chemi-luminescence and chemi-ionization in selected flames and a systematic comparison of the identity of ions with the chemical nature of the combustible mixture. The flame conductivity apparatus has been modified and used to determine upper and lower flammability limits in hydrocarbon flames as well as the influence of temperature upon them. A new extraction device has been built for the mass spectrograph to adapt it to the sampling and identification of ions in flames burning at atmospheric pressure.

14.59

Lund U., Sweden
THERMOCHEMISTRY OF FREE RADICALS, S. Sunner. Project 9750(801A), Contract AF 61(052)46; SRE, AFOSR.

Under this program, work is going forward on calorimetric measurements of recombinations of some radicals which might live long enough to make such measurements feasible. The study has started with thiyl radicals, produced by the symmetric splitting of alkyl disulfides. Once the method has been shown to work out for these bonds, it may conceivably be extended to others. Thiyl radicals are produced by action of ultraviolet light on alkyl disulfide in a glassy hydrocarbon matrix at temperatures around 80°K. It has been found that the recombination reaction (shown to be straight-forward in other respects) can be complicated by a side reaction with tertiary carbon bands if any branded-chain hydrocarbon is present in the matrix. Consequently a side effort has been necessary to prepare straight-chain hydrocarbons of extraordinary purity by chromatographic means. During the past year, a variety of different measurements have been made outside the calorimeter, in order to increase the certainty of interpretation of the calorimetric results. Viscosities of the hydrocarbon glasses have been determined, and recombination rates of the thiyl radicals in

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solution have been determined chromatographically.

14.60

Manchester U., Gt. Brit.
INHIBITION OF THE THERMAL REACTION BETWEEN HYDROGEN AND OXYGEN, R. F. Simmons. Project 9751(801A), Grant AF-EOAR-62-88; SREP, AFOSR.

Inhibition of combustion by chemical reaction with halogens and halides is well known but the fundamental mechanism of the reaction has not been explained. This research will attempt to obtain this basic knowledge by means of the explosion-limit technique and others which may be appropriate. Quantitative studies will be made of the inhibiting effect of the following group of materials on the hydrogen-oxygen thermal reaction: (a) halogens, (b) halogen acids, and (c) a series of organic halides.

14.61

Massachusetts Inst. of Tech., Cambridge.
INTERACTION AMONG BURNING FUEL DROPLETS, T. Y. Toong. Project 9751(801A), Contract AF 49(638)629; SRE, AFOSR.

It has been shown that the burning rate of two neighboring burning droplets can be related to the distance and relative position of the droplets in an air stream. The main objective of this research is to further a basic understanding of the general problem of combustion instability through a study of the detailed mechanisms of the interactions among fuel droplets in a forced convective air stream. Using a two dimensional combustion tunnel the interaction between burning fuel cylinders is observed for different orientations of the line joining their axes with the flow. The flame shape and flow conditions in the immediate vicinity of the fuel cylinder are observed using optical methods. Since combustion instability is actually a fluctuation of steady state pressure, the income air stream will be modulated in forthcoming experiments to show the effect of pressure waves on the merging and separation of the flames. Theoretical investigations are being carried out concurrently to directly compare experimental results.

14.62

Metallurgy and Ceramics Research Branch, ARZ, ARL, Dayton, Ohio.
COMBUSTION DYNAMICS, B. T. Wolfson, Project 7013(801A), Internal.

This research constitutes an experimental and theoretical study to provide data on detonation and shock-type phenomena. Studies were made on detonation parameters as a function on initial pressure, temperature, molecular weight, chemical composition and addition of additives. Thermodynamic data were compiled for components involved in the C-H-O-N-He-A system from 100° to 6000°K. Limited studies on detonation and shock-type phenomena in flowing gas streams were carried out, and preliminary experimental results have been reported. Investigation was made of a method for measuring highly transient pressures associated with hypersonic wave phenomena, with rise times on the order of 1 microsecond. This program made use of a precision shock-tube designed and fabricated especially for this investigation, as well as specialized pressure instrumentation and associated electronic equipment. This program also made use of a precision detonation tube and simple detonable gaseous mixtures as a convenient "low-pressure" tool for investigating highly transient high-pressure shock waves. Investigations were made on schlieren and shadowgraph systems and light sources for the Beckman-Whitley 1.2 million frame per second camera used to observe highly transient shock-type phenomena.

14.63

Michigan U., Ann Arbor.
STATIONARY GASEOUS DETONATION WAVES, J. A. Nicholls. Project 9751(801A), Contract AF 18(600)562; SRE, AFOSR.

A detonation wave may be described as a combustion wave ignited by the heating that results from shock conversion of stream kinetic energy to thermal energy which raises the static temperature of the gas to its ignition temperature. The stagnation temperature of the gas is adjusted by preheating the air and mixing it with cold hydrogen after the air stream has attained a high flow velocity so that the static temperature of the mixture is low enough to prevent premature ignition. In the actual experiment the air is heated by a pebble bed and is mixed with hydrogen in the nozzle which discharges the mixture at high pressure into the ambient atmosphere. A shock forms as a Mach disc and the mixture ignites downstream of this disc. The physical properties of the region behind the shock are being measured with pressure probes, temperature-probes, gas sampling probes, and by schlieren and direct photography. A model of the reaction zone in which the energy release is governed by the concentration of H atoms has been quantitatively worked out and appears to fit well with the experimental data. The evidence is that there is a delay

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between the shock and the self sustained chemical reaction. Since the delay time is determined by the concentration of H atoms, it can be controlled by hydrogen-air-diluent mixture ratio. The ignition time delay and the kinetics of the reaction zone for various fuel air mixtures and at higher operating temperatures is presently under study.

14.64

Michigan U., Ann Arbor.
SEEDING TECHNIQUES FOR INCREASING GAS ELECTRICAL CONDUCTIVITY, J. A. Nicholls. Project 7116(801A), Contract AF 33(616)8126; ARN, ARL.

A theoretical and experimental study is being conducted to determine effects of gas seeding on electrical conductivity during steady state operating conditions. Various gases will be used with such seeding materials as cesium, potassium, sodium, lithium, rubidium, barium, calcium, strontium, and aluminum. Evaluation will be made of the effects on electrical conductivity of change in temperature (3000°K to 7000°K stagnation), pressure and degree of ionization for a given gas.

14.65

National Bureau of Standards, Washington, D.C.
ENERGY TRANSFER PROCESSES INVOLVING SIMPLE MOLECULES AND RADICALS, T. Carrington. Project 7013(801A), Contract DO(33-657)62-387; ARC, ARL.

The contractor shall continue investigation on the vacuum ultraviolet photolysis of water vapor, using photons of about 10 volt energy, determining in detail the energy and angular momentum distributions of the fragments H and OH. A study of the influence of exciting photon energy and of inert gases should give information on the mode of dissociation of the water molecule. The contractor shall also study the monochromatically excited fluorescence of nitric oxide using the experimental techniques developed previously under this contract for the OH fluorescence. The theory also developed under this contract for treating data from experiments of this type will be used to analyse the over-all features of the rotational relaxation of NO.

14.66

National Bureau of Standards, Washington, D.C.
HYPERVELOCITY MISSILE IN A COMBUSTIBLE GAS, F. W. Ruegg. Project 9751(801A), Contract ISSA 60-6; SRE, AFOSR.

In this experimental study a nylon sphere is fired into the reaction chamber which is filled with the detonable mixture. The variables in the system are Mach number, chamber pressure and mixture composition. The Mach numbers vary from 4 to 8, and chamber pressures from 1/50 to to 1/2 air atmosphere. Detonation waves are observed using schlieren photography. Combustion can be seen at flight Mach numbers exceeding 4 but far behind the missile. As the Mach numbers increases the wave attaches itself behind the normal shock indicating a detonative ignition lag. It is planned to study these phenomena up to Mach 8.

14.67

National Inst. of Aeronautics, Spain.
COMBUSTION OF SPRAYS, DROPLETS & FLAMES, G. Millan. Project 9751(801A), Contract AF 61(514)221; SRE, AFOSR.

The theoretical model formulated for laminar flames in a premixed gas assumes a steady state distribution of chemical species resulting from a first order reaction. The model provides for an appropriate activation energy, heat losses and diffusion. The model for combustion with a phase change that is, combustion of droplets, follows along similar lines. The major assumption is that there is no liquid phase reaction and that no energy is transmitted to the droplet by radiation. In the mathematic formulation of these models, the steady state distribution of chemical species appears as a first order approximation making an extension to time dependent distributions of species readily available. Numerical results for velocities, flammability limits and temperatures are in good agreement with experiment. The comparison for liquid propellant combustion seems also to be promising. One very important result of the theory is the indication that the chemical kinetics is particularly important in small droplets. It also appears that large activation energies put a lower limit on the droplet radius for steady combustion.

14.68

New York U., N. Y.
ENERGY TRANSFER IN LIQUID AND SOLID SYSTEMS, H. Kallmann. Project 7013(801A), Contract AF 33(616)8317; ARC, ARL.

This is a study of the energy transfer characteristics of electronically excited states of complex molecules in the condensed states.

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This research involves the measurements of lifetimes of excited states by the phase shift technique, investigations of the metastable states of complex molecules at low temperatures and energy transfer studies in systems which can be conveniently found in both liquid and solid phases. Comparison of luminescence phenomena under ultraviolet and high energy radiation is also made. This research also includes a study of the synthetic utility of the Meerwein method of aromatic arylation, using monosubstituted anilines as the source of aryl radicals. This synthesis is to provide a unique group of compounds in which the nature position and interaction of substituents can be assayed with respect to optical properties.

14.69

New York U., N. Y.
IGNITION AND COMBUSTION OF ORGANO-METALLICS, C. J. Marsel. Project 9750(801A), Contract AF 49(638)173; SRE, AFOSR.

The objective of this program is the elucidation of the mechanisms of ignition and combustion of metal alkyls and metal hydrides. Such compounds are of interest in propellant applications because of high energy or pyrophoricity or both. Under this contract, a great deal of pioneering work has been done on measurement of ignition delay times in both flowing and static systems. At the same time, much data has been collected on the spontaneous ignition, in air and oxygen, of aluminum trimethyl, aluminum triethyl, various alkyl borons, and mixtures of these with hydrocarbon fuels. This data has considerable value in itself, and is now being assembled for publication. It has become apparent, however, that the study of spontaneous ignition delays is insufficient to define unequivocally the combustion mechanism of these pyrophoric materials. Emphasis in the experimental program has now been shifted to conventional and mass-spectrometric studies in kinetics. The initial processes in both thermal decomposition and oxidation of the fuel are being observed analytically and with a specially built rapid-response mass spectrograph. In addition to the organo-metallics, aluminum hydride and some other metal hydrides are of interest. The study of the vapor phase pyrolysis of triethylaluminum (TEA) has been completed by conventional analysis.

14.70

New York U., N. Y.
CRITERIA OF INFLAMMABILITY LIMITS, E. S. Campbell. Project 9751(801A), Contract AF 49(638)976, SRE, AFOSR.

This research will attempt to elucidate the role of the several factors affecting the stability of steady-state flames. Although much experimental data is available on the effects of additives and temperature on inflammability limits, as well as on the structure of the flame-front in near-limit mixtures, the theory of the subject is at present probably the most controversial aspect of combustion. A number of different hypotheses have been advanced concerning the criterion for the limit of stability of a flame; this study will attempt to decide among these hypotheses by correlating all of the available data by means of each proposed mathematical formulation, and comparing the results with each other and the known facts.

14.71

New York U., N. Y.
ORIENTATION AND REACTIVITY IN FREE RADICAL AROMATIC SUBSTITUTION, R. T. Morrison. Project 9762(802A), Grant AF-AFOSR-62-34; SRC, AFOSR.

This research is a study of orientation and reactivity in free radical aromatic substitution, with particular emphasis on polar factors. It is aimed specifically at the testing of a theory which proposes to account for the data on attack by phenyl radicals, and which is supported by data on attack by substituted phenyl radicals. More fundamentally, the research should throw light on the whole subject of polar factors in free radical reactions. Phenylation of charged molecules like N-methyl pyridinium ion and phenoxide ion, and systems like pyridine N-oxide and furan will be studied. Solvent effects and ester formation from the decomposition of peroxides will be investigated.

14.72

New York U., N. Y.
HYDRODYNAMIC EQUATIONS FOR A FREE RADICAL FLAME, E. S. Campbell. Project 9751(801A), Contract AF 49(638)169; SREP, AFOSR.

The principal objective of this work is to evaluate mathematically the relative importance to a flame of chemical kinetics, conductivity, and diffusion. The hydrogen-bromine flame and the ozone decomposition flame have been chosen for study because the chemical kinetics, while not entirely known for these systems, are reasonably uncomplicated. These two systems are being investigated for the ideal one-dimensional (flat-flame) case. The differential equations of continuity, diffusion and energy balance are being solved, under the above assumptions, for the distance-temperature

relationship and other flame characteristic The solution of these simultaneous non-linear equations is being accomplished by numerical methods and suitable computer programs.

14.73

Northeastern U., Boston, Mass.
ENERGY CONVERSION AND STORAGE, M. W. Essigman. Project 6694(750F), Contract AF 19(604)7358; CRZA, AFCRL.

Work will be done on a broad, long range program of studies on energy conversion and storage mechanisms and systems, leading to the development of scientific information, criteria of feasibility, design parameters, etc. From these data, the design, development and evaluation of energy conversion and storage systems may proceed. Areas of research will include photochemistry, photocatalysis, photobiology, biophysics, photoelectric effects, electrochemistry, etc. Current effort is devoted to definition, development and implementation of the program

14.74

Ohio State U. Research Foundation, Columbus.
SPHERICAL DETONATION WAVES, R. Edse. Project 7013(801A), Contract AF 33(616)8129; ARC, ARL.

An experimental investigation is to be conducted of the mechanisms of initiation and propagation of spherical detonation waves in combustible gas mixtures. Measurements are to be made of the detonation induction distances and propagation velocities in the experimental mixtures, which include acetylene-oxygen, hydrogen-nitric oxide, and methane-oxygen. The effects of a variety of parameters such as method of ignition, fuel-oxidizer ratio, vessel geometry, and additives on the mechanism of the transition from deflagration to detonation are to be investigated. This effort will complement in-house research activities on one-dimensional detonation waves.

14.75

Ohio State U., Columbus.
INFRARED FLAME EMISSION, F. P. Dickey. Project 7670(770A), Contract AF 19(604)6150; CRZI, AFCRL.

The purpose of the research is to observe the presence and distribution of radicals in flames as well as stable molecules making use of various techniques such a phase discrimination and alternately looking at two flames, one with an excess of fuel or oxidizer. They have obtained OH rotational lines in emission and are looking for other radicals such as CH in emission.

14.76

Ohio State U., Columbus.
FLUID DYNAMICS OF HIGH ENTHALPY FLOW, R. Edse. Project 7065(806A), Contract AF 33(616)5615; ARL, ARF.

The research objective under this contract is the determination of nitrous-oxide-system characteristics essential in the chemical reaction technique for producing high enthalpy air for hypersonic research at Mach numbers up to 33. This program was established to determine the detonability, mechanism and rate of decomposition, and explosion limits of nitrous oxide (N_2O) and mixtures with nitrogen and air in flow processes. The detonability characteristics are being investigated at initial pressures from 1 to 200 atmospheres and initial temperatures from 520°R to 1800°R or to the ignition temperature of the mixture. The mechanism of inducing a detonation wave in these gas mixtures is being studied. The mechanism and rate of decomposition are being determined at initial pressures from 1 to 200 atmospheres and initial temperatures from 1800°R to 3000°R. Efforts will be made to extend the temperature to 5000°R. Explosion limits are being established as a function of temperature and pressure within the above ranges of these parameters. The effect of impurities in the gases upon the detonability, mechanism, and rates of decomposition are to be included in these studies.

14.77

Ohio State U., Columbus.
PROCESSES CAUSED BY COLLISIONS OF ELECTRONS WITH MOLECULES, E. N. Lassetre. Project 7635(770A), Contract AF 19(604)4541; CRZA, AFCRL.

Performs experimental and theoretical studies of collisions which transfer kinetic energy of free electrons into internal energy of molecules. Determines electron collision energy loss spectra and differential inelastic electron scattering cross sections for atmospheric gases. (Work provides insight into mechanisms and rates of thermalization of fast electrons in upper atmosphere). Recent results include high resolution electron energy loss spectra determinations made on H_2O, NH_3, and CO_2, and theoretical work on H_2.

14.78

Paris U. (France).
ENERGY TRANSPORT PHENOMENA IN CADMIUM SULFIDE CRYSTALS, M. Balkanski. Project 7885(802A), Contract AF 61(052)130; ARX, ARL.

This contract is for research on the storage and conversion of energy in cadmium sulfide and zinc

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ARC- Chemistry Research Lab
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ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
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sulfide at different temperatures. It includes (1) work with the establishment and decay of photo current, designed to reveal the role of excitons in photon-electron interactions, (2) computation of lifetimes and diffusion coefficients as functions of temperature, impurity concentration and incident radiation, (3) measurements of cyclotron resonance and polarization of absorbed and emitted radiation as a means of studying energy band structure and (4) theoretical investigations designed to establish a general theory of exciton states.

14.79

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
PHOTOELECTRIC CONVERSION RESEARCH, N. F. Yannoni. Project 6694(750F), Internal.

In order to develop a better understanding of organic semiconductors and related substances, a program devoted to the analysis of the crystal structures and electrical properties of these materials is being established. Simple and complex compounds representative of the main categories of possible solar energy converters are under investigation so that plausible theories of charge transmission through the bulk material can be developed.

14.80

Pittsburgh U., Pa.
FREE-RADICAL ATTACK ON TRIVALENT PHOSPHOROUS DERIVATIVE, C. E. Griffin. Project 9762(802A), Grant AF-AFOSR-62-48; SRC, AFOSR.

There is ample evidence that trivalent phosphorus derivatives (tertiary phosphites and phosphines) undergo free radical chain reactions with a variety of radicals derived from alkyl halides, peroxides, mercaptans and disulfides. The research program proposed here involves a detailed study of such radical reactions, with emphasis upon the reaction of alkyl radicals with trialkyl prosphites. The approach involves a study of the reaction for determination of relative initiator effectiveness, product composition, extent of reaction and optimum conditions for suppression of competing ionic reactions.

14.81

Polytechnic Inst. of Brooklyn, N. Y.
PHOTOREDUCING DYE SYSTEMS AS POSSIBLE SOLAR ENERGY CONVERTERS, G. Oster. Project 6694 (750F), Contract AF 19(604)8056; CRZA, AFCRL.

Studies and experimental investigations are being performed for the development of photoreducing systems as a source of solar to electrical energy converters. The work includes the evaluation of photoreducing dye systems as possible solar energy converters. The research now being carried out includes: (a) studies on the energy storage and availability of photo-reversible systems; (b) research on the photo-potentials of the acridine dye systems, both free and bound to high polymers; (c) studies of the effect of light intensity, ionic strength, pH, dye concentration, and reducing agent concentration on the photo-potentials of the dye systems; (d) studies on the utility of systems composed of mixtures of spectrally selective dyes; and (e) research on the photochemical properties of water soluble chlorophyll (chlorophyllin) when bound to a polymer.

14.82

Polytechnic Inst. of Brooklyn, N. Y.
HIGH FREQUENCY OSCILLATORY COMBUSTION, V. D. Agosta. Project 9751(801A), Contract AF 49 (638)165; SRE, AFOSR.

Although combustion is never smooth, it would be desirable to limit oscillations in a rocket chamber to some value which is in accord with the heat transfer characteristics and the material strength of the walls, without sacrificing performance. The basic problem is to formulate an analytical description of the phenomena in a rocket combustion chamber so as to predict the relative importance of the various parameters. The combustion process is conceived to have three major elements. The first is a change of phase from liquid to gas, the second is heat release from mixing and chemical reaction and the third is the gas dynamics of the combustion products. The whole process is described by a set of non-linear equations defining the gas dynamics, chemical composition and the evaporation process. The experiment is to introduce an oscillatory disturbance into the chamber and measure the pressure to detect the onset of instability. An important feature is to see if instability is associated with a significant increase in evaporation rate which might be detected photographically. The longitudinal case of shock wave amplification will be followed by the radial and tangential modes of oscillation. The analysis will include wave train and "one shot" disturbances, as well as shock waves.

14.83

Princeton U., N. J.
MOLECULAR PROBLEMS IN HEAT AND MASS TRANSFER,

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
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SRE- Directorate of Engineering Sciences
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SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
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CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

M. Boudart. Project 9751(801A), Contract AF 49(638)32; SRE, AFOSR.

Four separate areas of study have been in progress under this contract. They are (1) recombination rates at surfaces, (2) vibrational relaxation times in gaseous molecules, (3) absolute evaporation rates of liquids, and (4) kinetics of oxygen atoms in ozone solution. Recombination rates for hydrogen atoms on glass surfaces have been studied in detail under conditions where the gas-phase recombination is insignificant. This work is essentially complete. Relaxation phenomena (rates of transference of translational to vibrational energy) have been studied in N_2O and SO_2, and during the past year, using a pitot-tube technique, have been extended to NO. A dynamic technique has been devised for studying evaporation rates of liquid films; two jets of liquid impinging head-on provide moving thin films of liquids which are particularly useful for study. Emphasis is now on the fourth area, which has some hope of producing vibrationally excited oxygen molecules from the atomic oxygen-ozone reaction.

14.84

Princeton U., N. J.
IGNITION OF SOLID PROPELLANTS, M. Summerfield. Project 9751(801A), Grant AF-AFOSR-62-91; SREP, AFOSR.

The present work has two objectives. One is the investigation of the applicability of the theory, and its quantitative formulation, over much wider ranges of propellant composition, gas composition, temperature, pressure, and heat flux. The experiments are principally carried out in shock tubes, as before. The second objective is to reduce the theory to a set of guiding principles for designing, or scaling up, rocket igniters. This will be accomplished through carefully planned ignition experiments in a laboratory rocket motor. The first set of these experiments, using hot gases for ignition, has been performed.

14.85

Purdue U., Lafayette, Ind.
PARAMETRIC STUDY OF ROCKET MOTOR INSTABILITY, M. Zucrow; Osborn. Project 9751(801A), Contract AF 49(638)756; SRE, AFOSR.

The objectives of this research are to obtain information which will improve the understanding of the phenomenon of combustion pressure oscillations, which will provide the designer with a prior design criteria for predicting conditions for stable combustion and which will indicate procedures for attenuating undesirable combustion pressure oscillations. The first phase of this experimental investigation, using a premixed gaseous bi-propellant rocket motor to analyze the cause of transverse mode combustion pressure oscillations, has been completed. Investigated were the effects of chamber geometry, fuel-oxidizer combination, equivalence ratio, and steady-state pressure upon the transverse mode of oscillations. Indications are that the results obtained with simple premixed gaseous combustion systems are applicable to a more complicated system; i.e., a liquid rocket motor. Investigations using unmixed gaseous propellants are now underway, and upon completion of this phase, investigations will be made employing gas-liquid propellant and liquid bipropellant rocket thrust chambers.

14.86

Purdue U., Lafayette, Ind.
PROPERTIES OF SILYL RADICALS, G. Urry. Project 9762(802A), Contract AF 49(638)927; SRC, AFOSR.

This project is a study of the little-explored silicon free radicals, with an eye on silicon's 3d orbitals and their role in differences from carbon. The specific radicals proposed for study are: mercury-arc-generated R_2SiX, amine-generated Cl_3Si, trimethylsilyl from its azide (plus heat) or its chloride (plus aluminum), trimethylsilylmethyl, trimethylsilylsulfenyl and the 1, 2-bis-(trimethylsilyl)-ethynyl biradical.

14.87

Radiation Applications Inc., Long Island City, N. Y.
RADIATION-INITIATED SOLID PROPELLANT DECOMPOSITION, G. Odian. Project 9751(801A), Contract AF 49(638)1125; SREP, AFOSR.

Ionizing radiation from gamma ray and penetrating electron sources offer a unique tool for the study of kinetic mechanisms of fast reactions. It is proposed to irradiate the fuel in intimate contact with a rapidly flowing inert gas preheated to the desired temperature and to trap the radicals formed with an efficient scavenger such as iodine or diphenyl picryl hydrazyl. The advantage of this approach is the ability to quench the gas phase reaction to any extent desired and thus to study the primary, intermediate and final products.

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14.88

Reaction Motors Div., Thiokol Chemical Corp., Denville, N.J.
ELECTRICAL EFFECTS IN COMBUSTION, H. G. Wolfhard. Project 9752(801A), Contract AF 49(638)305; SRE, AFOSR.

By utilising the Langmuir probe and interpreting its characteristics, the positive ion concentrations in a rocket chamber have been compared with thermal equilibrium calculation based on the Saha equation. These measurements revealed that, for seeded rocket flames, the thermal ionisation predicted by equilibrium considerations establishes an upper limit to the degree of ionisation (10^{-2} mol percent) which can be attained by the combustion process in a typical rocket combustion chamber, and which is therefore rather low for many MHD experiments. During the past year greater emphasis has been placed on the basic interaction mechanisms between ionized flames and electric and magnetic fields. At the present time these studies are being extended into the realm of subatmospheric pressures (to and below 10^{-2} atmosphere) and higher gas velocities associated with typical high altitude rocket exhausts. In this region the additional experimental difficulties are more than compensated by three natural advantages: (1) higher degrees of ionization (and conductivity), (2) the magnetic interaction parameter is increased, and (3) the problems of heat transfer to electrode surface are greatly diminished.

14.89

Reaction Motors Div., Thiokol Chemical Corp., Denville, N. J.
TRACING METHOD FOR SOLID PROPELLANTS, H. G. Wolfhard. Project 3827(801A), Contract AF 29(600)3020; SRA, AFOSR.

The contractor shall study the spectroscopic phenomena caused by tracer elements in the flame. This investigation will be conducted in the laboratory and on test sites studying the flames of large rockets. The study will concern methods for the detection of spectral lines on the continuous background spectrum characteristic for propellants delivering liquid or solid combustion products, and the development of experimental optical apparatus for this purpose. The research work on low temperature flames will investigate the applicability of absorption spectroscopy. Furthermore, the phenomena of time delay and changes of the tracer concentration in the combustion gases within the rocket will be studied.

14.90

Rensselaer Polytechnic Inst., Troy, N. Y.
FUNDAMENTAL ELECTROCHEMICAL PARAMETERS AFFECTING FUEL CELL PERFORMANCE, N. D. Greene. Project 6694(750F), Contract AF 19(604)8377; CRZA, AFCRL.

The objective of the contract is to determine the fundamental factors controlling the suitability of a redox-system for use in electrochemical energy conversion devices. The electro chemical parameters of individual electrode reactions will be related to the overall performance of an energy-producing cell. The research has commenced with a study of the hydrogen-oxygen fuel cell system. The parameters include exchange currents, Tafel slopes and limiting diffusion currents and the influence of environmental variables, e.g. temperature, electrode composition and feed rate, on these variables. Exploratory studies of new and novel redox systems suitable for electrochemical energy conversion will also be undertaken.

14.91

Republic Aviation Corp., Farmingdale, N. Y.
ELECTROMAGNETICALLY INDUCED CHEMICAL REACTIONS, A. E. Kunen. Project 9752(801A), Contract AF 49(638)552; SRE, AFOSR.

A cylindrical column of a combustible gaseous mixture is contained between two circular electrodes. A rapid electrical discharge is sent through the gas. When the current build up is rapid enough, most of it will be confined to the outside surface of the column. The magnetic field induced by this current will move the current sheath radially inward compressing the trapped gas and detonating it. The experiment is to induce the discharge and record its motion by streak photography. The evidence of detonation will be furnished by the combustion products and the speed of the pinch. New experimental techniques have been developed to prove the concept of electromagnetically induced detonations. Positive experimental results are expected soon. Significant advances have been made in the study of pinch initiation and a number of analyses have been produced accounting for the electron inertia and time variable conductivity. Techniques for studying magnetically driven shocks have been tested using Eulerian and Lagrangian formulations. A cold plasma tunnel has been designed, capable of basic plasma physics and diagnostic development studies. As a by product an integrated plasma pinch engine has been designed, built and tested, producing specific impulses, thrusts and efficiencies of commendable magnitudes.

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14.92

Research Division, AECD, Tullahoma, Tenn.
STANDING DETONATION WAVE RESEARCH, E. Latvala. Project 9751(801A), Contract AF 40(600)800; SRE, AFOSR.

The speed of combustion for any mixture is determined primarily by the temperature of the reactants. The heat must be provided by transporting energy from the combustion products to the reactants either directly by recirculation or indirectly by forming a shock in the gas mixture. The shock converts the kinetic energy of the stream into thermal energy. Premixed preheated combustible gas is forced into a wind tunnel at high velocity so that the static temperature is below the ignition point. A shock is formed in the test section by slight obstructions at the walls raising the static temperature of the gas beyond the ignition point. The chemical reaction is observed by schlieren photography, by watching emission of the Na-D line and by temperature and pressure probes. The effect of the following parameters on combustion wave characteristics will be explored: total pressure and temperature changes varying fuel air ratio, and fuel composition.

14.93

Research Div., AEOR, AEDC, Tullahoma, Tenn., (ARO Inc.)
KINETIC PROCESSES OF HIGH ENERGY GASES, W. K. McGregor. Project 8951(806A), Internal.

The objective of this study is to conduct a research investigation on the kinetic processes of gases associated with hypersonic flight. A broad experimental investigation is being performed to determine the real gas effects of a highly energized gas rapidly expanding through a nozzle. Parameters to be varied include gas temperature or energy level, pressure level, nozzle length to area ratio and gas composition. The ranges of interest of the parameters are temperatures from 3,000°K to 25,000°K and pressures from 10^{-4} atmospheres to several atmospheres. The Mach number range of interest is from 1 to 10. Considerable effort has gone into the development and refinement of the experimental techniques, particularly the determination of the plasma generator properties and of gas temperature. The plasma generator is now being exhausted into a small vacuum chamber. Argon has been the primary working fluid to date.

14.94

Research Div., AEOR, AEDC, Tullahoma, Tenn. (ARO, Inc.).
EMISSIVITY DETERMINATION, E. S. J. Wang. Project 8951(806A), Internal.

The emissivity of bright metallic surfaces with various gas condensate thickness will be measured at 80°K and below. A calorimetric method will be employed to measure the radiation heat transfer from surfaces at known conditions. This will furnish data which can be used for cryogenic pumping system design in large space-simulation chambers.

14.95

Rocketdyne Div., North American Aviation, Inc., Calif.
PHYSICAL PROCESSES OF ROCKET COMBUSTION, R. Lawhead. Project 9751(801A), Contract 49(638)817; SREP, AFOSR.

The current program is directed towards the formulation of an analytical model of spray combustion for the liquid oxygen/liquid hydrogen rocket system. The approach will be similar to that previously used to develop an experimentally confirmed analytical model of combustion for the LOX/RP-1 rocket system. This model describes the over-all combustion in the thrust chamber by summing the combustion histories of individual propellant droplets. Equations expressing the vaporization rate, and acceleration of single droplets, the number and size of droplets on the spray, and a continuity equation relating over-all spray vaporization to combustion gas generation are employed. Solution of the equations is by digital computation. Good experimental data relative to these parameters are included in the model. The analytical model will be verified experimentally using a transparent two-dimensional model thrust chamber. Streak photography will be used to obtain axial flow velocities of the product gases and propellant droplets for comparison with analytical predictions.

14.96

Saint Joseph Coll., West Hartford, Conn.
ENERGY TRANSFER REACTIONS, Maria Clare Markham, Sister. Project 6694(750F), Contract AF 19(604) 7224; CRZA, AFCRL.

The research is a study of the formation of hydrogen peroxide in zinc oxide suspensions saturated with oxygen and containing organic additives. The basic mechanism of this reaction has been studied by investigating the electron spin resonance of the system, and the formation of polymers when a

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monomer is present. Different parameters in the formation of polymers were studied. It has been shown conclusively that surface-absorbed oxygen is essential to chain initiation. Dyes absorbed on the photocatalyst do not initiate polymerisation when the system is irradiated by light that is absorbed only by the dyes. A study of energy transfer reactions among pheophytin, chlorophyll and carotene pigments is now being undertaken.

14.97

Sheffield U. (Gt. Brit.).
RECIRCULATION WITHIN ROCKET COMBUSTION CHAMBERS, M. W. Thring. Project 7013(801A), Contract AF 61(052)150; ARF, ARL.

The immediate objective of this experimental research is to render visible the recirculating patterns in rocket-type combustion chambers. The technique has been developed to the extent that flow patterns can be obtained in "cold" flow but not sufficiently well defined. The patterns are complex and not stationery. Considerable effort is being directed toward improving the clarity of the recirculating pattern. Some question regarding the validity of the scaling laws applied to the cold model has led to the decision to check the observations in a "hot" model. Pertinent test equipment is being prepared for this phase of the study.

14.98

South Carolina U., Columbia.
FREE RADICAL REACTIONS WITH AROMATIC RINGS, D. F. Detar. Project 9760(802A), Contract AF 49(638)88; SRC, AFOSR.

The research involved an experimental determination of the reactions of shortlived free radicals with aromatic ring compounds. In particular intermediates which are structurally capable of undergoing either intra- or inter-molecular free radical reactions were studied; arylcarboxylic acid peroxides and aryldiazonium compounds.

14.99

University of Southern California, Los Angeles.
CHEMISTRY OF THIOPEROXIDES, N. Kharasch. Project 9762(802A), Contract AF 49(638)330; SRC, AFOSR.

The research is a study of the free radical dissociation of thioperoxides, an evaluation of their ability to act as initiators of polymerization, and a study of the resulting polymerization reactions. The reaction of sulfur dichloride and disulfenyl chloride with diepoxides and polyols and an attempt to synthesize compounds of the type, RSOOR' is also being investigated.

14.100

Stanford Research Inst., Manlo Park, Calif.
DETONATION CHARACTERISTICS OF LOW DENSITY GRANULAR MATERIALS, M. Evans. Project 9751 (801A), Contract AF 49(638)1124; SREP, AFOSR.

An analytical study will be made of the mechanism by which a shock might initiate a chemical reaction in a low density, granular material such as ammonium perchlorate, incorporating an expression for chemical reaction at grain surfaces into a von Neumann detonation wave. To demonstrate the validity of the analytical model, experimental data will be obtained by measuring the detonation velocity as a function of diameter and grain size and an attempt will be made to determine the failure diameter of the material.

14.101

Stevens Inst. of Tech., Hoboken, N. J.
LOW TEMPERATURE PHYSICS AND IONIZED GASES, J. Fajans. Project 9751(801A), Contract AF 49(638)352; SRPP, AFOSR.

This research began with a study of non-equilibrium processes with the aim to developing equations similar to the equation of state and Boltzman transport equation of systems in equilibrium. The possibility of analytic expressions for these quantities was investigated starting with systems where the molecule is approximated by a hard sphere. Since Dr. Fajans took over this research, emphasis is being placed on the low temperature physics aspects of this program. In particular, an investigation of the focusing of phonons and thermal waves in superfluid helium is being conducted.

14.102

Sunstrand Tool Co., Pacoima, Calif.
SCALING PROCEDURES FOR LIQUID FUEL ROCKET ENGINES, L. Bixon. Project 9751(801A), Contract AF 18 (603)107; SRE, AFOSR.

The design of new and larger liquid rocket engines, unfortunately, is still more art than science. While some general rules are available, the stability of a proposed chamber cannot be predicted beforehand, based on similar configurations. This is undoubtedly due to our lack of complete understanding of the physical and chemical processes that occur in rocket combustion. The approach taken in this experiment is to identify one mechanism which may predominate in the overall reaction and see what can be done to predict stability. According to

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Penner, if the chemical delay time is of the same order as the wave propagation time, the system will be unstable. The acoustic modes for a chamber can be evaluated from the geometry. The chemical delay which is dependent on the construction of injectors, as well as the chemistry of the fuel, must be measured. The means for doing this is by simultaneously shutting down both fuel and oxidizer and observing the chamber pressure decay. The experimental work is being carried out at Edwards AF Base in cooperative effort between the rocket scaling facility and Sunstrand. The validity of these procedures is being tested with a 750 lb. chamber and a 3,000 lb. chamber having similar injection characteristics. The scaling laws will be checked over a factor of 4.

14.103

Systems Research Lab., Dayton, Ohio.
ION ENERGY EXCHANGE MECHANISMS, J. Ballard. Project 4152(803A), Contract AF 33(616)8301; ASRNE, ASD.

Experimental research is being performed on energy exchange mechanisms within gas plasmas, at plasma-solid interfaces, and in electromagnetic fields. Research is being carried out on the determination of excitation levels by spectroscopic methods, the determination of the velocity spectra of sputtered atoms, and on related research in the ion bombardment and plasma diagnostic fields. The design and construction of necessary ultra-high vacuum equipment is included in this effort. Additional work is in progress on the design of microwave subassemblies for frequency determination above 50 Gigacycle.

14.104

Texas U., Austin.
GAS PHASE AND SURFACE REACTIONS OF HYDROCARBONS AT MODERATELY HIGH TEMPERATURES, R. G. Anderson. Project 9751(801A), Contract AF 18(603)142; SRE, AFOSR.

The decompositions and interactions of gaseous hydrocarbons are being studied in both static systems and flow reactors. Mass and infrared spectroscopy and gas chromatography are used to determine the course of the reactions. During these studies the roles of vinyl acetylene and diacetylene in the kinetics of thermal reactions of acetylene and acetylene-benzene mixtures have been determined. Further elucidation of the mechanism is being attempted with deuterated hydrocarbons. Experiments on the decomposition of ethylene oxide have been followed by studies of acetylene - ethylene oxide flames, which are being continued.

14.105

Thermo Electron Engineering Corp., Waltham, Mass.
THERMIONIC CONVERTERS, G. Hatsopoulos. Project 6694(750F), Contract AF 19(604)8453; CRZA, AFCRL.

An experimental investigation is being conducted into the performance of cesium thermionic energy converters having close interelectrode spacing. The results obtained will be correlated with the current theory, and the theory will be refined if necessary. An attempt will be made to determine the optimum converter parameters for obtaining the maximum possible efficiency.

14.106

Thermomechanics Research Lab., ARN, ARL, Dayton, Ohio.
ELECTROSTATIC FLUID DYNAMIC ENERGY DIRECT CONVERSION, S. H. Hasinger. Project 7116 (801A), Internal.

Within the general effort of converting gas kinetic energy directly into electric energy, a study is nearly completed on the performance potentialities of electrostatic energy conversion processes. A special investigation on the use of condensation droplets in a gas stream as a means of carrying electric charges against an electric field is under way. In an analytical phase, the physical dimensions have been determined for a proper experimental system consisting essentially of a vapor feed device, an expansion nozzle, and an electric charging device. Since the system uses expansion into a vacuum, vacuum technology enters strongly into the experimental considerations. The presently planned experiments will measure energy conversion efficiencies with varying geometric and electric conditions, and also with expanding media. An important portion of the investigation will be the diagnosis of the prevailing physical conditions in such energy conversion systems.

14.107

Thermomechanics Research Branch, ARN, ARL, Dayton, Ohio.
ELECTRICAL ENERGY CONVERSION STUDIES, E. D. Stephens. Project 7116(801A), Internal.

Initially, theoretical studies will be conducted into some of the primary characteristics of electrical conductivity in ionized media. Evaluation of the several theories will be made. The effect of ion charge characteristics on electrical conductivity will be studied. Emphasis will be placed upon non-equilibrium aspects of influencing factors.

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14.108

United Aircraft Corp., East Hartford, Conn.
THERMODYNAMIC AND TRANSPORT PROPERTIES OF GASES AT HIGH TEMPERATURES, H. H. Michels. Project 9750 (801A), Contract AF 49(638)1133; SREP, AFOSR.

Analytical data is needed for calculating the chemical reactions occurring at the high temperatures encountered in chemical propellant combustion and plasmas. No experimental thermochemical data in the temperature region above 2000K is presently feasible. This effort could produce accurate theoretical procedures for predicting thermochemical and transport properties for molecular species in the high temperature region. The research will be divided in two phases - Phase I will consist of theoretical research to obtain practical and reliable computational programs for the prediction of thermochemical properties of diatomic and triatomic gases at high temperatures. Phase II will consist of analytical examination of the functional behavior of integrals used in the calculation of the transport properties of gases at high temperatures in order to obtain a computational program for prediction of these properties.

14.109

University Coll. of Wales (Gt. Brit.).
REACTIONS OF FREE RADICALS CONTAINING NITROGEN, A. F. Trotman-Dickenson. Project 9751(801A), Grant AF-EOAR-62-18, SREP, AFOSR.

The reactions of radicals in which the unpaired valence is on a nitrogen atom are being investigated in order to build up a body of knowledge comparable to that now becoming available for alkyl radicals. The work will supplement in kinetics the considerable body of work now being supported in the chemistry and thermodynamics of nitrogen compounds for future propulsion systems. Sources of such radicals as NH, NH_2, NF_2, and $N(CH_3)_2$ are being studied. In particular during the past year, the pyrolysis of sym-dimethyl hydrazine, tetramethyl hydrazine, N-methyl benzamine, and N,N-dimethyl benzamine have been studied as radical sources. Also, the photolysis of certain compounds such as tetramethyl urea is being used. The reactions of the radicals formed from these sources are being studied by following the rates of production of certain key compounds such as tetramethyl hydrazine and dimethylamine, by gas chromatography.

14.110

Uppsala U. (Sweden).
REACTIONS BETWEEN EXCITED MOLECULES AND MOLECULAR FRAGMENTS, S. Claesson. Project 9751(801A), Contract AF 61(052)70; SRE, AFOSR.

This program has had as its object the determination of mechanisms of formation of free-radicals and excited molecular states by photolysis, and especially the mechanisms of the recombinations or interactions of such species. Flash photolysis, in which the light is transmitted to the sample in a period of less than 100 microseconds, is especially useful for this type of work, because time is available immediately after the flash for following the various reactions which occur. This may be done by absorption spectroscopy or by freezing out and examining the products. The laboratory at Uppsala is unique in the range and power of its flash photolysis equipment. The largest of the four apparati can produce a flash of 200,000 joules of energy within 100 microseconds. The analytical equipment includes an ultraviolet spectr graph, time-of-flight mass spectrometer and high-resolution gas chromatograph. With this equipment, studies of the mechanisms of free-radical reactions have been made, with carbon-containing materials susceptible to photolysis such as acetone, acetaldehyde and n-butyraldehyde. Emphasis during the past years has shifted to photolysis of molecules whose fragments are of interest in higher energy chemical propulsion. Also during the past year a method has been discovered for containing a gas sample directly in the arc of the largest flash thus subjecting it briefly to temperatures higher than 10,000°K. This technique is being followed up with studies of the decomposition products from different types of molecules at such temperatures.

14.111

Utah U., Salt Lake City.
IGNITION AND BURNING OF SOLID PROPELLANTS, N. W. Ryan. Project 9751(801A), Grant AF-AFOSR-62-99; SREP, AFOSR.

In current work, an effort is being made to provide much higher heat fluxes through radiation sources in order to extend the ignition studies. Studies of the ignition and burning of large, but separate, bodies of fuel and oxidizer in close proximity are being made under various pressure conditions. An investigation has been initiated to determine the mechanism of combustion of aluminum powder in a shock tube.

14.112

Vitro Labs, West Orange, N. J.
SOLAR SIMULATOR SOURCES, C. Sheer, D. Fitz. Project 6694(750F), Contract AF 19(604)7241; CRZA, AFCRL.

Studies are being performed to determine the requirements for design and development of a laboratory device for simulating the energy and spectral distribution of solar radiation. The approach used by this contractor is the study of the high intensity

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arc under various conditions.

14.113

Warner and Swasey Research Corp., New York.
INFRARED TEMPERATURE DISTRIBUTION MEASUREMENTS IN COMBUSTION GASES, R. H. Tourin. Project 9751(801A), Contract AF 49(638)1132; SREF, AFOSR.

The research effort has two objectives: (1) the development of methods for determining temperature distributions in hot gases from infrared spectral data; and (2) the application of the technique developed to gaining new information about phenomena in high temperature gas systems including combustion gases, plasmas and detonations. A program of experimental, theoretical and mathematical research will be conducted to measure temperatures in combustion gases and to study methods for determining temperature distributions in such gases by means of infrared radiation.

14.114

Westinghouse Electric Corp., Pittsburgh, Pa.
PARAMAGNETIC RELAXATION IN MASER CRYSTALS, J. G. Castle. Project 5621(802A), Contract AF 19(604)5589; CRRC, AFCRL.

The purpose of this work is to conduct experimental and theoretical studies of energy transfer processes by which paramagnetic relaxation is effected in crystalline solids, especially in crystals of interest for solid state masers. Mechanisms determining the nature of relaxation are being studied and efforts are being directed towards establishing means of recognizing and enhancing crystal properties conducive to more favorable relaxation times. Extensive work has been done in potassium cobalticyanide doped with trivalent chromium and on magnesium oxide doped with various transition metal ions. Cross doping in chromium doped rutile has also been studied.

14.115

Wisconsin U., Madison.
FUNDAMENTAL INTERACTIONS IN HIGH TEMPERATURE GASES, J. O. Hirschfelder. Project 7013(801A), Contract AF 33(657)7311; ARC, ARL.

The Contractor shall conduct a theoretical program of research on fundamental interactions in high temperature gases, designed to establish theoretical foundations for the calculation of the properties of hi-temp gases. He shall investigate intermolecular forces, energy exchange mechanisms between molecules and within molecules, and transport properties in hi-temp gases; examine the relationship between the properties of gases and liquids and the properties of their constituent molecules; explore new quantum mechanical methods for use in determining intermolecular forces and the properties of molecules; and analyze the detailed mechanism and kinetics of chemical reactions in gases occurring under a variety of conditions and particularly in flames and detonation.

14.116

Yale U., New Haven, Conn.
MOLECULAR FRAGMENTS IN SHOCK WAVES, R. S. Berry. Project 9760(802A), Grant AF-AFOSR-61-25; SRC, AFOSR.

This project is directed toward observing and characterizing certain chemical species which are present in gases at temperatures beyond those attainable with furnaces by the use of shock wave techniques. Information about these species should deepen our understanding of the interaction of electrons with atoms, and of the chemical bond itself. Research in this area can help toward determining the actual chemical reactions which occur in a burning fuel or in a shock produced by an object moving at supersonic speed.

See also: 1.11, 1.20, 1.27, 1.44-45, 1.58, 3.13, 3.20, 3.39, 3.44, 3.51, 3.74, 3.119, 4.14, 4.37, 4.101, 7.46, 7.61, 7.68, 7.72, 8.12-13, 8.52, 9.54, 11.8, 12.7, 12.10 12.12-13, 12.18, 12.30, 12.37, 12.40-41, 12.51, 12.58, 12.66-67, 12.81, 12.89, 12.109, 12.123, 12.126, 12.129, 12.136, 15.27, 16.5, 16.46, 16.81, 22.2, 22.3, 22.41, 22.61, 23.8, 23.106, 23.108, 23.115, 23.118, 24.45

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15. SOLID MECHANICS AND STRUCTURES

Brittle Fracture, Buckling of Shells, Crack Propagation, Dynamic Behavior; Fatigue; Flight Structures, Flutter, Friction and Wear, High-Speed Impact, Loading Stresses, Thermal Stresses; Vibration.

15.1

Advanced Technology, Corp., Goleta, Calif.
EFFECTS OF UNSTABLE MOTION ON THE DESCENT TRAJECTORY OF BODIES, J. E. Brunk. Project 7856(806A), Contract AF 29(600)-2936; SRAS, AFOSR.

The research work is directed toward determining of those body and shape parameters which have a destabilizing effect on a descending body and which support an autorotative motion in the whole spectrum of speeds and in a variety of environmental conditions. A computer program will be used to study the characteristic effects encountered during the transient and equilibrium phases of the autorotative motion as well as for the extraction of significant body parameters and contours securing a self-sustained rotation in representative speed ranges and for a wide variety of environmental conditions.

15.2

Aerospace Research Associates, Studio City, Calif.
ENERGY ABSORBING STRUCTURES, B. Mazelsky. Project 9782(806A), Contract 49(638)-1144; SREM, AFOSR.

A basic method of providing variable geometry to a structure is through the use of preset convoluted geometry which, when forces are applied, can absorb or release energy. The proposed research is to investigate the manner in which energy can be absorbed or released by convoluted structures.

15.3

Armour Research Foundation, Chicago, Ill.
HIGH TEMPERATURE FRICTION OF SINGLE CRYSTALS, C. H. Riesz. Project 7022(802A), Contract AF 33(616)-6920; ASRCM, ASD.

To correlate and evaluate the factors which affect high temperature friction and wear, and to correlate such data with the Bowden and Tabor and Archard and Hirst theories. Sapphire crystals were chosen as the rubbing surfaces because of their high temperature stability and the fact that single crystals have the best defined surface know. In atmospheric tests, the coefficient of friction appears to rise and fall inversely as the modulus of rupture of the sapphire up to 1000°C; in a vacuum, the coefficient of friction is much higher and it varies approximately as the modulus of rupture of the sapphire. At room temperature in a vacuum, the sliding ball produces a series of cracks in the separation planes of the sapphire, the cracks appearing as a series of chevrons across the sliding path. At high temperatures for long periods in a vacuum, a thin film of an unknown material is deposited on the surface and lubricates the sliding. Experiments are continuing to explore the nature of these observed phenomena and investigate the effects of noble gases, higher vacuums, and crystal orientation. By use of another material such as periclase, which can be cleaved, the effect of an ultra clean surface may be evaluated.

15.4

Battelle Memorial Inst., Columbus, Ohio.
COLUMN ACTION DURING CREEP BUCKLING, R. L. Carlson. Project 7063(806), Contract AF 33(616)-6301; ARN, ARL.

An experimental and analytical study is being made to obtain basic and new knowledge relating to the behavior of columns subjected to creep buckling, and to determine the accuracy of Girard's theory of creep buckling. An attempt will be made to develop new analytical methods to predict the behavior and ultimate life of columns subjected to creep buckling. Relationships will be derived between creep buckling instability and the elementary stability theory for columns. The basic mechanisms of column creep buckling will be mathematically described.

15.5

Biot, M., New York.
INCREMENTAL AND NONLINEAR THEORY OF DEFORMATION OF SOLIDS, M. Biot. Project 9782(806A), Contract AF 49(638)-837; SRE, AFOSR.

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The research to be conducted under the subject contract constitutes a unified treatment of the deformation of solids and is applicable to a large variety of phenomena including finite elastic deformations, flow and creep, stability, incremental deformation and wave propagation in prestressed solids. The original approach to study the nonlinear deformation of solids enables a number of rigorous theories to be developed without recourse to tensor theory or notation. Specifically, a rigorous theory of stability will be presented and its use illustrated by considering problems involving thick plates, buckling of anisotropic and laminated plates, torsional buckling, etc. A nonlinear theory of twist will also be derived for thin sections and will permit investigation of the stability of such sections under axial compression or tension. Other information which will be presented includes (1) a comparison of the elementary equations and those obtained by the more advanced (and powerful) techniques of classical tensor theory, (2) study of dynamical problems and wave propagation, (3) wave propagation in fluids under initial stress, and (4) wave velocities in prestressed media.

15.6

California Inst. of Tech., Pasadena.
PANEL FLUTTER, Y. C. Fung. Project 9782(806A), Contract AF 49(638)-220; SRE, AFOSR.

This program consists of theoretical and experimental studies in select areas of panel flutter, namely, flutter of buckled plates of finite aspect ratio, limiting amplitudes of flutter, flutter at transonic speeds, the effect of thermal stresses on flutter and flutter of a membrane. The research includes an experimental program to develop a technique for observing the onset of flutter. Moreover, a variable frequency excitor will be developed to measure panel response at increasing and decreasing excitation frequencies. The excitor and response measuring equipment will subsequently be used in the experimental phase of the program. An approximate aerodynamic theory will be developed for the two dimensional supersonic flow problem to bridge the gap between quasi-steady aerodynamic theory and full linearized theory. The investigations will be extended to take into account the case of flat finite aspect ratio rectangular plates in a supersonic flow. It is felt that simplified aerodynamic theories can be developed in this area for particular cases and employed with success in prototype flutter analyses.

15.7

California Inst. of Tech., Pasadena.
KINETICS OF DEFORMATION AND FRACTURE, M. L. Williams. Project 7024(802A), Contract AF 33(616)-6270; ARZ, ARL.

The contractor has constructed a modified Ellis type high speed framing camera specifically for this study. This camera is to be used to study the kinetics of crack propagation in b.c.c. metals or alloys as affected by level of interstitial element content, intensity and duration of applied stress pulse, and crack length. A theory has been proposed which allows an interpretation and prediction of fatigue failures under high stresses, and is currently being investigated.

15.8

California Inst. of Tech., Pasadena.
MECHANICS OF CRACK INITIATION, M. L. Williams. Project 703(806A), Contract AF 33(616)-7806; ARN, ARL.

This is a study to investigate the basic phenomena of crack propagation and to relate this phenomena to structures of flight vehicles. Observations are being made of the plastic and elasto-plastic stress fields in the vicinity of cracks in initially flat sheets. The effect of sheet curvature on stress distribution will be determined. Photoelastic techniques, and an extremely fast camera, are being used in portions of this research. Efforts will be made to compute the distortion energy of crack propagation. If possible both internal and external cracks will be studied, and the curved sheet investigation will be extended to include the case of a cylindrical shape with an initial crack.

15.9

California Inst. of Tech., Pasadena.
STUDIES IN VISCOELASTIC MEDIA, M. L. Williams. Project 7063(806A), Contract AF 33(616)-8399; ARN, ARL.

At present there exists a very meager knowledge of the time-dependent behavior of materials subjected to complex histories of temperature and multiaxial loading. Therefore, a critical evaluation will be made of available property measuring techniques in relation to the information required for realistic stress analysis. This will be followed by experiments to attempt to determine failure criteria in viscoelastic media under combined stress fields. These will include a thin, pressurized membrane for biaxial tension, and a thin disc for triaxial tension.

15.10

California U., Berkeley.
CREEP BEHAVIOR OF AIRCRAFT STRUCTURAL MATERIAL,

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J. E. Dorn. Project 7353(802A), Contract AF 33 (616)-7213; ASRC, ASD.

Research is being conducted in an effort to equate structure factor, barrier density and activation energy for creep, recovery, and diffusion to predict isothermal creep behavior. The effects of temperature on recovery in the cross-slip region is being evaluated for the purpose of obtaining an accurate measurement of the activation energies for recovery. The rate of migration of low angle subgrain boundaries and their effect on the creep rate and rate of recovery are being investigated. The effect of alpha solid solution alloying on recovery in the climb region is being studied in hope of determining a quantitative relationship between the rate of recovery and the quantity of solute alloy in the solid solution. In the future the mechanism and rate of sub-boundary movement as related to the substructure will be studied.

15.11

California U., Berkeley.
DYNAMIC STABILITY PROBLEMS FOR MISSILES, E. V. Laitone. Project 9781(806), Contract AF 49(638)-515; SRE, AFOSR.

Theoretical investigations were conducted on the limitations of current stability criteria for the dynamic stability of both non-rolling unsymmetrical and rolling symmetrical missiles. The analytical studies included: (a) a basic investigation of the mathematical and physical implications of the differences found when taking small perturbations about different coordinate systems and a theoretical interpretation to explain the essential difference between $C_{m_{\alpha}}$ and $C_{m_{o}}$ in accelerated motion; (b) an analysis of the long period or phugoid oscillations for large forward speeds and either large accelerations or large variations in air density; (c) an analysis of the stability criteria for spin-stabilized missiles at nearly constant forward speed and an attempt to evaluate the effect of high rates of acceleration.

15.12

Carnegie Inst. of Tech., Pittsburgh, Pa.
CREEP AND FATIGUE OF METAL SINGLE CRYSTALS, G. T. Horne. Project 7024(802A), Contract AF 33(616)-6418; ARZ, ARL.

Two studies are being performed in this research. The first is an investigation of the 33,000 calorie/mole activation energy associated with the Koster internal friction peak in iron, and of the strain rate and temperature dependence of the strength of iron. Secondly, a study is being made of the effect of slip on twinning in zinc in an effort to elucidate the role played by slip in suppressing twinning.

15.13

Carnegie Inst. of Tech., Pittsburgh, Pa.
EFFECT OF STIFFENERS ON FAST CRACK PROPAGATION, J. P. Romauldi. Project 9782(806A), Contract AF 49 (638)-237; SRE, AFOSR.

An analytical and experimental investigation pertaining to the mechanism of fracture in complex built up structures, with particular attention to the effect of riveted stiffeners on the propagation of the crack front. The stress field in the vicinity of a crack tip will be interpreted in terms of a generalized crack extension force, as proposed by Irwin and general expressions for the effect of stiffeners in the crack front in terms of stiffener spacing, stiffener size, rivet spacing and geometry of stiffener will then be derived. Tests will be conducted to check the accuracy of the theoretical results and to evaluate the fracture resistance of certain aircraft type alloys.

15.14

Columbia U., New York.
NATURE OF FRACTURE IN METALS, M. Gensamer. Project 9760(802A). Contract AF 49(638)-408; SRPS, AFOSR.

In this investigation the correlation between twinning and brittle fracture and the general conditions under which twins enter into the mechanism of brittle fracture is underway. In this connection, a systematic study of the relationships among the following is being done: twinning stress; the number, size, and distribution of twins; specimen size, shape and orientation; temperature; prior mechanical history of strain; surface conditions including coatings and other barriers such as twins and grain boundaries. Research on single crystal zinc and magnesium will be extended to polycrystalline samples. The influence of ordering on the binary cadmium-magnesium system and the role of interstitial elements in body centered cubic materials will be investigated for their influence on the fracture mechanism in these systems.

15.15

Columbia U., New York.
DYNAMIC BEHAVIOR OF PLATES AND SHELLS, G. Herrmann. Project 9782(806A), Contract AF 49(638)-430; SRE, AFOSR.

The objectives of this research consist of obtaining a deeper insight into the dynamic behavior of thin-

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walled structural elements, such as plates and shells. Particular attention has been concentrated on the vibratory behavior of circular cylindrical shells under a variety of conditions including limiting instability and thermoelastic response. It was shown that an initial bending moment has only a small influence on the frequencies of vibration and that a circular cylindrical shell can become unstable under the action of a radial shear, in a manner similar to the shear buckling of a bar. Further studies include investigations of the range of validity of various shell theories in dynamic problems, investigations of displacements and strains produced by initial stresses, and a preliminary investigation of the dynamic response of layered shells.

15.16

Convair, San Diego, Calif.
LINEAR STRAIN THEORY OF FATIGUE LIFE PREDICTION, C. R. Smith. Project 7062(806A), Contract AF 33(616)-8828; ARN, ARL.

An experimental program will evaluate the effects of various degrees of preloading, and occasional high loads, on the subsequent fatigue life of riveted joints. Systematic tests will be run on a large number of samples, providing S-N curves for each loading condition. Results will be analyzed to determine whether a better method of fatigue life prediction can be established.

15.17

Convair, San Diego, Calif.
THERMAL STRESSES IN PERFORATED PLATES AND BODIES OF REVOLUTION, R. D. Sutherland. Project 9782(806A), Contract AF 49(638)-592; SRE, AFOSR.

The research being accomplished under this contract can be generally divided into two separate investigations: (a) the extension of the work begun on thermal stresses in singly perforated plates and experimental verification of analytical results, including an investigation of the vico-elastic case for simple configurations under thermal loading; and (b) the development and solution of the thermoelastic equations derived for thick-wall, low drag shells of revolution subjected to hypothetical temperature gradients intended to approximate aerodynamically induced thermal loads. This last was evolved from the development of an ogive coordinate system through which configurations from a circular cylinder to a sphere can be expres. d by variation of a single parameter.

15.18

Detachment 4, ASD, Eglin Air Force Base, Fla.
CHANGE IN VERY HIGH VELOCITY IMPACT PHENOMENA WITH HYPERSTRENGTH PARTICLES, F. E. Howard. Project 9860(806A), Internal.

Continuing from previous in-house firings of hyperstrength particles from explosive projectors and shock tube projectors, the types of strong particles will be enlarged to include intermetallics and cermets as projectiles and targets. The explosive driven shock tube projector is a new technique which has already provided 25,000 fps and is expected in current designs to yield 35,000 fps. The inclusion of brittle high strength materials requires a comparison with brittle low strength rocks and ceramics. An in-house attempt will be made to detect electron-diffusion effects from impacts as related to Fermi surfaces and electron-phonon energy transfers.

15.19

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
HYDROGEN PENETRATION MECHANISMS, R. J. Barton. Project 7022(802A), Internal.

As a contribution to the greater understanding of problems arising from hydrogen embrittlement, a basic program on the mechanism of hydrogen penetration of a metal cathode during an electrochemical reduction is being undertaken. The measurement of diffusion of hydrogen through the metal foil gives an insight to the mechanisms of hydrogen entry. Research to date indicates that penetration is dependent upon the interface reaction and is not necessarily diffusion controlled. Currently the penetration effect is being studied as a function of foil thickness. This in-house study is coordinated with a contractual program on the mechanism of hydrogen evolution. A second phase of work is being initiated for the study of reduction processes in fused salts. At the present time the "solvent" system is being investigated.

15.20

Directorate of Materials and Processes, ASRC, ASD, Dayton, Ohio.
FUNDAMENTAL FRICTION AND WEAR STUDIES, T. Liu. Project 7342(802A), Internal.

Emphasis in this program will be placed on a study of single crystals (initially quartz) to better illustrate the friction and wear mechanism in both the lubricated and unlubricated states. This effort will be directed toward the development of a more sound theory of behavior. Investigations will be limited to pure sliding contact. Ultimately research will be conducted on the effect of vacuum, high temperature and advanced bearing materials.

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CRRD- Electromagnetic Radiation Lab
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15.21

Directorate of Research Analysis, SRAS, AFOSR, Washington, D. C.
DYNAMIC STABILIZATION OF BODIES, H. A. Melkus. Project 7856(806A), Internal.

The work in this in-house effort will be directed toward expanding of procedures permitting accurate analyses of the dynamic behavior of bodies, when subjected to accelerative and decelerative effects, and verification of findings on the Holloman track. Research in this direction is of importance as the proper assessment of the dynamic stability of vehicles during acceleration and retardation significantly contributes to the improvement of motion predictions.

15.22

Directorate of Research Analysis, SRAS, AFOSR, Washington, D. C.
RE-ENTRY DYNAMICS, H. A. Melkus. Project 7856(806A), Internal.

Research is planned on development of computational techniques and concepts showing a greater utility in describing the physical behavior of bodies in motion. A study of methods permitting incorporation of nonlinear effects is contemplated. Emphasis will be placed on the development of engineering approaches by simulating the processes involved such as, e.g., interaction phenomena, shock and vibration environment, damping, etc., on electronic computers.

15.23

Dynatech Corp., Cambridge, Mass.
STRUCTURAL FATIGUE IN SHELLS OF DOUBLE CURVATURE, R. E. Goode. Project 9782(806A), Contract AF 49 (638)-1096; SREM, AFOSR.

The objective of this research is to investigate the dynamic behavior of shells of double curvature and to attempt to determine these combinations of load which lead to fatigue or failure conditions.

15.24

Engineering Supervision Co., New York.
STRESS DISTRIBUTION AND STRENGTH CHARACTERISTICS OF LOAD MAGNIFICATION ANVILS FOR ULTRA-HIGH PRESSURE APPARATUS, A. Zeitlin. Project 5621(802A), Contract AF 19(604)-7438; CRRC, AFCRL.

The research called for in this contract is an investigation of stress distribution and strength characteristics of anvils for ultra-high-pressure apparatus. At the present time, ultra-high-pressure research is being hampered by the lack of knowledge regarding anvils which are utilized for load magnification. Two problems should be investigated. These are, means to prevent breakage of the anvils, and means to increase the pressure of which they can be utilized. Anvil breakage is a serious and costly defect in present-day anvil design. The maximum pressures which can be obtained are also determined by the anvil strengths of such anvils. The research called for above must be verified under actual operating conditions by the design and construction of special load magnification anvils for the ultra-high-pressure press at AFCRL.

15.25

Florida U., Gainesville.
RESPONSE OF STRUCTURES TO RANDOM NOISE, W. Nash. Project 9782(806A), Contract AF 49(638)-328; SREM, AFOSR.

The purpose of this investigation is to study theoretically the response of structural elements, curved panels in particular, when there is random acoustic excitation, atmospheric turbulence, and other sources of "noise" in addition to the normal aerodynamic loading. Several treatments of the response of certain structural elements to random loads are to be found in the literature. These studies are based upon the techniques of generalized harmonic analysis. Unfortunately, the pressure cross-correlations employed in the existing work are not entirely realistic. The present study will replace the unrealistic situation existing in random acoustic excitation, atmospheris turbulence, and many other phenomena of interest in aeronautical design. The study also takes account of boundary conditions other than those already treated and even more important would treat, analytically, the response of curved panels to random noise. Also, the study treats, analytically, the effect of reinforcements on structural components subject to random noise and investigate the optimization of such reinforcement. Lastly, the investigation provides basic information regarding the characteristics of certain sound fields. This information is necessary to evaluate the reality of existing analyses. A small-scale experimental study of the statistical properties of the acoustic field near a siren or air jet is being made. It is expected that more detailed jet noise spectra than currently available will be obtained.

15.26

Forest Products Lab,, Madison, Wis.
MECHANISM OF PLASTIC REINFORCEMENT, C. B. Norris. Project 7342(802A), Contract DO (33-616)61-03, ASRC, ASD.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

The elastic and strength properties of structural plastic materials are directly related to the properties of the matrix, the reinforcement, and the bond between the two. The fundamental interrelation of these properties will be investigated to provide a better basis for the synthesis of improved component materials. A theoretical method of determining the stiffness of the bond between the reinforcement and the matrix will be further developed. This method will involve mathematical analyses followed by experimental observations to confirm the theoretical relationships. Several materials will be explored to vary the rigidity of the interfacial bond.

15.27

General Electric Co., King of Prussia, Pa.
STRUCTURAL RESPONSE TO INTENSE ELECTROMAGNETIC RADIATION, F. Wendt. Project 9782(806A), Contract AF 49(638)-1030: SREM, AFOSR.

The research will include: (1) investigation of the nature of energy conversion from electromagnetic to strain energy. This will include prediction of temperature, density, and pressure profiles by analytical means, verification of these predictions, and establishment of ranges of validity by laboratory experiment; (2) study two dimensional shock-wave propagation in solids and investigate the possibility of making interior measurements without changing the propagation characteristics; (3) investigate relations between failure mechanisms, their respective failure thresholds and fundamental properties of the microstructure of the material under given stress-histories.

15.28

General Electric Co., Philadelphia, Pa.
THEORY OF HIGH SPEED IMPACT, T. D. Riney. Project 9860(806A), Contract AF 08(635)-1713; PGWR, APGC.

The visco-plastic model of impact was formulated by introducing viscosity and yield stress factors into perfect fluid equations. The study extension will consider the effect of varying the material of the projectile/target system, projectile L/D ratios, projectile mass and impact velocities. A major portion of the study extension will be investigations of the selected difference scheme with regard to stability, convergence and sensitivity with respect to errors in data or variation of parameters.

15.29

General Mills, Inc., Minneapolis, Minn.
FRICTION ON TITANIUM SURFACES, A. A. Anderson. Project 7022(802A), Contract AF 33(616)-6178; ARC, ARL.

The friction coefficient and frictional stick-slip phenomenon are being determined on coated titanium surfaces as a function of the nature of the surface film and the normal applied force. Effect of the type of polar group on the organic film, the chain length and the surface coverage of the organic molecules and the nature of inorganic films such as titanium oxide layers are being investigated. Adhering film thickness is being determined by polarization spectrometry; the determination of titanium oxide and the corresponding calibration techniques have been completed and reported.

15.30

Giannini Controls Corp., Buffalo, N. Y.
ADVANCED AEROELASTIC STUDIES, M. Zisfein. Project 9782(806A), Contract AF 49(638)-1015; SRE, AFOSR.

The intent of this program is to conduct advanced investigations of dynamics of airframes. The objectives include: (a) a theoretical study of the effects of damping on flutter. (The purpose is to obtain a better understanding of the significance of damping on the flutter stability of structural components at high supersonic and hypersonic speeds. Particular attention is directed toward evaluating the variety of approximate methods presently in use for the prediction of flutter and to study the phenomenon of velocity-damping "loop backs"; (b) investigate the binary and ternary aeroelastic system solutions using incompressible aerodynamics; and (c) investigate the extension of the devised aeroelastic system approximations into the low supersonic flight regime.

15.31

Harvard U., Cambridge, Mass.
PLASTICITY AND STRUCTURAL MECHANICS, B. Budiansky. Project 9782(806A), Contract NONR 188602; SREM, AFOSR.

This was a joint AFOSR-ONR effort for support of problems in plasticity and structural mechanics including analysis of the behavior of bodies containing plastic inclusions, analysis of the elastic-plastic behavior of bicrystals, elastic-plastic buckling analysis of clamped shallow spherical shells, and studies in the theory of thin elastic shells.

15.32

Hayes Corp., Birmingham, Ala.
TARGET PENETRATION PREDICTION BY HIGH SPEED AND ULTRA HIGH SPEED BALLISTIC IMPACT, C. M. Askey. Project 9860(806A), Contract AF 08(635)-2155; PGWR, APGC.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
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This study is expected to provide a penetration prediction theory and formulae that will establish the degree of probability of high speed and ultra high speed projectiles to penetrate: (a) unstressed complex targets; and (b) complex targets under dynamic loads. The targets will be typical of advanced air- and space-craft, satellite and missile structures. The initial effort will be limited to the production of a first order approximation theory for predicting target penetration under certain favorable conditions, i.e., when values of combinations of certain critical factors are sufficiently high to produce critical stresses and structural disintegration. In developing the first order theory, such factors as the dynamic strengths of the material of the target and projectile, dynamic effects in fracture propagation, shock and stress waves and the energy distribution among the various failure modes are to be considered, in addition to projectile mass and velocity, densities of projectile and target and the geometrical parameters of projectile dimensions, target thickness and projectile/target contact areas. This study will evaluate the relative significance and interaction of four impact processes, elastic, plastic, hydrodynamic and explosive or thermodynamic in order to gain a better understanding of the complete penetration process leading to more accurate extrapolation into areas beyond experimental capabilities.

15.33

Illinois Inst. of Tech., Chicago.
PLASTIC FRACTURE OF METALS IN TENSION, N. H. Polakowski. Project 9760(802A), Contract AF 49 (638)-308; SRPS, AFOSR.

This investigation is designed as a careful study of the plastic fracture of metals with the broad objectives (1) to review, analyze and correlate various data relating to the problem of ductile fracture; (2) develop a phenomenological theory of failures under torsion and tension, and discover, if possible, the criterion by which they are governed; (3) investigate experimentally and theoretically these two known varieties of plastic fracture in tension; and (4) attempt to devise a generalized diagram representing in an integrated manner the conditions of flow and failure which would eliminate the deficiencies of previous interpretation. A good many experimental results indicate that ductile metals in the annealed or moderately work-hardened condition break in tension under a remarkably constant stress. Thus, the breaking stress seems to be independent of the method of prior straining provided that the latter does not exceed a certain minimum value. This leads logically to the conclusion that the incidence of fracture is associated with some limiting crystallographic orientation brought about by tensile strain. It is desirable to further explore this condition with the prospect that it may contribute to the causes of structural failure through ductile fracture. An item of particular interest in this investigation is the evidence that fracture is not a result of stress hardening but involves considerably more complicated crystallographic modifications of the metal than has previously been suspected.

15.34

Illinois U., Urbana.
TIME AND TEMPERATURE DEPENDENCE OF THE DUCTILE BRITTLE TRANSITION, G. M. Sinclair. Project 7024 (802A), Contract AF 33(657)-7619; ARZ, ARL.

The contractor will study the anomalous brittle behavior of Fe, Nb, and Mo over a very wide strain-rate range (at least 5 orders of magnitude) and at all temperatures required (4.2°K to 1500°K). He will make a continual analysis of the data in the literature to ascertain the validity of the octahedral shear stress criterion of fracture.

15.35

John Hopkins U., Baltimore, Md.
PLASTIC WAVE PROPAGATION IN METALS AT ELEVATED TEMPERATURES, J. F. Bell. Project 9782(806A), Contract AF 49(638)-1067; SREM, AFOSR.

A new technique has been developed by this investigator for the study of plastic wave propagation in metals. It involves the cutting of a diffraction grating on the metal to be studied. Reflections from this grating are recorded as the piece is subjected to impact or to static deformation. It can also be applied to samples in high speed motion. The present investigation at elevated temperatures will use this technique to study the transient mechanical behavior of metals subject to impact.

15.36

Johns Hopkins U., Baltimore, Md.
THERMAL EFFECTS IN SOLIDS, O. W. Dillon. Project 9782(806A), Grant AF-AFOSR-62-204; SREM, AFOSR.

The objective of this research is to investigate the process by which heat is generated when materials are deformed. This process is being studied from the point of view of continuum mechanics and an attempt is being made to define those problems in which this coupling of thermal and mechanical fields is significant. Preliminary results indicate that the coupling can be significant during torsional oscillations even though only a small amount of heat

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ASD- Aeronautical Systems Division
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AEDC- Arnold Engineering Development Center
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is generated during a single cycle. These incremental temperature increases are equivalent to appreciable mechanical energies and the temperature of the specimen increases due to temperature accumulation. A limited number of experiments verify the phenomenon.

15.37

Louvain U. (Belgium).
DYNAMIC BEHAVIOR OF PLATES AND SHELLS UNDER THERMAL STRESSES, F. Buckens. Project 9782(806A), Contract AF 61(052)-499; SREM, AFOSR.

The purpose of this research is to theoretically and experimentally study the dynamic behavior of thermally stressed plates and shells under the action of excited vibrations and shocks. The stress level may be such that the plates and shells are subject to buckling, and this is to be taken into account. The objectives of the research are to predict the natural frequencies and, more generally, the dynamic behavior of plates and shells under thermal loads. A second objective is to investigate the possibilities of evaluating thermal stresses by simple vibration or acoustical measurement.

15.38

Louvain U. (Belgium).
KINEMATICS OF STRUCTURES, F. Buckens. Project 9782 (806A), Grant AF-EOAR-62-107; SREM, AFOSR.

The twofold objectives of this research are: (1) from the point of view of general kinematics, to obtain a better understanding of the laws governing the synthesis of linkages; and (2) from the standpoint of structures, formulate conclusions on the relative merits of configurations and their application to limit analysis.

15.39

Martin, Glenn L., Co., Baltimore, Md.
EFFECT OF VACUUM ENVIRONMENT ON MECHANICAL BEHAVIOR OF MATERIALS, I. Kramer. Project 9782(806A), Contract AF 49(638)-946; SRE, AFOSR.

The objective of this research is to conduct an analytical and experimental investigation of the effects of pressures, approaching those that will be encountered by space vehicles, on the mechanical behavior of materials. In particular, this research will include: (a) study of tension, creep and fatigue behavior in a vacuum environment to establish threshold pressures beyond which mechanical behavior is no longer affected; (b) study of the effect of atmospheric composition on the tensile, creep and fatigue behavior of materials; and (c) investigate the relationship between applied stress and pressure for fatigue and creep behavior.

15.40

Massachusetts Inst. of Tech., Cambridge.
AEROTHERMOELASTICITY, R. L. Bisplinghoff. Project 9782(806A), Contract AF 49(638)-219; SRE, AFOSR.

The purpose is to study, both analytically and experimentally, the effects of elevated temperature and resulting thermal stresses on the deformation, stiffness and frequency of vibration of various structural elements important to aircraft and missile components, namely, shell-type beams, thin panels and plate-type structures. As a necessary step in the determination of flutter boundaries for tapered cylindrical shells, the influence of taper on their natural vibration modes and frequencies is being established. Since no exact solutions of this problem have been obtained, various approximate methods of approach had to be tried so that reliable conclusions may be drawn about the behavior of these shells from the sometimes diverse results of different approaches. A basic understanding of the process for membrane and plate-like shells has been obtained, and the appropriate methods of analysis have been determined. These results are now being applied to the solution of the flutter problem by incorporating the aerodynamic effects. The flutter of an extremely low aspect ratio free-free delta wing characterized by only chordwise vibratory modes has been studied on the basis both of piston theory and slender body theory aerodynamics. Progress has been made in developing the energy balance for a fluttering system in the supersonic regime; and some simple applications have been made.

15.41

Massachusetts Inst. of Tech., Cambridge.
MECHANICAL BEHAVIOR OF METAL COMPOSITES, R. L. Bisplinghoff, E. Orowan, J. Wulff. Project 9782 (806A), Contract AF 49(638)-775; SREM, AFOSR.

The principal objective of this research is to theoretically investigate the mechanical behavior of metal composites which are expected to play an increasingly important role in our future aeronautical progress. A complementary experimental phase of the research is directed toward investigating the mechanical behavior of such materials subjected to a variety of loading conditions. The loading conditions will include pure shear, tension, compression, bending and transverse shear.

15.42

Massachusetts Inst. of Tech., Cambridge.

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RANDOM VIBRATION IN AEROSTRUCTURES, S. H. Crandall. Project 9782(806A), Contract AF 49(638)-564; SREM, AFOSR.

The research objectives are to study the nature of random vibrational energy and how it is affected by transmission through structure. Principal emphasis will be placed on extension of existing theory which is considered adequate for treating cases where the structural systems are completely linear and where the random vibration is stationary and ergodic. Consideration will thus be given to the problem of characterizing non-stationary random processes. Moreover, the effect of nonlinear damping and nonlinear elasticity of the structure on the filtering of random vibration will also be examined.

15.43

Massachusetts Inst. of Tech., Cambridge.
NONLINEAR STRUCTURAL PROBLEMS RELATED TO FLIGHT VEHICLES, T. H. H. Pian. Project 9782(806A), Grant AF-AFOSR-62-239; SREM, AFOSR.

This research includes: (1) study of the dynamic buckling of shallow shells with thermal effects; (2) study of the dynamic response of beams and plates when the material is considered as rigid-plastic; (3) study of the snap-buckling of elastic-plastic structures; and (4) study of the dynamic buckling of structures which fail by snap-buckling under static load.

15.44

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
INFLUENCE OF HYDROGEN ON THE FLOW AND FRACTURE OF IRON, A. M. Adair. Project 7021(802A), Internal.

A fundamental study of the influence of hydrogen on the flow and fracture characteristics of iron is being conducted in order to gain insight into the lattice contribution to hydrogen embrittlement. The lower yield point of high purity iron will be determined as a function of hydrogen concentration, grain size and temperature. For a given temperature, plots of lower yield point versus the inverse square root of the grain diameter will be made to determine both the lattice friction stress σ_i, and the dislocation locking parameter, K_y. The same measurements will also be made for non-hydrogen containing specimens for comparative purposes. The data obtained will be analyzed in terms of modern fracture theories. Preliminary data reveal yield points at -150°C in a high purity iron to which hydrogen had been introduced electrolytically. This yield point occurs after aging at a temperature where hydrogen is the only mobile interstitial and is believed to be the first observation of hydrogen causing a yield point to return in a manner like carbon or nitrogen. An anomalous yield point has also been observed at low temperatures in both a hydrogen-containing and hydrogen-free iron and is also under investigation.

15.45

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
MECHANISM OF THE BRITTLENESS OF CHROMIUM, R. E. Hook. Project 7024(802A), Internal.

An investigation is being conducted on the effect of thermal treatment on the microstructure, second phase constituents present, and mechanical behavior of pure chromium. Recrystallized chromium which is ductile at room temperature has been produced. When this material is tested to failure, it is invariably found that the initiation of fracture occurs at an intercrystalline nucleus. Profuse amounts of visible oxide phases are found segregated in the grain boundaries when chromium is recrystallized in the temperature range 1400°C to 1800°C. The segregation of solutes and submicroscopic phases will be studied by thin film electron transmission microscopy for annealing temperatures below 1400°C.

15.46

Metallurgy and Ceramics Research Lab., ARZ, ARL, Dayton, Ohio.
MECHANISM OF THE FATIGUE LIMIT IN METALS, H. A. Lipsitt. Project 7024(802A), Internal.

The present research employs the purest titanium and three dilute alloys containing C, N, and O, respectively. The data gathered to date indicate a marked dependence of fatigue behavior on the amount and type of interstitial element present. This research is being extended to both higher and lower temperatures to study the effects of increasing or decreasing the amount of strain aging that is allowed to occur.

15.47

Michigan U., Ann Arbor.
EFFECT OF STATE OF STRESS ON THE FAILURE OF METALS AT ELEVATED TEMPERATURES, S. K. Clark. Project 7353(802A), Contract AF 33(657)-7531.

The general objective of the program is directed towards the precise precalculation of failure in metals at various temperatures thus extending from the brittle to the ductile range and under inclusion of the mechanisms of failure subject to various stress combinations. The observation of strain,

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creep rate fracture type, and fracture sequence under combined stresses will be pursued. The temperature range for specially selected materials will extend from -250°F to +250°F. Since previously a material belonging to the hexagonal system was used, the emphasis will now be on the cubic body centered materials. It was suggested to use vanadium; however, because of the material cost a switch to another material may evolve. A comprehensive theoretical treatment will be made besides careful experimental measurements and both will be compared and critically discussed.

15.48

Midwest Research Inst., Kansas City, Mo.
FRICTION AND WEAR BEHAVIOR OF SOLID FILMS, P. Bryant. Project 7342(802A), Contract AF 33(616)-7823, ASRC, ASD.

The basic mechanism of lubrication by graphite and the conditions which affect the reduction of friction and wear will be described experimentally and examined theoretically on the basis of knowledge of single crystal structure and the bonding energies of crystals. The crystalline and molecular configuration are being studied to determine the surface energy considerations necessary to achieve low friction and wear. The energy of cohesion and shear strength of the basic graphite system is being studied, as well as the effect of various atmospheres on these properties.

15.49

Midwest Research Inst., Kansas City, Mo.
MECHANISMS OF FATIGUE ON ULTRA SMALL SPECIMENS, J. C. Grosskreutz. Project 7353(802A), Contract AF 33(616)-7858; ASRC, ASD.

Research is being conducted on the mechanism of fatigue in materials. The following areas of research are being investigated: (1) the mechanism of fatigue crack initiation has been studied by observations of bulk behavior of dislocations during fatigue stressing. Techniques being used in this study include resistivity measurements and X-ray scattering; (2) the mechanism of fatigue crack propagation has been studied using specially developed equipment for strobe micro-photography which permits observation of a propagating crack during cyclic stressing. The influence of crystalline orientation, grain boundaries, and atmospheres other than air on fatigue crack propagation are being studied. An investigation of the role of dislocation cross-slip and stacking faults in fatigue is being conducted. Transmission electron microscope techniques are being developed for direct observation of dislocations in slip bands.

15.50

Midwest Research Inst., Kansas City, Mo.
EFFECT OF EXTERNAL FORCE EXCITATION ON PANEL FLUTTER, E. Zeijdel. Project 9782(806A), Contract AF 49 (638)-389; SRE, AFOSR.

The objective of this research is to theoretically determine the effect of external-force excitation on the flutter of panels. The equations of motion for panels in both two and three dimensional supersonic flow will be studied, taking into account external forces due to sound pressures and frame transmitted vibrations.

15.51

Minnesota U., Minneapolis.
COMPOSITE STRUCTURES, C. C. Chang. Project 9782 (806A), Contract AF 18(603)-112; SREM, AFOSR.

This research consisted of a theoretical and experimental study of the elastic characteristics of sandwich type structures subjected to temperature gradients. Particular consideration was given to sandwich construction with non-isotropic cores and different facing materials. Moreover, this research included a study of the vibrational characteristics of sandwich panels with linear viscoelastic cores. An additional aspect of this study was concerned with the plastic buckling of simply supported composite panels with orthotropic cores and different face thicknesses. The theoretical phase of this program was augmented by an experimental phase to establish the validity of the necessary simplifying assumptions used in phrasing the problems analytically.

15.52

Minnesota U., Minneapolis.
CERTAIN WEAKLY NONLINEAR SYSTEMS, P. R. Sethna. Project 9783(806A), Grant AF-AFOSR-62-275;SREM, AFOSR.

This research is directed to the solution of problems of vibrating systems where the motion about stable solutions are sufficiently large to make the first nonlinear terms in the Taylor expansions of the differential equations of motion significant. The averaging methods introduced by Bogoliuboff and Mitropolsky will be used.

15.53

Mississippi State U., State College.
MECHANISM OF PLASTIC BEHAVIOR IN INORGANIC OXIDE-PHOSPHATE BONDED MATERIALS, J. H. Lauchner. Project 7342(802A), Contract AF 33(616)-8134; ASRC, ASD.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
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To determine the mechanism of plastic behavior of certain inorganic oxide-phosphate bonded materials. Three primary materials parameters will be studied. One concerns the relationships between starting materials and processing with structure of the fabricated inorganic body. Factors such as particle packing, size, shape and chemistry of filler materials, crystal phase orientation, grain boundaries, and process variables shall be studied. Another phase of study concerns the contribution of viscous flow and residual stress relief characteristics to plastic behavior of fabricated inorganic bodies. Also, mechanism of fracture and the nature of crack propagation in these materials will be investigated.

15.54

National Bureau of Standards, Washington, D. C.
PARTICLE IMPACT PHENOMENA AT HYPERSONIC VELOCITIES, O. G. Engel. Project 7342(802A), Contract DO 33 (616)59-3; ASRC, ASD.

The objective involves research on the phenomena which occur during the impact of hypervelocity particles against structural materials. The investigation will include an analysis of impact sites resulting from collision of hypersonic metal and plastic spheres. Pit depth vs. velocity data will be derived and theory formulated to arrive at mathematical relationships which will predict damage. The impact phenomena will be analyzed particularly to ascertain the degree to which the theoretically predicted liquid-to-liquid type collisions occur. The phenomena of true liquid collisions will also be studied using liquid drop accelerators. The various parameters will be investigated to determine their effect on the depth/diameter of cavity. This study will result in elucidating liquid-to-liquid collision phenomena and the results will be translated to hypervelocity impact.

15.55

National Research Corp., Cambridge, Mass.
INFLUENCE OF SURFACE PHENOMENA ON THE MECHANICAL PROPERTIES OF STRUCTURAL MATERIALS, J. Ham. Project 9782(806A), Contract AF 49(638)-1005; SRE, AFOSR.

The purpose of this research is to theoretically and experimentally investigate the mechanical behavior of structural materials in vacuum to 10^{-10} mm Hg. It is calculated to yield information concerning the existence and severity of changes in the behavior of materials exposed to ultra high vacuum environments.

15.56

New Mexico U., Albuquerque.
INELASTIC BEHAVIOR OF MATERIAL BY DISLOCATION PHENOMENON, F. D. Ju. Project 9782(806A), Grant AF-AFOSR-62-208; SREM, AFOSR.

The objective of this research is to analyze the inelastic deformation of structural members due to the formation of Lueders' bands and to analyze failures in structural members due to the formation of cracks adjacent to holes or cutout sections. The analyses will be made in accordance with dislocation theory.

15.57

New York U., N. Y.
KINETICS OF DEFORMATION AND FRACTURE, R. F. Bunshah. Project 7024(802A), Contract AF 33(616)-6430; ARZ, ARL.

Extremely high speed photomicrographic techniques (about 10^6 frames/sec) are being used for a basic study of the several processes associated with fracture, and the effects of variables thereon. Included in this study are the kinetics and nature of crack propagation in large grained pure metals, including any variations in velocity as a function of grain orientation or at a boundary; an examination of the kinetics and nature of cleavage in single crystals as a function of temperature and microstructure; and a study of the flow and fracture of two phase single crystals having a solid-state bonded interface.

15.58

New York U., N. Y.
NONLINEAR THEORIES OF DEFORMATION AND BUCKLING, J. J. Stoker. Project 9782(806A), Contract AF 49 (638)-1049; SREM, AFOSR.

The research objective is to conduct an analytical and numerical study of nonlinear theories of elasticity which arise from the relations between stress and displacement occurring in the failure of columns and buckling of spherical shells. The program treats both general and specific problems, e.g., the derivation and analysis of mathematically tractable formulations of the basic equations on the one hand, and the study of methods of treating special cases on the other. The latter includes study of the deformation of thin plates or slender rods under large external forces; the buckling of geometrically simple solids; the deformation and buckling of

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spherical and cylindrical shells; the development of practical computational procedures for the numerical solution of buckling and large deflection problems; and the establishment of criteria for distinguishing between situations in which thick-shell or thin-shell approximations are appropriate.

15.59

Ohio State U. Research Foundation, Columbus.
EFFECTS OF LARGE, SPANWISE, TEMPERATURE GRADIENTS IN LONG THIN PLATES, B. E. Gatewood. Project 7063 (806A), Contract AF 33(616)-8330; ARN, ARL.

When certain electromagnetic induction methods are used to heat structural specimens, a "striped" temperature distribution can occur in which the local temperature under each element of the work coil is higher than the average temperature. A theoretical and experimental investigation is being pursued to evaluate the structural significance of such temperature distributions. It is anticipated that radiant heating methods, on scaled-up models, will be suitable for this study. The ARL induction heater may be used to produce very high gradients if it is found that such tests are necessary or desirable.

15.60

Pennsylvania State U., University Park.
EFFECT OF TRIAXIAL STRESSES ON MECHANICAL PROPERTIES OF METALS UNDER HIGH PRESSURE, L. W. Hu. Project 9782(806A), Grant AF-AFOSR-62-113; SREM, AFOSR.

This research consists of an experimental and theoretical investigation of the elastic and plastic behavior of metals under triaxial stresses created by subjecting specimens to hydrostatic pressures up to 200,000 p.s.i. with superimposed loading. The immediate research objectives are to develop testing techniques for conducting triaxial stress experiments and to subsequently investigate the effects of triaxial stress on elastic constants, plastic behavior and fracture properties of metals. Although the triaxial state of stress is not presently well understood, it is known that prediction of the desired information predicated on linear or biaxial stress theory is not valid. The use of hydrostatic pressure with superimposed loading appears to offer considerable promise for obtaining reliable data for triaxial stress studies.

15.61

Pennsylvania State U., University Park.
TRANSIENT THERMAL STRESSES IN SOLIDS, W. Jaunzemis. Project 9782(806A), Grant AF-AFOSR-62-115; SREM, AFOSR.

The research objectives are to theoretically investigate transient thermoelastic stresses such that the effects of thermal inertia of the structure can be taken into account. The statement of work also includes investigation of thermal stresses in elastoplastic bodies and viscoelastic bodies.

15.62

Pennsylvania State U., University Park.
STRAIN ANALYSIS OF METAL SHEETS WITH NOTCHES AND CRACKS, C. U. Oppel. Project 7063(806A), Contract AF 33(616)-7298; ARN, ARL.

Research is being conducted to determine the strain distribution at the base of notches and cracks, and the manner in which this distribution changes with fluctuating uniaxial tension loadings. An important aspect of the research is the development of accurate and reliable techniques for the measurement of strains. Preliminary experimentation indicates that the photo-elastic layer method is well suited for strain measurements in the elastic range, while direct optical methods have certain advantages in the plastic range. Photo-grid techniques will also be investigated.

15.63

Pennsylvania State U., University Park.
EFFECT OF ENVIRONMENTAL CONDITIONS ON THE MECHANISM OF FATIGUE, M. A. Wilkov. Project 9782(806A), Grant AF-AFOSR-62-273; SREM, AFOSR.

The main mechanisms proposed for fatigue crack formation can be grouped into three categories: (1) dislocation models which postulate a sequence of movement and interaction to produce the various experimentally observed phenomenon; (2) accumulation of point defects which result from non-conservative motion of dislocations; and (3) pile-ups of densely packed groups of dislocations. It is probable that all mechanisms exist simultaneously and that their relative contribution toward the actual formation of a fatigue crack is dependent upon the type of material as well as the environmental conditions. The objective of this research is to isolate the environmental dependence of the controlling fatigue mechanism.

15.64

Polytechnic Inst. of Brooklyn, N. Y.
LOADING AND ELEVATED TEMPERATURES, J. Kempner. Project 9782(806A), Grant AF-AFOSR-62-200; SREM, AFOSR.

The principal purpose of this research is to develop methods of analysis for stresses in and deformations

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CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
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of structural components of aircraft and missiles which are subjected to external loads and elevated temperatures. More specifically, the objective is to determine fundamental relations appropriate for the accurate analysis of plates, shells and bars subjected to the mechanical and thermal environments produced during high-speed flight, and to apply these relations to specific problems of basic interest. In the solution of such problems, new methods of analysis, e.g., refinements in numerical methods, are also being sought. A considerable part of this work includes the determination of techniques for investigation of the heat-conduction problems which must be solved before stresses and deformations can be determined. In view of the fact that material properties are seriously influenced by high temperatures, studies of the effects of variable thermal and mechanical properties as well as the influence of plasticity and creep are included in the over-all program.

15.65

Polytechnic Inst. of Brooklyn, N. Y.
VIBRATIONS OF CYLINDRICAL SHELLS; Y. Y. Yu. Project 9782(806A), Contract AF 49(638)-453; SRE, AFOSR.

The primary objective of this research is to theoretically investigate the vibrational characteristics of finite shells with various degrees of edge restraint. The theoretical developments are to account for the effects of transverse shear deformations and rotational inertia which have not been extensively studied to date. Moreover, consideration will be given to incorporating these effects into the vibrational analysis of both homogeneous and sandwich shells.

15.66

Rensselaer Polytechnic Inst., Troy, N. Y.
DYNAMIC EFFECTS ON ELASTIC SYSTEMS, G. Handelman. Project 9782(806A), Contract AF 49(638)-962; SRE, AFOSR.

The research objectives in this case fall into two general categories: (a) the extension of asymptotic methods for the approximate analysis of vibration and wave motion problems; (b) the analysis of the effects of random elements in elastic systems. One of the objects of this contract is to extend and exploit asymptotic, or singular perturbation, methods for use when the initial stresses are large.

15.67

Rensselaer Polytechnic Inst., Troy, N. Y.
THEORY OF DYNAMIC EFFECTS DUE TO VIBRATIONS AND ELASTIC WAVES IN STRUCTURES, G. Handelman. Project 9782(806A), Contract AF 18(600)-1586; SRE, AFOSR.

The objectives of this investigation were to study the applicability of the techniques of geometrical optics to elastic wave motion and diffraction problems in solids, and in the extension of methods applicable for ordinary loading to the response of composite structures subjected to random loading.

15.68

Rensselaer Polytechnic Inst., Troy, N. Y.
HEAT AND MASS TRANSFER EFFECTS IN SLIDING METAL SYSTEMS LUBRICATED BY SOLID INTERFACIAL FILMS, F. F. Ling. Project 7342(802A), Contract AF 33 (616)-8016; ASRC, ASD.

To investigate interfacial temperatures between two sliding metal surfaces lubricated by a non-metallic solid film. A suitable method is to be derived for computing this temperature and the results are to be verified by experimental measurements. The effect of interfacial temperature on mass transfer phenomena, both diffusion and vaporization, is to be considered. Also, the relationship between interfacial temperature and ambient pressure will be determined both theoretically and experimentally. This problem of vaporization or sublimation of the solid lubricant is of particular importance in practical lubrication under extreme conditions.

15.69

Rutgers U., New Brunswick, N. J.
EARLY DETECTION OF MICRO-CRACKS RESULTING FROM FATIGUE OF METALS, S. Weissman. Project 9763(802A), Contract AF 49-(638)-17; SRPS, AFOSR.

The influence of intersecting slip systems to the formation of voids, the interaction of dislocations and lattice vacancies generated during cyclic stressing, and the effect of stress level will be studied in detail to determine their possible relationships to the fatigue mechanism.

15.70

Southwest Research Inst., San Antonio, Tex.
NONDESTRUCTIVE EVALUATION OF METAL FATIGUE, W. L. Donaldson. Project 9782(806A), Contract AF 49(638)-1147; SREM, AFOSR.

The objectives of this research are: (1) investigate the progress of fatigue damage using magnetic nondestructive sensing techniques; (2) investigate the degree of correlation between nondestructive testing indications and physical changes in the material; and (3) investigate the correlation of theory with the actual metallurgical results and nondestructive test data.

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15.71

Southwest Research Inst., San Antonio, Tex.
REASSMENT OF THE THEORIES OF CREEP BUCKLING, E. F. Stowell, T. Wah. Project 7063(806A), Contract AF 33(657)-8125; ARN, ARL.

It is the objective of this work to discover the basic cause or causes for the difference between theory and experimental results of creep collapse of circular cylinders and to determine what improvements in the theory are needed to bring prediction into closer agreement with experimental data.

15.72

Southwest Research Inst., San Antonio, Tex.
CREEP COLLAPSE OF HEATED, EXTERNALLY PRESSURIZED SHELLS, T. Wah. Project 7063(806A), Contract AF 33(616)-6914.

A theoretical and experimental program is being pursued to analyze the creep collapse of shells in order to gain knowledge of the relationship between the time to failure and the parameters of loading, temperature, material, and end restraints. The theoretical analyses will be checked by an experimental program which will include the performance of necessary material data tests as well as tests of shell specimens.

15.73

Space Recovery Systems, Inc., El Segundo, Calif.
SOFT RECOVERY, T. Knacke. Project 7856(806A), Contract AF 29(600)-2925; SRAS, AFOSR.

The work is directed toward examining techniques suitable for a "soft" land recovery of nonexpendable items highly sensitive to attitude and g-load variations encountered during the various phases of the flight after their release from the booster. In the work accomplished each of a number of pertinent recovery techniques was carefully examined for a realistic choice of parameters affecting the deceleration and the attitude control during flight. On the basis of this survey a recovery technique for a package released from a conventional two stage booster was proposed. Emphasis was placed on utilization of components already proven reliable, which were slightly modified to meet the imposed requirements. As a by-product of this investigation charts displaying velocity and acceleration profiles as well as aerodynamic heating for various load factors and re-entry conditions have been obtained.

15.74

Stanford U., Calif.
THERMAL EFFECTS IN AIRCRAFT STRUCTURES, N. J. Hoff. Project 9782(806A), Grant AF-AFOSR-62-146; SREM, AFOSR.

The present program is quite comprehensive and has a number of research objectives which include (1) the study of creep phenomena, (2) study of buckling of structural elements, and (3) development of structural heating equipment and measuring techniques. For clarity, the work being performed in each of these areas will be described separately. The work presently being conducted in the area of creep phenomena is directed toward explaining the phenomena of primary and secondary creep and includes consideration of creep recovery. Analytical techniques are being developed which show promise of ultimately explaining these phenomena in a more precise (and tractable) form then currently available. Detailed and rigorous mathematical theories for the calculation of the thermal buckling of shell type structures are being developed. The present work is limited to consideration of circular cylindrical shells and thin solid wedge-shaped wing sections. Consideration will be given to the thermal buckling of circular cones and spheres. The work in the area of heating equipment and testing techniques is being directed toward establishing advanced structural test techniques to support theoretical accomplishments. Of particular interest are the techniques to study the onset of edge buckling of solid wedge-shaped wing sections.

15.75

Systems Research Lab., Dayton, Ohio.
STRUCTURAL BEHAVIOR RESULTING FROM CONDITIONS OF EXTREME HEATING, P. Bunce. Project 7063(806A), Contract AF 33(616)-7169; ARN, ARL.

The contractor is performing exploratory structural experiments under conditions of extreme heating utilizing the 200kw induction heating facility of the Aeronautical Research Laboratory. The objective is to gain experience in the application of induction heating to the testing of structures and to establish techniques for the proper simulation of aerodynamic heating. The attainment of realistic distribution of heat throughout a structural specimen is a difficult problem. Completion of this research has been delayed by electrical and mechanical malfunctions of the induction heater and its related control equipment. These malfunctions have been corrected, and a limited study of the characteristics of electromagnetic induction coils is planned.

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15.76

Technion Research and Development Foundation (Israel).
DEPENDENCE OF THE STRENGTH OF METALS ON THE RATE OF STRAIN, M. Reiner. Project 7063(806A), Contract AF 61(052)-304; ARN, ARL.

Systematic experiments are being conducted to determine the dependence of the strength of various metals on the rate of strain. Mathematical relationships between the strain rate and strength of the metal will be developed and correlated with some easily observed property of the metal, such as the logarithmic decrement of free oscillation. The results of the program will be compared with the theory previously developed by Reiner and Wissenberg.

15.77

Technion Research and Development Foundation (Israel).
BUCKLING OF CONICAL SHELLS SUBJECTED TO THERMAL STRESSES, J. Singer. Project 9782(806A), Grant AF-EOAR-62-61; SREM, AFOSR.

The intent of this research is to theoretically investigate the buckling of thin conical shells subjected to (1) uniform hydrostatic pressure and (2) circumferentially and axially varying temperature distributions resulting from aerodynamic heating. It is further intended to obtain solutions for the buckling of thin truncated conical shells using the differential equations derived by Seide which remove the restriction of small cone angles. An experimental study of the critical pressures of thin truncated conical shells under hydrostatic pressure will also be performed.

15.78

Technische Hochschule, Hannover (Germany).
MATRIX METHODS FOR APPLICATION TO VIBRATION PROBLEMS, E. Pestel. Project 9782(806A), Grant AF-EOAR-61-46; SREM, AFOSR.

The research conducted under this contract consists of a theoretical investigation to develop a practical general method for setting up matrix equations, including transfer matrices, for vibration problems of beams, frames, plates and shells involving positive and negative damping. The results of this research may enable the effect of fuselage deflection on the deformation of low aspect ratio wings to be taken into account.

15.79

Technische Hochschule, Hannover (Germany).
STABILITY AND ULTIMATE STRENGTH OF THIN-WALLED COLUMNS, A. Pfluger. Project 9782(806A), Contract AF 61(052)-365; SREM, AFOSR.

The research objectives were to complete the experimental work and to establish the influence of preliminary local buckling and temperature on the failure of a column by Euler buckling.

15.80

Thermomechanics Research Lab., ARN, ARL, Dayton, Ohio.
DESIGN OF REDUNDANT TRUSSES, R. J. Mayerjak. Project 7063(806A), Internal.

The objective of this research is to obtain a better understanding of the weight of redundant trusses subjected to alternative loadings and to develop procedures for their design. The effects of various strength criteria (entirely elastic, yielding with shakedown to elastic, and plastic without shakedown) on the weight of the truss are being studied. Particular attention is being given to the state of stress within the truss at proportions of low weight. The concept of a "fully-stressed" design in the loading history is sometimes useful, but not always attainable.

15.81

Thermomechanics Research Lab., ARN, ARL, Dayton, Ohio.
STRUCTURAL BEHAVIOR UNDER RE-ENTRY HEATING AND LOADING CONDITIONS, R. J. Mayerjak. Project 7062(806A), Internal.

The 200 kw induction heater that is available in the Thermomechanics Research Branch is capable of producing in small structural specimens the heating conditions associated with re-entry. However, due to the nature of induction heating, the distribution of heat produced in the specimen is not satisfactory, and in fact, not even well determined. Therefore, the present research effort is concerned with methods by which the heat distributions may be determined and changed to produce more satisfactory conditions. Present theory, based on limited prior testing, assumes satisfactory heat distributions may be achieved through proper electromagnetic coil configurations. However, as of this date, little experimental data exists to justify these theoretical predictions. Once these predictions have been experimentally verified, then structural behavior under re-entry heating and loading conditions will be investigated.

15.82

Toronto U. (Canada).

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BEHAVIOR OF AEROSTRUCTURES, E. D. Poppleton. Project 9782(806A), Contract AF 49(638)-548; SREM, AFOSR.

The research objective was to investigate the validity of nonlinear damage laws for predicting the failure of hypothetical flight structures. The initial phase of the investigation entailed studying the applicability of the results of small-scale dynamic tests, performed on materials specimens, for determining the values of the components in an analytical expression for a structures damage law, in particular when alternating axial loads are applied to the specimens.

15.83

University Coll., Cork (Eire).
THIN ELASTIC SHELLS, DOUBLE FOURIER SERIES FOR BOUNDARY-VALUE PROBLEMS AND NONLINEAR ELASTICITY, P. M. Quinlan. Project 9752(801A), Grant AF-EOAR-62-43; SRMA, AFOSR.

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.

15.84

Utah U., Salt Lake City.
PRESSURE DEPENDENCE ON MECHANICAL PROPERTIES OF METALS, IONIC AND VALENCE CRYSTALS, P. Gibbs. Project 9760(802A), Contract AF 49(638)-853; SRPS, AFOSR.

The purpose of this research is to study experimentally the pressure, temperature, and imperfection dependence of creep, internal friction, and fracture in a series of metal and ionic and valence crystals. Experiments will attempt to verify current theories of the pressure dependence of vacancy concentration; the critical resolved shear stress for deformation; the transition temperature in materials showing a ductile to brittle fracture transition.

15.85

Vitro Corp. of America, Silver Spring, Md.
ELASTIC SOLIDS VIBRATION STUDIES, D. S. Moseley. Project 9751(801A), Contract AF 49(638)-1148; SRPP, AFOSR.

To obtain arbitrarily exact solutions for the frequencies and particle displacements of the natural vibrational modes in solid, isotropic cylinders of arbitrary dimensions and having friction free surfaces. Solutions will be restricted to those modes in which the displacement functions have axial and radial symmetry. Solutions will be in terms of physically measurable parameters of the material. The approach will be based upon a unique method of relating constants of the arguments of the Bessel and Neumann functions of those trigonometric functions appearing in solutions of the differential equations of motion. Suitable solutions will be tested by a computational and experimental program designed to calculate and measure harmonic frequencies for specific length to diameter ratios. Cylinders having appropriate dimensions will be fabricated of barium titanate or other suitable piezoceramic material. The resonant frequencies will be measured under conditions of very low polarization so that anisotropic elastic responses will be minimum.

15.86

Wisconsin U., Madison.
MECHANISM OF STRESS CORROSION CRACKING FACE-CENTERED-CUBIC METALS, R. A. Dodd. Project 9760(802A), Grant AF-AFOSR-61-68; SRPS, AFOSR.

The process of stress corrosion cracking will be investigated to gain an insight into the mechanisms which are believed responsible: first an initial crack nucleation and second, the subsequent crack propagation. The embrittlement considered necessary for crack nucleation will be investigated for the influence of both electrochemical attack and structural defects on crack nucleation. The question of propagation of stress corrosion cracks will be studied with an emphasis on the effect of the rate of yielding on dislocation velocity. Additional information will be sought for an explanation of the discontinuous nature of propagation and the parameters involved. Specifically the importance of short range order in transgranular stress corrosion cracking in selected face centered cubic alloys systems will be investigated, giving particular attention to propagation. The systems Au-AG, Au-Cu, which contain particularly crack sensitive compositions will be studied.

See also: 3.9, 3.128, 4.70, 4.98, 5.50-51, 6.68, 6.96, 7.57, 8.41, 9.58, 11.50, 12.9, 12.113, 12.119, 12.128, 14.33, 16.15, 16.122, 17.107, 18.37, 23.115

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16. FLUID MECHANICS

Aerothermodynamics; Boundary Layers; Flow Measurement; Free Molecular Flow; Heat Transfer in Aerodynamics; Hypersonic Flow; Interactions Between Two Streams; Mass Transfer Cooling; Particular Shapes in Subsonic and Supersonic Flow; Particular Shapes in Hypersonic Flow; Propagation and Application of Shock Waves; Sound Propagation; Turbulent Shear Flow; Viscous Flow Effects; Vortices.

16.1

Advanced Technology Labs., Mountain View, Calif.
NOVEL TECHNIQUE OF MEASURING VERY HIGH GAS TEMPERATURE, Giedt. Project 7063(806A), Contract AF 33 (616)-7805; ARM, ARL.

Investigations are being made of a two-element temperature probe for the measurement of subsonic and supersonic gas streams over the range from 1000 to 10,000 degrees Kelvin. The two temperature sensing elements are of equal geometry but of different heat capacity. The instantaneous temperature of a stream in which these elements are immersed can be computed from the transient temperatures and rates of change of the temperatures of the sensitive elements. The probes can be made quite small, and used to measure variations in temperature throughout streams of gas or plasma.

16.2

AeroChem Research Labs., Princeton, N. J.
INTERFACIAL RATE PROCESSES IN FLOW SYSTEMS, D. Rosner. Project 9751(801A), Contract AF 49(638)-1138; SREP, AFOSR.

A theoretical research program will be conducted on the effects of interfacial processes in flow systems by the application of boundary layer methods. The program will cover three main divisions, namely: diffusional falsification of interfacial kinetics in isothermal flow systems; diffusional falsification of interfacial kinetics in non-isothermal flow systems; effects of the kinetics of surface reactions on convective energy transfer rates.

16.3

Aeronautical Research Associates of Princeton, N. J.
PROPERTIES OF DRIVEN VORTICES, C. D. Donaldson. Project 9781(806A), Contract AF 49(638)-255; SRE, AFOSR.

Theoretical and experimental investigations are being performed of a vortex flow such that the axial, radial and tangential velocities are to be found as functions of the radial coordinate of the flow. Further theoretical study of more general vortex flow is to be conducted with particular attention to flows in which all components of velocity are time dependent. Experimental investigations will be performed to check the theoretical predictions previously obtained as the motion in driven vortices by the use of vortex chambers. In addition, investigations of the turbulence in two dimensional vortices shall be performed by a method consisting of probing the vortex by means of hot wire anemometry. With this data, the applicability will be determined of a proposed mixing length distribution within two-dimensional vortices with various parameter changes.

16.4

Aeronautical Research Inst. of Sweden.
THREE-DIMENSIONAL FLOW EFFECTS ON THIN WINGS, G. Drougge. Project 9781(806A), Contract AF 61(052)-75; SREM, AFOSR.

The objective of this research effort is to study, both theoretically and experimentally, three-dimensional flow effects on thin wings in supersonic flows of Mach No. 2.5 to 7 with particular emphasis on the effects of scope, cross-wise curvature of wing surfaces, and the effects of non-uniformities in the flow field. The results are to be analyzed in regard to their applicability to flow interference at high speeds.

16.5

Allied Research Associates, Inc., Boston, Mass.
ANALYSIS OF HEAT CONDUCTION AND CONVECTION IN AEROSTRUCTURES, T. R. Goodman. Project 9782(806A), Contract AF 49(638)-839; SRE, AFOSR.

The objective of this research is to investigate transient heat conduction problems using the heat balance integral techniques. These problems are to include finite and multilayer slabs, and problems with polar or spherical symmetry and pulse

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RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEGR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGNR- Ballistics Directorate
ESD- Electronics Systems Division
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type heat flow. This program will also include study of heat flow through boundary layers when the wall temperature is nonuniform and nonsteady, as well as the problem of temperature distribution in solids.

16.6

Applied Mathematics Research Lab., ARM, ARL, Dayton, Ohio.
DETERMINATION OF FORCES AND MOMENTS IN OSCILLATORY SUBSONIC FLOW, H. Pottle. Project 7071(806A), Internal.

The accuracy of the presently available values of lift and moment coefficients for a two-dimensional airfoil, oscillating in subsonic flow, which have been computed by approximation methods, will be verified using existing exact formulations. The range of parameters, usually required for conventional wings will be extended in this computation. The tabulation will be extended to include also chordwise bending effects.

16.7

Applied Mathematics Research Lab., ARM, ARL, Dayton, Ohio.
FUSELAGE SHAPES OF MINIMUM DRAG FOR SUPERSONIC FLOW, K. G. Guderley. Project 7071(806A), Internal.

This problem is concerned with the determination of fuselage shapes of minimum drag in supersonic flow. By choosing a characteristic surface as a control surface for momentum and mass flow, the problem is formulated using the calculus of variations. The variational problem is finally reduced to the solution of a system of ordinary differential equations and the construction of a flow field by means of the method of characteristics. The initial variational problem is modified to incorporate a shock wave determined by the blunt nose.

16.8

Applied Mathematics Research Lab., ARM, ARL, Dayton, Ohio.
VISCOUS FLOW BETWEEN TWO ROTATING DISKS, K. Pohlhausen. Project 7071(806A), Internal.

Considered in this effort is the viscous flow between two parallel disks that rotate in the same direction with constant angular velocity. The flow enters the space between the disks at a finite radius. By frictional forces it is set into rotation and the centrifugal forces then cause a pressure build up in the radial direction. Thus, such an arrangement can be used as a pump.

16.9

Applied Mathematics Research Lab., ARM, ARL, Dayton, Ohio.
SPECIAL ASPECTS OF THERMODYNAMIC PROBLEMS, A. N. Tifford. Project 7071(804A), Internal.

Present research efforts are concerned with mass transfer cooling in hypersonic flow, analysis of jet mixing and wake studies. The present investigation correlates heat transfer phenomena obtained for cooling gases of different molecular weight and shows the physical causes of the high effectiveness of coolants with low molecular weight. At present a study is being accomplished of the mixing of jets lying in different planes and forming a cross flow. Significant ionization effects occur in the wake of a missile that enters the atmosphere. A theoretical study of such effects has been initiated.

16.10

Arizona U., Tucson.
DETERMINATION AND MEASUREMENT OF SMALL ANGULAR DEFLECTIONS, E. L. Morrison. Project 7856(806A), Contract AF 29(600)-2907; SRAS, AFOSR.

The effort is directed toward examining the penetration process of a light beam through shock layers in the Mach number range from 1 to 4. The investigation was initiated to determine whether or not nonlinear optics must be applied when small orientation changes in the order of 1 second of arc are being measured. Another objective of this effort is the comparison of various promising techniques suitable for detecting and recording of small orientation changes in systems suspended in fast moving objects and subjected to high accelerations.

16.11

Armour Research Foundation, Chicago, Ill.
VIBRATIONAL RELAXATION OF SOME DIATOMIC GASES, W. Roth. Project 9730(801A), Contract AF 49(638)-1136; SREP, AFOSR.

Using a shock tube with associated spectroscopic equipment, experimental research will be performed in the measurement and interpretation of vibrational relaxation in excited electronic states of N_2 and CN. Results will be applied to and correlated with observations reported in the literature on the chemical kinetic and spectroscopic behavior of these molecules in the upper atmosphere and in flames.

16.12

Aerospace Surveillance Sciences Lab., CRR, AFCRL, Bedford, Mass.

AFOSR- Air Force Office of Scientific Research
MA- Directorate of Research Analysis
NM- Directorate of Chemical Sciences
PH- Directorate of Engineering Sciences
MP- Directorate of Information Sciences
LS- Directorate of Life Sciences
MA- Directorate of Mathematical Sciences
PP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRE- Computer & Mathematical Sciences Lab
CRRE- Electronic Materials Sciences Lab
CRRE- Electromagnetic Materials Lab
CRRE- Aerospace Instrumentation Sciences Lab
CRRE- Propagation Sciences Lab
CRRE- Communications Sciences Lab
CRRE- Control Sciences Lab

CRE- Geophysics Research Directorate
CRZA- Photochemistry Lab
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CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
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CRZR- Sacramento Peak Observatory

ODATION COEFFICIENT, R. Murphy. Project 5633
, Internal.

fort is being initiated in order to supplement
oretical analysis involving the solution of
ltzmann transport equation. The perimental
m involves the regime between free molecular
ntinuum flow as it applies to the particle
y surrounding orbiting space vehicles. The
tion of the vehicle traveling through space
e made by allowing controlled particle den-
to enter an evacuated glass enclosed region
appropriate velocity and to impinge on the
ed body enclosed therein. By suitable probing
ques, the particle distribution function may
/ be determined.

elle Memorial Inst., Columbus, Ohio.
TY OF AIR AT LOW TEMPERATURES AND PRESSURES,
Goldthwaite. Project 8951(806A), Contract AF
-933; AEOR, AEDC.

cosity of air in the gaseous state will be
d in the temperature range from 75°R to 2000°R
pressures from 0.001 psia to atmospheric pres-
An oscillating disk viscometer will be used,
s obtained in the slip-flow regime extrapol-
obtain true viscosity. An attempt will be
correlate the measured values with empirical
ns which have been established at higher tem-
es and pressures.

Beranek and Newman, Inc., Cambridge, Mass.
OF SOUND AND SHEAR FLOW, P. Jackson.
A), Contract AF 33(616)-8001; ARH,

be performed to bring to light some
al parameters involved in the inter-
flow with an external oscillatory
s a surface vibration or a sound
l be closely controlled to deter-
reaming patterns can be made useful
undary layer control by virtue of
ial changes to the velocity profile.
search will also be conducted on the
stics of a sphere exposed to flow
intensity, complex sound waves.

vidence, R. I.
OW PROBLEMS, M. Holt. Project 9781
t AF 49(638)-232; SRE, AFOSR.

Research under this contract is directed mainly to the theoretical investigation of non-linear aspects of gas dynamics. Numerical techniques for solving non-linear problems are developed including the method of characteristics, for purely supersonic flow problems involving two or three independent variables, and methods for solving mixed elliptic hyperbolic problems. Particular attention is given to the linearized method of characteristics which can be used to estimate finite span effects on thick supersonic wings, and stability or flutter characteristics of supersonic non-slender bodies of revolution. Particular problems being investigated include supersonic flow past double-wedge section wings of variable thickness, stability derivatives of non-slender supersonic cones, supersonic panel flutter of cylindrical shells, and supersonic flow past flat-headed cylinders.

16.16

Brown U., Providence, R. I.
EFFECTS OF FREE STREAM TURBULENCE AND OSCILLATION ON HEAT TRANSFER AND SURFACE DRAG, J. Kestin. Project 7063(806A), Contract AF 33(616)-7749; ARH, ARL.

Experimental and analytic research will be conducted on the effects of free-stream turbulence and free-stream oscillations on the shearing stresses and rates of heat transfer across laminar and turbulent boundary layers and wakes (separated regions), with and without pressure gradients. Some earlier work on cylinders and flat plates will be repeated, using a newly developed transistorized hot-wire anemometer for greater accuracy. A systematic, analytic study of the effect of free-stream oscillations on the velocity field and temperature field in an incompressible boundary layer will be made.

16.17

Brown U., Providence, R. I.
DEVELOPMENT OF LINEARIZED TRANSONIC AND SUPERSONIC THEORY, P. P. Maeder. Project 9781(806A), Contract AF 49(638)-444; SRE, AFOSR.

Theoretical and experimental transonic and supersonic studies were made: (a) into the flow about slender bodies and bodies of revolution in order to extend the present linearized flow theory for such problems as wind tunnel interference and pressure distributions on rear portions of fuselages; (b) to determine the influence of large scale vorticity on recovery temperatures in boundary layer and separated regions; (c) on the interference effects of wing-body combinations; and (d) to predict the dynamic behavior of bodies and wings.

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ASD- Aeronautical Systems Division
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SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESHR- Operational Applications Lab

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16.18

Brown U., Providence, R. I.
THERMAL AND AERODYNAMIC CHARACTERISTICS AT HYPERSONIC SPEEDS, R. F. Probstein. Project 7064(806A), Contract AF 33(657)-7215; ARR, ARL.

The contractor is to perform a theoretical investigation of low density hypersonic aerothermodynamic phenomena related to atmospheric re-entry flight. The objective of the studies will be (a) to clarify the existing differences between the various vorticity interaction theories, (b) to determine the "hot core" effects on the blunted slender body pressure distribution, (c) to develop a "logical similarity" technique for solving both the incipient merged and merged layer flows near the nose of slender aerodynamic configurations, (d) to determine how relaxation effects modify the concept of shock wave development in a rarefied flow, (e) to develop simple models, based on kinetic theory, of scattering to circumvent the difficult task of applying the Boltzmann equation to calculate rarefied flows about practical aerodynamic bodies, and (f) to investigate the importance of electro-hydrodynamic drag and lift forces by means of collision-free and near collision-free concepts.

16.19

California Inst. of Tech., Pasadena.
HYPERSONIC AERODYNAMICS AND MAGNETOGASDYNAMICS, J. Cole. Project 9781(806A), Grant AF-AFOSR-62-184; SREM, AFOSR.

The principal objective of research carried out under this contract is the development of analytical methods for the calculation of air flows around vehicles flying at hypersonic speeds. At first, perfect non-viscous, non-reacting flows are considered and afterward the various real gas effects are introduced.

16.20

California Inst. of Tech., Pasadena.
VISCOUS EFFECTS AND HEAT TRANSFER IN SEPARATED FLOWS, L. Lees. Project 9781(806A), Grant AF-AFOSR-62-29; SREM, AFOSR.

A theoretical study is being made of the general problem of separating and reattaching laminar boundary layers in supersonic flow. The work is aimed at obtaining a reliable theory, within the framework of boundary layer approximations, for the detailed structure and behavior of separated flows subject to considerable variations of free stream Mach number and Reynolds number.

16.21

California.U., Berkeley.
THREE DIMENSIONAL PROBLEMS OF SUPERSONIC AND HYPERSONIC FLOW AND PANEL FLUTTER OF CYLINDRICAL SHELLS, M. Holt. Project 9781(806A), Grant AF-AFOSR-62-277; SREM, AFOSR.

The purpose of this research is to improve existing methods and develop analyses for calculating three dimensional fields of hypersonic or supersonic flow. An analysis of the supersonic flow past cones at large angles of yaw will be undertaken. The method of integral relations will be used in this analysis. Panel flutter of cylindrical shells of finite length will be investigated. In supersonic flow past flat-headed cylinders and other blunt nosed bodies of revolution with sharp corners, a local region of separation is frequently formed behind the sharp sonic corner. This boundary layer phenomenon of local separation in transonic flow will be analyzed theoretically.

16.22

California U., Berkeley.
DETERMINATION OF LOCAL SKIN FRICTION AND INDUCED PRESSURE IN SLIP FLOW, G. F. Maslack. Project 7064(806A), Contract AF 33(616)-6161; ARR, ARL.

This research program is to determine the local skin friction distribution on a sharp leading edge flat plate in the so-called strong interaction flow regime. This investigation involves the direct measurement of the drag force on a small floating element situated in a comparatively large flat plate model. The second program being carried out under this contract is concerned with the determination of the local heat transfer coefficients and surface pressure for blunt bodies in the so-called vorticity interaction range of flow conditions.

16.23

California U., Berkeley.
DETERMINATION OF LOCAL SKIN FRICTION AND INDUCED PRESSURE IN SLIP FLOW, G. F. Maslack. Project 7064(806A), Contract AF 33(651)-8607; ARR, ARL.

The skin friction and heat transfer investigation of basic aerodynamic bodies will be continued in the new operating range of the modified wind tunnel. Local heat transfer measurements will be made on hemisphere-cylinder models utilizing the transient technique as described in NACA Report No. 1323, 1957. Attempts will be made to minimize the uncertainty of property values of the model by machining the thin-wall structures. A new model cooling technique will be attempted so that the end result would be an establishment of the validity and usefulness of the thin-wall model method. More complicated geometries will then be utilized to further exploit the developed

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CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
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technique. Local skin friction measurements will be extended to a wider range of geometry, Mach and Reynolds number conditions.

16.24

Case Inst. of Tech., Cleveland, Ohio.
FLOW, HEAT TRANSFER, AND STABILITY OF CONFINED FLUIDS SUBJECT TO BODY FORCES, S. Ostrach. Project 9781 (806A), Grant AF-AFOSR-62-44; SREM, AFOSR.

The theoretical and experimental research being conducted under this program is being directed along two lines. The first is to define the basic parameters and then to predict and determine the flow and heat transfer characteristics of confined and interacting fluids subject to body forces. The second is to find the influence of geometrical, flow, and thermal end conditions on the unstable type of flow driven by body forces. Now under investigation is the particular case of determining the transient behavior and configuration of liquids which fill only part of a container, as the gravity force is decreased towards zero or increased significantly by rapid acceleration.

16.25

Catholic U. of America, Washington, D. C.
FLOW SEPARATION, P. K. Chang. Project 9781(806A), Grant AF-AFOSR-62-80; SREM, AFOSR.

This attempt is being made to relate and analyze the many diverse theoretical and experimental results on flow separation which have been published to date.

16.26

Centre National d'Etudes (Belgium).
LAMINAR BOUNDARY LAYER SEPARATION IN SUPERSONIC FLOW, J. J. Ginoux. Project 9781(806A), Grant AF-EOAR-62-52; SREM, AFOSR.

Studies are being made to further the understanding of separated flows. Theoretical and experimental work is planned to determine the flow model and heat transfer. The effect of three-dimensional perturbations and the reattachment process in the heat transfer will be investigated.

16.27

Cincinnati U., Ohio.
HYPERSONIC REAL GAS FLOW PROBLEMS, T. Y. Li. Project 9781(806A), Grant AF-AFOSR-62-210; SREM, AFOSR.

The contractor proposes to study the effect of real gas phenomena, i.e., dissociation and possibly ionization, on the hypersonic flow stream for both equilibrium and non-equilibrium flow conditions. From these studies, lift and drag coefficients for bodies of arbitrary cross section will be computed.

16.28

Columbia U., New York.
HEAT TRANSFER WITH VARIABLE FLUID PROPERTIES AND FLOW CURVATURE, H. G. Elrod, G. S. Longobardo. Project 9781(806A), Contract AF 49(638)-1001; SREM, AFOSR.

By use of an experimental apparatus consisting of a rotating, hot cylinder within a concentric, stationary cool cylinder, a study of heat transfer with variable fluid properties and flow curvature will be made. Traverses of total pressure, density and turbulence intensity will be made. In addition, surface pressures and temperatures and overall heat transfer will be measured. The data to be taken will permit the determination of overall heat-transfer coefficients, wall shear stresses, velocity and temperature distributions, and the distributions of the eddy diffusivities of momentum and heat. From the time-mean data and the semiquantitative turbulence measurements it is intended that further clarification of the flow structure in turbulent, variable property, curved flow will be obtained.

16.29

Compagnie d'Etudes et de Recherches Aeronautiques (France).
CONTROL OF CIRCULATION AROUND A CIRCULAR CYLINDER, J. Brocard. Project 9781(806A), Contract AF 61(052)-333; SREM, AFOSR.

The contractor is investigating the circulation around a porous cylinder to obtain information leading to the control of the rear stagnation point for the purpose of achieving the maximum lift coefficient. A systematic study of the parameters which influence separation will be made under a wide range of Reynolds numbers and mass flows. Tests will be made in a water tunnel and the wind tunnel at the Institut Aeronautiques de Saint-Cyr, of a porous circular cylinder which is designed to provide either suction or blowing to control the boundary layer. Measurements of the lift and drag will be made on a balance in the wind tunnel as well as pressure distributions over the cylinder. Flow visualization studies will be made in the water tunnel.

16.30

Cook Electric Co., Morton Grove, Ill.
DYNAMICS OF SEPARATING BODIES IN BALLISTIC TRAJECTORIES, PHASE I, R. O. Fredette. Project 7856 (806A), Contract AF 29(600)-1711; SRAS, AFOSR.

It is the purpose of this research effort to develop

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
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ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

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general prediction methods for separation processes on high speed missiles. The first part of the work consists of a fundamental theoretical analysis considering different separation and ejection modes in super and hypersonic flow fields.

16.31

Cook Electric Co., Morton Grove, Ill. DYNAMICS OF SEPARATING BODIES ON BALLISTIC TRAJECTORIES, PHASE II, R. O. Fredette. Project 7856 (806A), Contract AF 29(600)-2956; SRAS, AFOSR.

This research is a continuation of the work under the program, "Dynamics of Separating Bodies," Phase I. Its purpose is to investigate the influence of the relative motion on the flow field of capsules ejected from missiles flying at super and hypersonic speeds. This new information will be used to confirm or correct the theoretical prediction methods for ejection trajectories and the dynamic behavior of ejected capsules established under Phase I.

16.32

Cornell Aeronautical Lab., Inc., Buffalo, N. Y. HYPERSONIC FLOWS OF NITROGEN AND AIR OVER SLENDER BODIES, J. G. Hall. Project 8761(806A), Contract AF 40(600)-928; AEOR, AEDC.

An experimental and theoretical study will be made of the flow of nitrogen and air over slender bodies. The studies will include stagnation temperatures in the range 5,000°K to 8,000°K and Mach number of 20 to 25. Particular attention will be given real-gas and viscous interaction phenomena. The experimental program will entail heat-transfer, pressure, and force measurements on the simple models. It will include the effects of the slender bodies at high angles of attack.

16.33

Cornell Aeronautical Lab., Inc., Buffalo, N. Y. NONEQUILIBRIUM FLOWS, J. G. Hall. Project 9781 (806A), Contract AF 49(638)-792; SREM, AFOSR.

Research under this contract is concerned with the theoretical and experimental study of nonequilibrium flows. Specifically, the emphasis in the present program is on experimental and theoretical study of chemical nonequilibrium in expanding flows at high temperature. The present experiments involve measurement of nonequilibrium static pressure distributions in supersonic nozzle flows of dissociated diatomic gases. A shock tube is used to generate a reservoir of hot dissociated test gas sufficient for a nozzle-flow duration of several milliseconds. Spectroscopic studies are planned for determination of temperature and gas composition. The theoretical study utilizes a computer program developed at CAL to investigate the effects of coupled rate processes in such nonequilibrium expanding flows.

16.34

Cornell Aeronautical Lab., Inc., Buffalo, N. Y. HIGH-TEMPERATURE PHENOMENA IN HYPERSONIC FLOWS, A. Hertzberg. Project 9781(806A), Contract AF 49(638)-952; SRE, AFOSR.

The objective of this research effort is (1) to extend previous ideal-gas research to lower densities in both theoretical and experimental studies, and (2) to investigate nose bluntness and boundary-layer displacement effects on a flat plate under real-gas conditions. The objective in the ideal-gas research is to extend previous work in order to experimentally establish the upstream limit of strong interaction theory, to investigate the viscous-layer regime wherein viscosity dominates throughout the entire region between the shock wave and the body, and to study the approach to free-molecular flow where slip effects appear. The purpose of the real-gas research is to investigate the additional effects stemming from thermochemical nonequilibrium processes in the flow field of a flat plate, and more particularly to experimentally investigate the effects of flow nonequilibrium subject to large boundary-layer displacement effects. The interest is to check theoretical scaling laws, to investigate their range of validity, and to obtain a quantitative measure of the nonequilibrium effects. As in the previous research, the emphasis is on the flat plate problem with both a blunted and a sharp leading edge.

16.35

Cornell Aeronautical Lab., Inc., Buffalo, N. Y. HYPERSONIC FLOW BY MEANS OF THE SHOCK TUNNEL, A. Hertzberg. Project 9781(806A), Contract AF 18(603)-10; SRE, AFOSR.

The shock tunnel was developed and used as a tool for the study of high temperature air flows. The shock tube was successfully modified to incorporate a tailored-interface technique so as to eliminate attenuation and provide longer flow times. Transition, relaxation, dissociation, heat-transfer, and other related physico-chemical phenomena, were studied.

16.36

Cornell Aeronautical Lab., Inc., Buffalo, N. Y. BOUNDARY LAYERS IN HIGH-TEMPERATURE FLOWS, A. L. Myerson. Project 9781(806A), Contract AF 49(638)-782; SREM, AFOSR.

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A combined theoretical and experimental attack on the general problems of the behavior of boundary layers in high temperature gas flows. In particular the research concentrates on the effects of catalytic wall heat transfer effects through a dissociated or ionized gas. The catalytic efficiency for heat transfer of various materials for the wall will be investigated under varying conditions of chemical non-equilibrium at the surface. The present aim is to study the effects of lags in the oxygen recombination processes by studying the difference in surface heat transfer rates and the behavior of catalytic and non-catalytic surfaces.

16.37

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
MINIATURE ENTHALPY PROBE FOR GAS STREAMS OF EXTREMELY HIGH TEMPERATURE, G. A. Sterbutzel. Project 7063 (806A), Contract AF 33(657)-7774; ARM, ARL.

The purpose of this research is to establish a technique for measuring the enthalpy of extremely high temperature gases in the range from 9000°R to 16,000°R at high heat fluxes. A prototype miniature probe will be designed, built, and tested in known temperature gas streams and then in an arc environment. A research probe based on the final prototype design will be calibrated and delivered to the Aeronautical Research Laboratory.

16.38

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
THERMO-AERODYNAMIC CHARACTERISTICS AT HYPERSONIC SPEEDS, C. E. Witcliff. Project 7064(806A), Contract AF 33(616)-7812; ARR, ARL.

Both aerodynamic and aerothermodynamic research on basic hypersonic configurations at hypersonic speeds are being investigated. This investigation is both theoretical and experimental in nature and will involve flight conditions in the continuum and rarefied gas regimes. The experimental portion of the program will be carried out in the C.A.L. 11" x 15" hypersonic shock tunnel and other laboratory test facilities. In particular, the contractor will study the following problem areas: (1) continuum flow about axisymmetric and lifting bodies, (2) rarefied gas dynamics at hypersonic speeds, and (3) wake structure studies at hypersonic flight conditions.

16.39

Cornell U., Ithaca, N. Y.
HIGH-SPEED AERODYNAMICS, W. R. Sears. Project 9781 (806A), Grant AF-AFOSR-62-201; SREM, AFOSR.

The grantee will perform theoretical and experimental investigations in the field of high-speed aerodynamics under the following broad subdivisions: (a) three-dimensional effects in axial compressors and turbines. The overall objective will be to provide a better understanding of, and design procedures for, high-speed compressors and turbines, especially those operating in the transonic and supersonic regimes; (b) three-dimensional and unsteady effects in flows of small viscosity. These investigations will constitute extensions of familiar boundary-layer theory into three-dimensional and unsteady situations and into the rarefied-gas regime where the concept of a boundary layer is not usually applicable; and (c) the dynamics and magneto-dynamics of high-temperature gases. Here the grantee is studying magnetogasdynamic effects both from the standpoint of optimizing propulsion schemes and, more generally, in an effort to identify the phenomena that occur in magnetohydrodynamics, with the view towards indicating those phenomena of importance to engineering applications which may occur in high speed flight of aircraft missiles and space vehicles.

16.40

Dartmouth Coll., Hanover, N. H.
INTERACTIONS BETWEEN ELECTRIC ARCS AND GAS FLOWS IN THE ANODE SHEATH REGION, R. C. Dean. Project 7116 (801A), Contract AF 33(657)-8179; ARM, ARL.

An analytical and experimental study of the electrical conduction, heat transfer, and flow behavior of a moving, high pressure plasma in contact with a cooled anode will be made. The purpose of the work is to identify, measure, and analyze insofar as possible the significant modes of flow, electrical conduction from the plasma to the anode, and heat transfer and to determine the criteria for transition from one mode to another.

16.41

Detachment 4, ASD, Eglin Air Force Base, Fla.
SHOCK INTERACTION PROJECTION TECHNIQUES, F. E. Howard. Project 9860(806A), Internal.

A new experimental technique for the projection of hypervelocity particles was originated in an explosive driven expendable shock tube in which an interaction of shocks projected the particles. It is planned to explore the technique further in the search for repeatable particle velocities in the region of 50,000 to 60,000 fps.

16.42

Detachment 4, ASD, Eglin Air Force Base, Fla.
VARIATION OF AERODYNAMIC COEFFICIENTS OF A SIMPLE BODY OVER AN EXTREME MACH RANGE, F. E. Howard. Project 9860(806A), Internal.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
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Proceeding from previous in-house wind tunnel tests over a range of Mach 0.5 to 20, at angles of attack from 0 °to 90°, and over a wide range of Reynold's numbers, simple elliptical idealized wings (of Aspect Ratio 1, or circular in planform) are being boosted into free flight by three-stage in-house rockets assembled from overage standard motors available at no cost. Free flight data to correlate with tunnel data, and new dynamic stability coefficients, are being taken in the stable, no-lift attitudes by telemetry and electronic tracking at Mach 3 to 5 and down to impact in the Gulf Range. Subsequent work is in attitudes of small lift and at higher velocities to Mach 10 and 15 as funds permit procurement of longer burning third stages of low cost commercial motors or an alternative in-house fourth stage. Re-entry research vehicle application studies of this data continue in-house.

16.43

Directorate of Research Analysis, SRAS, AFOSR, Washington, D. C.
OPTICAL TECHNIQUES RESEARCH, W. Woehl. Project 7856 (806A), Internal.

Research is planned leading to the improvement of procedures and of pertinent equipment to analyze and evaluate flow phenomena at high speeds and altitudes. Experimental verification of the relative merits of the various procedures is a part of this program.

16.44

Dynamic Devices, Inc., Dayton, Ohio.
NEW ELECTRICAL HEATING TECHNIQUE FOR HYPERSONIC WIND TUNNELS, R. S. Hayes. Project 7065(806A), Contract AF 33(657)-7957.

The objective of this research is to obtain an electrical resistance heater capable of heating high pressure flowing air to temperatures up to 2800°R at a mass flow of 0.1 lb/sec and a pressure of 1000 psig. A theoretical analysis will be made and then a test model will be designed, fabricated, and its performance evaluated in the ARL 3-inch pilot hypersonic wind tunnel.

16.45

Eastern Research Group, New York.
AERO-THERMODYNAMIC STUDY OF THE FORCES OBTAINABLE BY DEFLECTION OF PROPULSIVE JETS, L. Meyerhoff. Project 9781(806A), Contract AF 18(600)-1530; SRE, AFOSR.

Forces obtained by deflection of the propulsive jet were investigated as a possible means of augmenting the control of jet aircraft. Emphasis was given to its use at lower speed, for example, thrust reversal. In addition, this study has considered jet propulsion for steering, jet and "forced" lifts to permit flights below the normal stalling speed, and thrust modulation of jet deflection. Detailed designs and drawings of a wind tunnel model have been prepared. This model is being tested in the two foot by two foot WADC (Aircraft Lab.) supersonic tunnel. Information concerning the changes in forces and moments caused by deflecting a jet exhaust from the usual rearward direction to a forward direction is being obtained.

16.46

Electro-Optical Systems, Inc., Pasadena, Calif.
INTERACTIONS BETWEEN ELECTRIC ARCS AND GAS FLOWS, G. Cann. Project 7116(801A), Contract AF 33(657)-7940; ARN, ARL.

The objective of this research is to further the understanding of the basic energy exchange phenomena between "convection cooled" electric arcs and their environment through a systematic analytical and experimental study of the fundamental interaction phenomena involved. This involves the construction and calibration of a constructed arc apparatus suitably instrumented to measure essential parameters (voltage gradient, pressure gradient, heat dissipation, etc.) of an arc column in a coaxial gas flow, experimental measurements to locate the different regimes of the flow column interaction and to determine the mean gas enthalpy of the asymptotic column regime as a function of the flow arc parameters, the calculation of transport coefficients (electrical and thermal conductivity) for at least two typical gases, and the calculation of theoretical voltage-current characteristics.

16.47

Flight Sciences Lab., Inc., Buffalo, N. Y.
HYPERSONIC AND RE-ENTRY VEHICLES, J. Isenberg. Project 7064(806A), Contract AF 33(616)-7203; ARF, ARL.

A survey and analysis of the conditions of flight to be encountered by lifting-type vehicles either upon re-entering the earth's atmosphere or in gliding at hypersonic speeds through the atmosphere are being conducted. The objective is to obtain an indication of effects of configuration parameters on the significant aerothermodynamic characteristics of such vehicles. Adverse flow phenomena and anomalies are to be singled out, and if possible, defined.

16.48

Flight Sciences Lab., Inc., Buffalo, N. Y.
SIMULATION OF HYPERVELOCITY AEROPHYSICAL PHENOMENA, J. Isenberg. Project 9781(806A), Contract AF 49(638)-1145; SREM, AFOSR.

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CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
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CRZI- Ionospheric Physics Lab
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An analytical study to clarify the general similarity laws of hypersonic flow and determine, where possible, reduced approximate "practical" similarity requirements and parameters. The significant problems (types and areas) associated with each of the various classes of hypervelocity vehicles, particularly lifting vehicles, will be covered with emphasis on the range of critical flights conditions. This study also includes evaluation of the capabilities and inherent limitations, including data acquisition, of the various types of laboratory facilities to provide the required partial or complete simulation for the various significant classes of problems.

16.49

Fluid Dynamics Facilities Lab., ARF, ARL, Dayton, Ohio.
TEMPERATURE, PRESSURE, VELOCITY, FORCE AND DENSITY MEASURING DEVICES, D. H. Murray. Project 7065(806A), Internal.

This work is concerned with the investigation of problems associated with taking physical measurements under a wide range of conditions. Included are methods for measurement, size of measuring device, read-out equipment, recording devices, and auxiliary equipment necessary for the determination of the temperature, pressure, density, velocity and dynamic forces in gas dynamic processes, particularly under high-temperature conditions.

16.50

Fluid Dynamics Facilities, ARF, ARL, Dayton, Ohio.
HYPERSONIC FLOW TECHNIQUES, E. J. Walk. Project 7065(806A), Internal.

Theoretical investigations and studies will be performed in real gas effects that play an important role in the high temperatures necessary for hypersonic flow simulation. General aerodynamic characteristics such as boundary layer growth, shock wave interactions, dissociation, ionization, and recombination effects will be studied.

16.51

Franklin Inst., Philadelphia, Pa.
CREATION OF TECHNOLOGY FOR GAS LUBRICATED BEARINGS, D. D. Fuller. Project 9781(806A), Contract NONR 2342(00); SREM, AFOSR.

A basic research program of both analytical and experimental nature is being made to determine the fundamental behavior of, and to develop a technology for, gas-lubricated bearings. The ultimate objective is to make the proper designing of both self-lubricated and externally pressurized gas bearings a matter of using the data taken from a handbook of design curves. Studies are being made: (1) to locate, collect, and evaluate available literature; (2) to determine the state of the art; (3) to establish liaison with other groups working on similar problems, and keep abreast of latest developments in the field; (4) to make theoretical analysis of gas bearing phenomena; (5) to obtain experimental verification of the theories advanced; and (6) to coordinate and disseminate all the above information to interested parties in the form of reports, technical papers and conferences.

16.52

General Applied Sciences Lab., Hempstead, N. Y.
AERODYNAMIC NOISE, L. Arnold. Project 9781(806A), Contract AF 49(638)-194; SRE, AFOSR.

The objective of this research is to obtain a better understanding of the important mechanisms operative in the generation and propagation of sound in subsonic and supersonic air jets. The approach being taken in the case of the subsonic jet is to develop analytical and numerical techniques for prediction of the near and distant sound pressure and directionality field due to a harmonic singularity localized in the jet, and then to generalize for source distributions with power spectral distribution compatible with the velocity and pressure fluctuations of the turbulent jet flow. Suitable experiments are being considered which could check selected aspects of the analytical work. In the case of the supersonic jet the approach of this research is to study the elements in the acoustic and aerodynamic feedback loop creating discrete frequency sound and of the apparent mechanism of transfer of energy from broad band to discrete frequencies.

16.53

General Dynamics Corp., San Diego, Calif.
FLOW SIMULATION IN HYPERSONIC VELOCITY FACILITIES, H. Yoshihara. Project 8951(806A), Contract AF 40(600)-971; AEOR, AEDC.

Test section conditions typical of those expected in advanced hypervelocity facilities will be determined using an existing non-equilibrium nozzle flow computer program. The inviscid and viscid flow over a series of slender wedges will be obtained numerically for the typical non-equilibrium free stream and an equivalent equilibrium free stream. Comparisons of the aerodynamic characteristics will be made to determine the effects of aerodynamic testing in the non-equilibrium free stream. Also, the stagnation point flow for a sphere will be computed for the same free stream conditions as above. From these results it will be possible to determine the adverse effects of aerodynamic testing in a non-equilibrium

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ARR- Hypersonics Research Lab
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ARZ- Metallurgy & Ceramics Research Lab
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ASRNE- Electronics Technology Lab
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RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEOR- Research Division
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SWR- Research Directorate
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free stream, and possible ways to minimize these effects.

16.54

General Electric Co., Cincinnati, Ohio.
HIGH TEMPERATURE HEAT TRANSFER FROM GASES TO CYLINDERS AND NOZZLES, M. L. Ghai. Project 9781(806A), Contract AF 49(638)-243; SRE, AFOSR.

To perform experimental and theoretical studies to obtain basic knowledge of heat transfer from gas flows to surfaces of various shapes such as nozzles, circular cylinders and flat plates at gas temperatures above 2000°F and pressures from 15 (or lower) to 750 psi. Plasma generators will be utilized to heat the gas to the temperatures required. The studies will include determination of thermodynamic and electrical properties of gases at high temperatures and will also include the effects of magnetic fields on heat transfer.

16.55

General Electric Co., Cleveland, Ohio.
INTERACTIONS BETWEEN ELECTRIC ARCS AND GAS FLOWS IN THE CATHODE SHEATH REGION, T. H. Lee. Project 7116 (801A), Contract AF 33(657)-8206; ARN, ARL.

The research involves a basic study of the interactions between electric arcs and gas flows, particularly in the cathode sheath region. Attempts shall be made to formulate a unified theory for the entire cathode region, from electrode to positive column, by integrating the knowledge of heat transfer mechanisms, electron emission processes, mass flow, heat flow into the cathode, etc., obtained from theoretical and experimental study.

16.56

General Electric Co., Philadelphia, Pa.
DIRECT MEASUREMENTS OF THE MOLECULAR VELOCITY DISTRIBUTION FUNCTION, E. P. Muntz. Project 9781(806A), Contract AF 49(638)-1152; SREM, AFOSR.

The purpose of this research is to develop an experimental technique for the measurement of the molecular velocity distribution function at any point in a flowing low density gas. The procedure is to use a beam of high energy electrons to excite emission from the atoms or molecules at a point in the flow. The emission will be observed with a Fabry-Perot spectrometer in order to obtain the Doppler profile of one of the emission lines. The Doppler profile will be a direct measure of the shape of the distribution function in the direction of observation. More specifically, the experiments will include the following static tests: (1) measure the Doppler profile of the helium line λ 6678.149 Å for three representative temperatures; and (2) with the establishment of the experimental technique, probe with the electron close to a heated plate in helium in which the pressure can be varied.

16.57

General Electric Co., King of Prussia, Pa.
HIGH ALTITUDE SHOCK WAVE STRUCTURE, S. Scala. Project 9781(806A), Contract 49 (638)-1157; SREM, AFOSR.

The primary objective of the research program, which involves both theoretical and experimental work on shock-wave structure, is to develop a better understanding of the structure of shock waves produced by vehicles travelling at hypersonic speeds in the high altitude regime of the earth's atmosphere, wherein the mean free path of the gaseous molecules is sufficiently large so that the shock wave which forms cannot be treated as a mathematical discontinuity, as it can at the lower altitudes where the mean free paths are small. The objective of the experimental program is to obtain ionization rates and other pertinent quantitative physical chemical data to supplement and verify the theory.

16.58

General Electric Co., Schenectady, N. Y.
TWO-PHASE FLOWS, N. Zuber. Project 9781(806A), Contract AF 49(638)-1153; SREM, AFOSR.

This is a theoretical and experimental study of the dynamics of two-phase flows. Included in this investigation will be an attempt to understand and determine the interactions between continuity and pressure waves.

16.59

Georgia Tech. Research Inst., Atlanta, Ga.
ACOUSTIC VIBRATIONS ON HEAT TRANSFER, T. W. Jackson. Project 7063(806A), Contract AF 33(616)-8396; ARN, ARL.

The physical effect of resonant acoustic vibrations on the forced flow heat transfer coefficient for air flowing in ducts is being studied by means of flow visualization. Experimental equipment previously used under the previous contract will be modified to obtain more detailed information about the flow structure mechanisms which produce significant increases in heat transfer under resonant acoustic internal flow conditions. Where feasible, parameters will be selected so that correlation with other research will be possible. Efforts will be made to develop a theory explaining the phenomena involved, based upon experimental studies.

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16.60

Hermann Foettinger Inst. fuer Stroemungstechnik, Berlin (Germany).
GROWTH OF TURBULENT FLUCTUATIONS IN FREE SHEAR FLOW, R. Wille. Project 9781(806A), Contract AF 61(052)-412; SREM, AFOSR.

This is an investigation of the mechanism of transition and turbulence in free shear layers. The primary area of concern is three dimensional phenomena. The contractor will be probing into the growth and stabilization of vortices leading to turbulence. The study is primarily an experimental attempt to gain an insight as to the origin of turbulence. A novel approach is the application of sound to obtain vortex stability.

16.61

Hypersonics Research Lab., ARR, ARL, Dayton, Ohio.
SHOCK WAVE AND VISCOUS INTERACTION PHENOMENA AT HYPERSONIC MACH NUMBERS, J. D. Anderson. Project 7064(806A), Internal.

The effect of shock wave and viscous interaction at hypersonic Mach numbers will be investigated in both the ARL 3-inch and 20-inch hypersonic wind tunnels. Surface pressures, heat transfer, and over-all force data as affected by this phenomenon will be investigated at various values of leading edge thickness, angle of attack, angle of yaw, free-stream Reynolds number, and hypersonic interaction parameter. Results will be compared with available data for the Mach number range from 10 to 14. The use of the existing high pressure peaks at the leading edge in order to increase the control effectiveness of a hypersonic vehicle will be a possible application of this research and shall also be investigated.

16.62

Hypersonics Research Lab., ARR, ARL, Dayton, Ohio.
AEROTHERMODYNAMIC CHARACTERISTICS OF THE HEMISPHERE CYLINDER AT MACH 10-14 AT VARIOUS ANGLES OF ATTACK, F. L. Daum. Project 7064(806A), Internal.

Measurements of pressure and heat transfer distributions on a hemisphere cylinder model will be made in the 20-inch Hypersonic Test Stand.

16.63

Hypersonics Research Lab., ARR, ARL, Dayton, Ohio.
FUNDAMENTAL BOUNDARY LAYER FLOW CHARACTERISTICS INCLUDING HEAT TRANSFER AND FLOW SEPARATION PHENOMENA, F. L. Daum. Project 7064(806A), Internal.

This broad theoretical and experimental study includes many of the aerothermodynamic problems that will be encountered in the design of advanced hypersonic glide and reentry vehicles. It includes a basic study of boundary layer behavior at the high Mach numbers and temperatures and low densities. Methods of treating the boundary layer to improve the vehicle performance will be explored. Delay of transition, body shaping, and flow separation are among the phenomena to be investigated. The goal of this study is the reduction of heat transfer and increase of vehicle performance through aerodynamic means.

16.64

Hypersonics Research Lab., ARR, ARL, Dayton, Ohio.
AERODYNAMICS OF FINLESS AND SPINLESS BLUNT BODIES, O. Walchner. Project 7064(806A), Internal.

This work concerns: (1) explanation of apparent discrepancy between free flight test - shadowgraphs and wind tunnel test - Schlieren pictures with respect to detachment distance of shock waves in front of blunt bodies; (2) investigation of the influence of nose spikes of various shapes upon the stability derivative of blunt bodies; (3) investigation of non-linearities in damping derivatives.

16.65

Illinois Inst. of Tech., Chicago.
INDUCED SEPARATION OF SUPERSONIC CHANNEL FLOWS, A. A. Fejer. Project 7116(801A), Contract AF 33(616)-8183; ARM, ARL.

This recently contracted study is an experimental investigation of the interaction between a supersonic channel flow and an adjustable transverse auxiliary supersonic jet. The details of the interaction and the resulting lateral force due to the induced flow asymmetry will be systematically studied.

16.66

Instituto Technologico de Aeronautica (Brazil).
WAVE DRAG OF SUPERSONIC AIR INLETS, J. P. Gorecki. Project 9781(806A), Contract AF 49(638)-581; SREM, AFOSR.

The contractor under this contract will develop rapid analytic methods for predicting the drag and pressure distribution of supersonic air inlets (diffusers) in as wide a Mach number range as possible. Among the parameters included in the study will be: (a) as many configurations as possible, including inlets with detached shock waves; (b) the effect of incidence angle; (c) comparative time studies for different methods of calculation; (d) precision or accuracy comparison for various methods of calculation, i.e., characteristic method, Lighthill's method, Schrenk's method, etc.

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16.67

Instituto Technologico de Aeronautica (Brazil).
AERODYNAMICS OF AN EXTERNAL JET FLAP, M. J. Krieger. Project 9781(806A), Contract AF 49(638)-583; SREM, AFOSR.

Investigate both experimentally and analytically the effect of a deflected air stream (produced by jet action utilizing an external jet flap located above the upper wing surface) on the maximum lift, drag, and lift-drag ratio. The optimum position of the flap for producing maximum lift, maximum thrust recovery, and maximum lift-drag ratio will be determined, with and without a simulated slipstream.

16.68

Israel Inst. of Tech., Haifa.
ROTATIONAL SUPERSONIC FLOW PAST THICK AIRFOILS, A. Kogan. Project 9781(806A), Contract AF 61(052)-281; SRE, AFOSR.

The objective of this research was to compute and present a set of detailed tables of shock wave parameters as required for the practical application of the calculation method for supersonic flow (including the rotational terms) in the entire region surrounding a sharp edged thick airfoil.

16.69

Johns Hopkins U., Baltimore, Md.
FUNDAMENTAL STUDIES IN MECHANICS, F. H. Clauser. Project 9781(806A), Contract AF 49(638)-496; SRE, AFOSR.

The objective is to perform theoretical and experimental research in mechanics with particular emphasis on nonlinear phenomena. Included within the scope of this broad effort are studies in nonlinear mechanics, magnetohydrodynamics, turbulence, boundary layer behavior, unsteady viscous flows, and flows of unusual fluids such as Helium II.

16.70

Johns Hopkins U., Baltimore, Md.
TURBULENT SHEAR FLOWS, S. Corrsin. Project 9781 (806A), Contract AF 49(638)-248; SRE, AFOSR.

This work is aimed at improving our understanding of turbulent shear flow. The immediate particular goals are the measurement of significant properties of turbulent jets, especially the round swirling jet and the "plane" jet. Another principal problem is an attempt to generate an approximately homogeneous turbulent shear flow with a grid of non-uniform solidity.

16.71

Maryland U., College Park.
MATHEMATICS RESEARCH IN FIELDS OF DYNAMICS AND APPLIED MATHEMATICS, J. B. Diaz. Project 9783(806A), Contract AF 49(638)-228; SRMA, AFOSR.

This research concerns problems in fluid dynamics and applied mathematics including flow about closed bodies of revolution, cavitation and free boundaries, transonic flow, steady states of helium atoms, approximations of partial differential equations, numerical methods in difference equations, elasticity, etc.

16.72

Maryland U., College Park.
TURBULENCE, F. R. Hama. Project 9781(806A), Contract AF 49(638)-645; SRE, AFOSR.

The research under this contract covers a number of areas. They all having bearing upon the intermittent and non-linear processes associated with transition and fully turbulent flows. Detailed transition investigations are being conducted in a very thick boundary layer, so that it will be easier to probe the basic mechanism associated with transition. A mathematical study of vorticity concentration in a simple shear flow is being pursued. The motions of a curved vortex will also be examined theoretically. Work on the instability and breakdown in a free-convection layer along a heated vertical plate is included under this contract. In addition an investigation of three-dimensional interactions and structure of separating laminar boundary layer will be studied to determine the influence of separation on transition.

16.73

Maryland U., College Park.
PRODUCTION OF LARGE VORTICES IN SHEAR LAYERS, R. J. Weske. Project 9781(806A), Grant AF-AFOSR-61-3; SREM, AFOSR.

To investigate the origin and mode of behavior of vortices in shear layers. Included will be an analysis of the effect of these vortices upon adjoining fluid layers. The objective of this work is to obtain a theoretical model for the formation of vortices in shear layers which should add to the understanding of the origin of turbulence and rotational fields.

16.74

Maryland U., College Park.
THREE-DIMENSIONAL FLOW IN AXIAL FLOW TURBO MACHINES,

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J. R. Weske. Project 9781(806A), Contract AF 49 (638)-385; SRE, AFOSR.

The purpose of this research was to investigate the three-dimensional motion occurring in the region between neighboring blades of fixed and rotating rows in axial flow turbomachines, and the interaction of secondary motion and rotating stall and the phenomena arising from three-dimensional flows in the transonic and supersonic regime, particularly, those affecting flow losses and reduction of effective flow area of axial-flow blade rows.

16.75

Massachusetts Inst. of Tech., Cambridge.
UNSTEADY GASDYNAMIC PROBLEMS RELATED TO FLIGHT VEHICLES, H. Ashley. Project 9781(806A), Grant AF-AFOSR-62-187; SREM, AFOSR.

The grantee will perform theoretical and experimental investigations into unsteady gasdynamics problems related to high speed flight vehicles: (a) theoretical models for predicting aerodynamic loading on two and three dimensional wings and bodies performing oscillations in high speed flow will be investigated; (b) the interaction between the thermal radiation field and the convection field in detached shock layers over hypersonic blunt bodies also will be investigated; (c) also, studies will be performed on unsteady magnetogasdynamics; and (d) the stability of physical systems which will include a shear flow with a boundary layer in contact with a flexible boundary.

16.76

Massachusetts Inst. of Tech., Cambridge.
HEAT TRANSFER CHARACTERISTICS OF DIFFUSION BOUNDARY LAYERS, J. R. Baron. Project 9781(806A), Contract AF 49(638)-245; SRE, AFOSR.

Viscous mixture flows are being investigated to assess the behavior and characteristics of the high speed boundary layer under mass transfer and real gas situations. By means of both experiment and analysis, understanding is sought for the contribution of thermodynamic coupling, geometry, materials and physical property specifications. Where feasible, simplified models of the flow are postulated and examined in order to overcome the difficulties inherent in arbitrary specification of surface conditions.

16.77

Massachusetts Inst. of Tech., Cambridge.
UNSTEADY STATE HEAT TRANSFER PHENOMENA, R. Pand. Project 7063(806A), Contract AF 33(616)-6076; ARH, ARL.

Experimental and analytical studies will be made on the heat transfer free convection from heated solids to gases (a) in the presence of strong sound fields, and (b) under the influence of surface oscillations. In both cases heated cylinders will be used as test models, one being suspended in strong standing and moving sound fields with intensity levels exceeding 150 db, the other being oscillated in a direction normal to its axis by a magnetic driver. Through analytical studies attempts will be made to analyze the effects involved and to predict the heat transfer effects.

16.78

Massachusetts Inst. of Tech., Cambridge.
FLOW FIELDS ABOUT BLUNT NOSED WINGS IN HYPERSONIC FLOW, J. A. F. Hill. Project 7064(806A), Contract AF 33(616)-7818; ARR, ARL.

This study is an experimental and analytical investigation of the inviscid flow field about a blunt-nosed wing at various angles of attach in hypersonic flow. The analytical portion of this study will attempt to develop an approximate theory valid up to large angles of attack for the inviscid flow field.

16.79

Massachusetts Inst. of Tech., Cambridge.
EFFECT OF DIFFUSING GAS ON AERODYNAMIC HEATING, J. Kaye. Project 9781(806A), Contract AF 49(638)-442; SREM, AFOSR.

An experimental investigation to study the basic aspects of the effects of diffusing gases such as argon, nitrogen, and helium on the aerodynamic heating process in a boundary layer of a supersonic stream of air. The gases are injected under controlled conditions, through a porous wall into the boundary layer and the velocity profile, temperature profile, and concentration profile at various points in the boundary layer were measured.

16.80

Massachusetts Inst. of Tech., Cambridge.
HIGH ALTITUDE EXPLOSION FLOWS, L. Trilling. Project 7635(770A), Contract AF 19(604)-5698; CRZA, AFCRL.

This contract involves experimental and theoretical research related to the understanding of upper atmospheric processes, including transport phenomena, atmospheric interactions with shock waves produced by explosives and rockets, and other mechanisms.

16.81

Massachusetts Inst. of Tech., Cambridge.

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FLUID DYNAMICS, G. B. Whitham. Project 9752(801A), Contract AF 49(638)-708; SRM, AFOSR.

This research in magnetohydrodynamics and gas dynamics concerns important contemporary questions of fluid flow. It investigates the structure of shock waves and the implications of results obtained to problems of detonation and combustion. It studies the necessity for boundary layers in problems of wave propagation.

16.82

Max-Planck-Institut fuer Stromungsforschung (Germany).
INTERACTION OF SOUND AND TURBULENCE, W. Tollmien. Project 9781(806A), Grant AF-EOAR-61-5; SREM, AFOSR.

Theoretical and experimental investigations will be performed on the interaction between the turbulent field and an external sound field. The theoretical research will be based upon Lighthill's and Kraichnan's work. Experimentally, the sound of definite frequencies will be generated at one side of a jet of air or water. The velocity profile and maximum velocity of the jet is to be measured at the other side. Further emphasis shall be put on the scattering of the sound field by the stream as well as extending the investigations to determine the influence of various turbulent properties such as isotropy, homogenity, eddy size, degree of turbulence, etc., on the scattering of sound.

16.83

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
BOUNDARY LAYER STUDIES, W. P. Elliott. Project 7655 (770A), Internal.

Analysis of micrometeorological data collected from various sources to determine the variations of wind, temperature and other micrometeorological parameters in the boundary layer and to relate these parameters as functions of one another.

16.84

Michigan U., Ann Arbor.
INVESTIGATION OF THE UNSTEADY SUBSONIC AND SUPERSONIC FLOW ABOUT BODIES EXHIBITING ANOMALOUS STABILITY CHARACTERISTICS, A. Kuethe. Project 7064(806A), Contract AF 33(616)-7628; ARR, ARL.

In-house research at low Mach numbers led to the indication that the wake flow behind very short blunt bodies induces damping-moment non-linearities with respect to angular velocity. The contractor's effort is aimed at proving or disproving the above hypothesis by analysing base pressure measurements on an oscillating circular plate with and without a conical borebody at subsonic, transonic and supersonic speeds and at various reduced oscillation frequencies.

16.85

Michigan U., Ann Arbor.
THREE-PHASE A.C. ARC HEATING TECHNIQUE FOR HYPERSONIC AERODYNAMIC SIMULATION, J. A. Nicholls. Project 7065 (806A), Contract AF 33(657)-8630; ARF, ARL.

An experimental and theoretical investigation of a 3-phase a.c. arc heating technique will be conducted for producing a continuous stream of high-enthalpy, high-velocity air. The broad purpose of the program is to provide data and analysis which will permit extension of the simulation range and reduction of contamination level in arc-heated hypersonic wind tunnels. The general objectives are (1) a sizable increase in the operational limits applicable to the arc heating technique, particularly high pressure at desirable enthalpy levels, (2) reduction of air-stream contamination to the lowest possible level, and (3) a theoretical analysis of the feasibility of further addition of energy into the airstream after arc heating.

16.86

Minnesota U., Minneapolis.
MASS TRANSFER COOLING, E. R. G. Eckert. Project 9781(806A), Contract AF 49(638)-558; SRE, AFOSR.

Theoretical and experimental investigations of mass transfer cooling as a means of protecting the surfaces of high speed aircraft of re-entry vehicles including weapons from the effects of intense aerodynamic heating. Specifically, the objective is to determine the influence of large differences in the properties of the main fluid and the fluid force into the main flow from the wall. The influence of chemical reactions within the boundary layer and at the surface are being investigated. The effects due to thermal diffusion are to be included. Both laminar and turbulent boundary layers are being considered.

16.87

Minnesota U., Minneapolis.
AERODYNAMIC AND HEAT TRANSFER STUDIES, R. Herrman. Project 9781(806A), Contract AF 49(638)-190; SREM, AFOSR.

To investigate hypersonic flow about basic body shapes with particular attention to real gas effects such as oxygen dissociation, and the determination of heat transfer characteristics with evaporative

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SRI- Directorate of Information Sciences
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SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

film cooling. Conduct a detailed investigation on evaporative film cooling in a stagnation point flow with special attention given to methods of coolant injection. Conduct a theoretical investigation of evaporative film cooling under conditions of re-entry and sustained hypersonic flight through the atmosphere.

16.88

Minnesota U., Minneapolis.
AERODYNAMIC AND HEAT TRANSFER STUDIES WITH EVAPORATIVE COOLING AT HYPERSONIC MACH NUMBERS, R. Herrmann. Project 9781(806A), Contracts AF 49(638)-130 and AF 18(600)-236; SRE, AFOSR.

To study and investigate aerodynamic and thermal characteristics of various body shapes. Analyze and experimentally determine heat exchange between such bodies and a high speed airstream at stagnation temperatures up to 3,000°R, particularly, the cases when the surface of a heat transfer model is cooled with liquid film continuously supplied by the body itself. Particular areas will include real gas effects and boundary layer development with liquid film cooling present.

16.89

Minnesota U., Minneapolis.
HEAT TRANSFER AND VISCOUS FLOW PHENOMENA ON DELTA WINGS AT MACH 7, R. Hermann. Project 7064(806A), Contract AF 33(616)-7402; ARR, ARL.

A combined theoretical and experimental study of the detailed flow characteristics of highly swept Delta wings is being conducted. The effect of sweep angle and angle of attack on the local flow field, the location and shape of the shock wave, and the extent of flow separation are to be determined utilizing optical methods and pressure distributions measured over the wing. Heat transfer rates will be measured under the conditions of a constant leading edge radius, variable angle of attack, and variable Reynolds number.

16.90

Minnesota U., Minneapolis.
ROCKET SLED BALLISTICS, R. Hermann. Project 7856 (806A), Contract AF 29(600)-2839; SRA, AFOSR.

This research is a continuation of work accomplished under three previous contracts, where the aerodynamic characteristics of basic and advanced sled body configurations have been investigated parametrically on a fundamental basis. This contract calls for two items. Item I is concerned with the blunt body-spike phenomena under the influence of ground interference, and the unsolved problem of recovering monorail rocket sleds from high supersonic velocities. Item II is concerned with the aerodynamics of slipper beams on dual rail rocket sleds and the possibilities of their use to compensate the extremely high lift forces which are acting on the sled bodies at supersonic velocities and balance system. Tests are under preparation at Mach numbers between 1.5 and 5.

16.91

Minnesota U., Minneapolis.
PROPERTIES OF THE HELIUM II FILMS, H. J. Werntz. Project 9751(801A), Contract AF 49(638)-615; SRPP, AFOSR.

Helium II films have many interesting and unusual properties. It is probable that the saturated thermal flow is equivalent to the gravitational flow and that both carry with them no entropy. The experiment consists of supplying power (heat) to one reservoir and measuring the mass transport toward the heated reservoir. The rate of mass transport is proportional to the rate of power supply and offers a method of measuring entropy which is independent of calorimetric methods. This continues until a saturation flow occurs, after which the reservoir temperature rises. Other phenomena to be investigated are the apparent abrupt change in flow-rate above a certain film height, and the propagation of second sound in Helium II films.

16.92

Minnesota U., Minneapolis.
ROTATIONAL MOTION OF SUPERFLUID LIQUID HELIUM, W. Zimmerman. Project 9751(801A), Grant AF-AFOSR-62-316; SRPP, AFOSR.

To repeat a critical experiment first performed by Vinen which demonstrates quantization of circulation of the superfluid component of liquid helium.

16.93

Naples U. (Italy).
MIXING PROBLEMS ASSOCIATED WITH HOMOGENEOUS STREAMS AND NON-REACTING GASES, L. G. Napolitano. Project 9781(806A), Contract AF 61(052)-160; SREM, AFOSR.

Theoretical research has been conducted and numerical computations made on mixing problems covering a wide range of interaction between two streams and non-reacting gases. The basic equations will be reduced to ordinary differential equations and the final solutions will be obtained by making numerical calculations on a digital computer.

16.94

Naples U. (Italy).

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
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ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRME- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEXR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGMR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

SUPERSONIC FLOW IN THREE DIMENSIONAL POINTED BODIES, L. G. Napolitano. Project 9781(806A), Contract AF 61(052)-327; SREM, AFOSR.

Non-equilibrium flows around circular cones at zero angle of attack will be investigated when a single chemical characteristic time is present. This problem shall be solved by deriving a slender body theory, by means of power series solutions and by developing the pertinent characteristics method. These methods will be compared with one another and their range of validity determined. Numerical examples shall be worked out for pertinent cases. Based on these results, the range of validity of the slender-body theory of non-equilibrium flows and that of the series solution shall be determined. The effects of such factors as intial conditions, semi-vortex angle, physicochemical parameters, etc., on the properties of the subject field will also be analyzed.

16.95

New York U., N. Y.
HIGH-SPEED GAS DYNAMICS, H. B. Keller. Project 9781 (806A), Contract AF 49(638)-446; SRE, AFOSR.

A theoretical study of high-speed gas dynamics with particular emphasis on effects associated with the motion and propagation of shock waves, the stability of converging shock waves, and the diffraction of shock waves by obstacles of various kinds. Analytical techniques applicable to related problems were developed; namely, numerical methods for shock wave analysis, detached shock waves on the nose of blunt bodies, uniform and non-uniform flow effects in the presence of shock waves, and magnetohydrodynamics.

16.96

New York U., N. Y.
DERIVATION OF EMMONS-SCHUBAUER SPOTS, J. Ludloff. Project 9781(806A), Contract AF 18(603)-25; SRE; AFOSR.

The contractor, by integrating step by step the time dependent non-linear Navier-Stokes equations, attempted to demonstrate theoretically the appearance of the Emmons and Schubauer turbulent spots in regions of incipiently unstable laminar flow which are subject to appropriate superposed disturbances. Furthermore, upon demonstrating the appearance, the contractor attempted to follow the development, in time, of the growth of turbulent spots.

16.97

North American Aviation, Inc., Downey, Calif.
STABILITY AND TRANSITION OF THE LAMINAR BOUNDARY LAYER, E. R. Van Driest. Project 9781(806A) Contract AF 49(638)-250; SRE, AFOSR.

The purpose of this contract is to study theoretically and experimentally the process of boundary layer transition including not only the breakdown of a pure laminar to a pure turbulent boundary layer but also the sustenance of a turbulent flow through the sublayer near a wall. A particular objective is the study of the transition process in the presence of discrete surface roughness and free-stream turbulence with and without heat transfer at supersonic speeds. In the present experimental program, the flow on a cone without pressure gradient as well as the flow on the face of a blunt body are being investigated.

16.98

Ohio State U. Research Foundation, Columbus.
HYPERSONIC AEROTHERMODYNAMICS, J. Lee. Project 7064 (806A), Contract AF 33(616)-7451; ARE, ARL.

The contractor is conducting a research investigation of hypersonic aerothermodynamics and test facility performance utilizing the hypersonic test facilities of the Aeronautical Research Laboratory. Specific study items include an investigation of boundary layer growth in nozzles and nozzle performance, a test section flow study, and overall system performance. In addition, aerodynamic tests of advanced configurations are planned.

16.99

Ohio State U. Research Foundation, Columbus.
HYPERSONIC AEROTHERMODYNAMIC SIMULATION, J. D. Lee. Project 7065(806A), Contract AF 33(657)-8106; ARF, ARL.

Research investigations will be conducted in the area of hypersonic aerothermodynamic simulation. Prior to the time that the ARL 30-inch Mach 18-20 hypersonic wind tunnel becomes available for experimental studies, research shall be conducted on methods of heating air to 10,000°R suitable for wind tunnel testing temperatures. After the 30-inch tunnel is available, the flow characteristics of a Mach 18 nozzle will be determined and compared with theoretical predictions, the characteristics of other components of the tunnel will be determined, models and probes needed for obtaining the experimental results will be designed and fabricated, and a basic research program outlined based on capabilities established in checking out the tunnel.

16.100

Pai, Dr. S. I., Beltsville, Md.
CRITICAL SURVEY OF MAGNETOFLUID DYNAMICS, S. I. Pai. Project 7116(801A), Contract AF 33(657)-7805; ARM, ARL.

AFOSR- Air Force Office of Scientific Research
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CREI- Astroservoillance Sciences Lab
CRES- Propagation Sciences Lab
CRET- Communications Sciences Lab
CREZ- Control Sciences Lab
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CRELA- Photochemistry Lab
CRELC- Thermal Radiation Lab
CRELE- Research Instrumentation Lab
CRELG- Terrestrial Sciences Lab
CRELH- Meteorological Research Lab
CRELI- Ionospheric Physics Lab
CRELR- Sacramento Peak Observatory

Dr. Pai will conduct a critical survey of the literature in the field of magnetofluid dynamics. The topics to be surveyed will include fluid flow and heat transfer phenomena, and power conversion and propulsion applications of MFD. In contrast to a bibliographical type survey, this survey will make a critical assessment of present MFD theory, as supported by experiment, to adequately predict and describe various MFD phenomena. Primary emphasis will be on the fundamental aspects of MFD theory with the secondary emphasis being on engineering applications.

16.101

Pisa U. (Italy).
AERODYNAMICS OF BODIES IN NON-UNIFORM FLOW, E. Pistolesi. Project 9781(806A), Contract AF 61(052)-209; SREM, AFOSR.

Theoretical investigations will be carried out on the aerodynamics of bodies in non-uniform flow. Specifically, a study will be made of the effects of an asymmetric supersonic jet on the aerodynamic characteristics of an airfoil immersed in a supersonic stream at a finite distance from the supersonic jet. The above investigations will include the three-dimensional problem of jet body interference. These investigations will be extended to determine a method which will define the flow past an axisymmetric supersonic jet as well as the flow of the external stream. These studies will also include the interference effects between a jet and a three-dimensional wing at a finite angle of attack and a finite distance from the jet.

16.102

Polytechnic Inst. of Brooklyn, N. Y.
MECHANICAL ACCELERATOR CONCEPT, A. Ferri. Project 7065(806A), Contract AF 33(657)-8286; ARF, ARL.

Efforts will be concentrated on "the mechanical accelerator" concept for producing gas streams whose properties are suitable for simulating the environmental conditions encountered by objects moving at high speeds at extreme altitudes. Studies pertinent to fluid dynamics of gas flows through curved channels at hypersonic speeds will be performed. Experimental investigations will be conducted on at least three stationary channels suitable for incorporation in a mechanical accelerator. Following these tests and analyses, a three-dimensional rotating cascade will be designed.

16.103

Polytechnic Inst. of Brooklyn, N. Y.
THERMAL AND AERODYNAMIC EFFECTS AT HYPERSONIC MACH NUMBERS, A. Ferri. Project 7064(806A), Contract AF 33(616)-7661; ARR, ARL.

This investigation is an extensive analytical and experimental study of aerodynamic and heat transfer effects in hypersonic flow. The experimental work is being performed in heated air hypersonic wind tunnels at Mach numbers up to 12.

16.104

Polytechnic Inst. of Brooklyn, N. Y.
THREE-DIMENSIONAL INTERFERENCE EFFECTS IN SUPERSONIC FLOW, A. Ferri. Project 9781(806A), Contract AF 49(638)-445; SRE, AFOSR.

Theoretical and experimental investigations will be made on the more promising combinations of favorably interacting elements in supersonic and hypersonic configurations. Force measurements, pressure distributions, and heat transfer measurements will be obtained from wind tunnel tests at practical high Reynolds numbers and at Mach numbers of practical interest. This research program will consider: (a) the effects of viscosity on favorable interference; (b) both lifting and non-lifting systems; (c) the effect of interference on the stability characteristics; (d) the effects of off-design Mach numbers on favorable interference; (e) the effectiveness of inlets located in regions of favorable interference; (f) the effectiveness of favorable interference for the reduction of heat transfer; (g) the hypersonic boundary layer problem with adverse pressure gradients; (h) studies of the equilibrium and non-equilibrium real gas effects; (i) the interaction between electric and magnetic fields and fluid flow; (j) the dynamics of flight of aircraft, missiles and satellite vehicles; (k) the mechanics of collision between particles and solid surfaces (drag mechanism at extreme altitudes); (l) an investigation of magnetohydrodynamic flows with application to communications with and propulsion of hypersonic and space vehicles; and (m) investigations of boundary layer problems in high speed flow with particular application to mixing and wake flows.

16.105

Polytechnic Inst. of Brooklyn, N. Y.
HYPERSONIC AND LOW DENSITY FLOW PROBLEMS, A. Ferri. Project 9781(806A), Contract AF 49(638)-217; SRE, AFOSR.

Experimental and theoretical studies will be made: (a) on configurations for hypersonic flight on reentry from space involving high lift and drag forces with small surface area and practical heat transfer and structural characteristics; (b) on bodies of the cowling type with large lift-drag ratios; (c) on nonlinear methods of analysis applicable to hypersonic three-dimensional flows including detached shock waves; (d) on the mixing of streams under conditions of streamwise pressure gradient, large velocity,

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RAS- Directorate of Engineering
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AEDC- Arnold Engineering Development Center
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SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
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ESRR- Operational Applications Lab

density differences, and different compositions, with or without chemical reactions; (e) on problems connected with complex aircraft and missile configurations involving interferences between elements; (f) on vorticity interaction between the main flow and the boundary layer for two and three-dimensional configurations within the continuum regime; (g) on rarefied gas flows in the transition regime including the analysis of non-aerodynamic phenomena; (h) on continuum gas flows with chemical reactions and departures from thermodynamic equilibrium; and (i) on the dynamics of ionized gases in the presence of model practical environments.

16.106

Polytechnic Inst. of Brooklyn, N. Y.
PHYSICAL PHENOMENA WHICH CAUSE ENERGY TRANSPORT ACROSS A HYPERSONIC BOUNDARY LAYER, P. A. Libby. Project 7364(802A), Contract AF 33(616)-5944; ASRC, ASD.

Additional studies on the problem of the application of mass transfer to the reduction of heat transfer under hypersonic flow conditions. This will include work on the effect of large rates of constant flow; and, in addition, mass transfer studies applicable to rocket nozzles will be performed. With respect to the nozzle analysis the following will be studied: (1) the importance of chemical reaction which will be established by experiments wherein chemically reactive coolants are injected into the boundary layer; and (2) the influence of non-uniformity in the external flow.

16.107

Politecnico di Torino (Italy).
AEROTHERMODYNAMIC STUDY OF THE FLOW OF HIGH SPEED RAREFIED GASES, C. Ferrari. Project 9781(806A), Contract AF 61(052)-208; SRE, AFOSR.

Theoretical and experimental aerothermodynamic studies will be made of the flow of high speed rarefied gases around bodies having sharp or blunt leading edges. Particular emphasis will be made to determine the effects of the following parameters on the distribution of pressure, of tangential stress, and of temperature in the proximity of the leading edge: (a) Knudsen number of the stream; (b) geometry of the body and radius of curvature of the leading edge; and (c) geometric and physical properties of the rigid surface as related to the interaction of the gas molecules with the body. In addition, studies shall be performed of the simultaneous transfer of momentum, heat and mass of high speed flows around bodies having various thermal characteristics and permeability with a view of extending the Reynolds analogy to both laminar and turbulent mixtures flowing at high speeds with and without fluid injection.

16.108

Politecnico di Torino (Italy).
RAREFIED GAS DYNAMICS, HYPERSONIC AND TURBULENT FLOWS, C. Ferrari. Project 9781(806A), Contract AF 61(052)-511; SREM, AFOSR.

Three fundamental studies pertaining to rarefied gas dynamics, hypersonic flows and turbulent flows are being performed; (1) theoretical research on the energy and momentum exchange between a stream and a body in free molecule flow is being conducted to obtain a better knowledge of the interaction phenomena and in order to determine quantitatively the principal parameter of the usual energy and momentum accommodation coefficients; (2) theoretical and experimental investigations will be made on the thermodynamics of reacting gas mixtures with special emphasis on the relationship of the reaction rate and the rate of entropy production; on the motion of mixtures of a reaction in a nozzle; on the influence of chemical reactions on strong shock wave reflection; and on heat transfer in hypersonic flow around a blunt body; (3) experimental research will be studied of the transition from laminar to turbulent flow in cylindrical, convergent, and divergent pipes and jets with emphasis on the intermittent transition phenomena.

16.109

Princeton U., N. J.
BOUNDARY LAYER CHARACTERISTICS IN THE PRESENCE OF PRESSURE GRADIENTS AT HYPERSONIC SPEEDS, S. M. Bogdonoff. Project 7064(806A), Contract AF 33(616)-7629; ARR, ARL.

This investigation consists of analytical and experimental studies of hypersonic flow over various aerodynamic bodies. The experimental work is being conducted in the Princeton helium tunnel. Flow over small delta wings at high angles of attack has been studied by flow visualization in the boundary layer and also by pressure measurements. A study of pressure distributions on blunt and sharp wing-like shapes is being conducted in the Mach number range from 7.5 to 20. Also, heat transfer investigations are being made in separated flows induced by cavities on bodies of revolution.

16.110

Princeton U., N. J.
HIGH SPEED GAS DYNAMICS, S. M. Bogdonoff. Project 9781(806A), Contract AF 49(638)-465; SRE, AFOSR.

This contract covers a broad area of gas dynamics. Work is being conducted on boundary layer problems associated with strong pressure gradients in

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CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRE- Geophysics Research Directorate
CREA- Photochemistry Lab
CREC- Thermal Radiation Lab
CREE- Research Instrumentation Lab
CREG- Terrestrial Sciences Lab
CREH- Meteorological Research Lab
CREI- Ionospheric Physics Lab
CREK- Sacramento Peak Observatory

non-steady phenomena. Viscous and non-viscous phenomena in the supersonic and hypersonic regimes are being investigated. Rarefied gas dynamics and the associated studies of viscous and magnetohydrodynamic interactions are included. There are a series of exploratory studies on the molecular structure of gases and their effects on turbulence, high speed particle impact, variable flows, Newtonian flows and heat transfer at high temperatures underway. Fundamental studies of hypersonic separated flows are also being emphasized.

16.111

Rensselaer Polytechnic Inst., Troy, N. Y.
HYPERSONIC FLOW PHENOMENA, T. Y. Li. Project 9781 (806A), Contract AF 49(638)-977; SRE, AFOSR.

The contractor completed theoretical studies to determine the influence of so-called real gas effects on theoretical lift and drag coefficients for slender bodies of arbitrary cross section. He was able to show to a first order of approximation the effects of dissociation on the flow over a body for non-equilibrium and equilibrium flow conditions. From this it was possible to compute lift and drag coefficients.

16.112

Rensselaer Polytechnic Inst., Troy, N. Y.
HYPERSONIC RAREFIED VISCOUS FLOW PHENOMENA AND MAGNETOHYDRODYNAMICS AT EXTREMELY HIGH MACH NUMBERS AND TEMPERATURES, H. Hagamatsu. Project 7064(806A), Contract AF 33(616)-7312; ARR, ARL.

The purpose of this research program is to investigate analytically and experimentally rarefied gas dynamic and magnetohydrodynamic phenomena. Since there are presently no available experimental facilities with the required performance operating ranges, the feasibility of extending the performance limits of the shock-tunnel testing method to the extremes in Mach number and low density is being investigated. The attainment of Mach numbers from 15 to 35 and stagnation temperatures as high as 12,000°K over a free stream static pressure range of approximately 1 mm to 0.05 microns of mercury are the objectives, from the test facility standpoint. Aerothermodynamic and magnetohydrodynamic studies, both experimental and analytical, will be carried out in these advanced shock tunnel research programs.

16.113

Rensselaer Polytechnic Inst., Troy, N. Y.
LAMINAR AND TURBULENT MIXING OF STREAMS, K. T. Yen. Project 9781(806A), Contract AF 49(638)-23; SRE, AFOSR.

This research was directed at an analytical study of laminar and turbulent mixing of fluid streams under pressure gradients in order to determine the flow conditions in the mixing region and to analyze the main features of the phenomena. Related problems such as methods of analysis and solutions were investigated. This study was mainly concerned with flows of compressible viscous ideal gas.

16.114

Research Div., AEOR, AEDC, Tullahoma, Tenn.
USE OF GAMMA RADIATION IN THE MEASUREMENT OF GAS DENSITY AND VELOCITY, J. Dicks. Project 8951 (806A), Internal.

This is a study of the use of gamma radiation to measure the density and velocity of high temperature gas flows. Velocity measurements will be made by using an interrupted beam of gamma rays to raise the local ion density and then detecting motion of the ions by using microwave techniques. Special attention will be given to the effects of background ionization in low density plasmas.

16.115

Research Div., AEOR, AEDC, Tullahoma, Tenn.
VISCOUS INTERACTION AT HYPERSONIC SPEEDS, B. J. Griffith. Project 8954(806A), Internal.

The objective of this study is to investigate the influence of viscous interaction on pressure, heat transfer and forces on simple shapes in hypersonic flows. Both numerical and similarity methods of solving the boundary layer equations will be attempted on slender cones. The effects of model wall temperature will be included. Experimental data for comparison with the theoretical results will be obtained from Hotshot tunnels.

16.116

Rochester U., N. Y.
MEASUREMENTS OF ELECTRON AND ION DENSITY PROFILES AHEAD OF SHOCK WAVES, H. Weymann. Project 9781(806A), Grant AF-AFOSR-62-26; SREM, AFOSR.

The contractor is measuring the electron and ion densities which appear in a shock tube ahead of the shock waves due to so-called precursor electrons which ionize the gas, "kick" electrons out of the shock tube wall, and themselves contribute to the charged particle density ahead of the shock wave.

16.117

Rome U., Italy.
REENTRY HEAT TRANSFER, L. Broglio. Project 9781 (806A), Contract AF 61(052)-198; SREM, AFOSR.

ARL- Aeronautical Research Laboratories
- ARC- Chemistry Research Lab
- ARF- Fluid Dynamics Facilities Lab
- ARP- General Physics Research Lab
- ARB- Plasma Physics Research Lab
- ARM- Applied Mathematics Research Lab
- ARR- Thermomechanics Research Lab
- ARH- Hypersonics Research Lab
- ARX- Solid State Physics Research Lab
- ARS- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
- ASRC- Directorate of Materials & Processes
- ASRMC- Electronics Technology Lab

RADC- Rome Air Development Center
- RAEW- Intelligence & Electronic Warfare Div.
- RAOR- Advanced Studies Office
- RAS- Directorate of Engineering
- RAHA- Advanced Development Lab
- RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
- AEOR- Research Division

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AMRL- 6570th Aerospace Medical Research Laboratories

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The investigations under this contract are concerned with the overlapping problems associated with re-entry heating. They include generalized studies of trajectories, including optimization, guidance as it affects heat transfer, structural considerations and methods of heat conduction analysis. Work will also be conducted on similarity laws and modeling techniques necessary for hypersonic wind tunnel testing.

16.118

Royal Coll. of Science and Tech., Glasgow (Gt. Brit.)
THEORY OF THE HODOGRAPH METHOD IN GAS DYNAMICS, D. C. Pack. Project 9783(806A), Contract AF 61(052)-407; SRE, AFOSR.

Studies will be made by means of the hodograph method of transonic flow past a wedge-shaped body at angles of incidence. Exact solutions will be obtained for unsymmetrical flow past wedges and flat plates in sonic free stream. The purpose of these investigations will be toward seeking solutions which will clarify the behavior of the free stream singularity for both the Chaplygin equation and the Tricomi equation. In addition, a study will be made of the effect of magnetic fields upon the unsteady motion of a conducting fluid. These investigations will be extensions of the generalized studies of gas dynamics problems which have been accomplished.

16.119

Royal Inst. of Tech. (Sweden).
LINEAR AND NON-LINEAR PROBLEMS, SURFACE INTERACTIONS, AND SHOCK WAVE DEVELOPMENT IN RAREFIED GASDYNAMICS, D. R. Willis. Project 9781(806A), Contract AF 61 (052)-348; SRE, AFOSR.

Theoretical analyses were performed on three aspects of rarefied gas problems, namely: (a) an attempt was made to prove the validity of the general method for solving Boltzmann's equation under more general conditions. This involved an extension to non-linear problems and the use of a more complicated molecular model than the Krook relaxation model; (b) the feasibility of determining the surface interaction, using a counter which only measures the number flux, in conjunction with a molecular beam impinging on a moving target, was investigated; and (c) a simple one-dimensional model study was made of the development of a shock wave as a body moves from rest into a gas at equilibrium.

16.120

Sidney U., Australia.
WAVE INTERACTIONS IN STEADY SUPERSONIC AND HYPERSONIC FLOWS, G. A. Byrd. Project 9781(806A), Grant AF-AFOSR-61-93; SREM, AFOSR.

The following aspects of wave interactions in steady supersonic and hypersonic flow will be investigated: (a) the interactions when the waves are regarded as discontinuities and/or of finite thickness will be studied in detail by numerical methods. Primary consideration will be given to the analysis of and obtaining reflection coefficients for all types of wave interactions; (b) the mixed flow region in a shock-shock interaction is to be experimentally examined using a supersonic wind tunnel available at the university; (c) for flows involving finite thickness waves or regions, some definite information is to be obtained by the method of characteristics programmed for a digital computer, of how long it takes for a "local" solution to change to the asymptotic solution.

16.121

Southampton U. (Gt. Brit.).
HYPERSONIC AEROTHERMODYNAMICS, K. N. C. Bray. Project 7064(806A), Contract AF 61(052)-250; ARR, AEL.

Three topics in the field of hypersonic aerodynamic research and associated thermodynamic problems are being investigated through experimental and analytical studies: (a) heat transfer rates and pressure distributions are being measured in areas of separated flows over bodies of revolution. This experimental work is being done in the University of Southampton light gas gun hypersonic wind tunnel at Mach numbers of 9, 12, and 15; (b) the feasibility of using a stabilized arc discharge to drive a low density hypersonic wind tunnel is being investigated both theoretically and experimentally. A small plasma generator is being used for the experimental work; (c) theoretical work is being done on real gas effects in hypersonic aerodynamics.

16.122

Southwest Research Inst., San Antonio, Tex.
THERMALLY INDUCED STRESS WAVES, H. N. Abramson. Project 9782(806A), Contract AF 49(638)-1119; SREM, AFOSR.

Recent studies in the field of thermoelasticity have indicated that sudden heating gives rise to impulsive particle velocities with the consequent propagation of a sharp-front elastic wave. The objective of this research is to initiate a theoretical and experimental study of such thermally induced elastic stress waves.

16.123

Stanford U., Calif.
HYPERSONIC FLOW THEORY, M. V. Dyke. Project 9781 (806A), Contract AF 49(638)-965; SRE, AFOSR.

A number of basic phenomena are imperfectly understood. An example is the conjecture regarding the stagnation streamline on an inclined body which has just been shown by this work to be incorrect. Second, entirely new approximations and numerical techniques are required to handle the complications of such practical problems as flow past three-dimensional configurations. Both developments were at first pursued under the contract, using a perfect gas model. However, sufficient progress was made that attention has turned this year to include viscous effects. It is likely that the effects of the departure of the gas from thermodynamic equilibrium can also usefully be studied using the methods already developed.

16.124

Stanford U., Calif.
COMPUTATION OF THE LAMINAR COMPRESSIBLE BOUNDARY LAYER, I. Flugge-Lotz. Project 9781(806A), Contract AF 49(638)-550; SRE, AFOSR.

Particular problems of interest under this contract are high Mach number flows with shock waves, that means flows in which the so-called exterior flow is rotational. The goal is an accurate computation of shear and heat transfer along bodies of arbitrary shape (two dimensional flow and flow with axial symmetry) without simplifying assumptions.

16.125

Stanford U., Calif.
EQUILIBRIUM AND STABILITY IN IRREVERSIBLE PROCESSES, A TURBULENT SHEAR STUDY, S. J. Kline. Project 9781 (806A), Contract AF 49(638)-201; SRE, AFOSR.

This is a theoretical and experimental investigation of the phenomena underlying fluid stability, shear and boundary layer separation. Work is being conducted on turbulent boundary layers, turbulent free-shear layers and upon the foundation of irreversible thermodynamics.

16.126

Stevens Inst. of Tech., Hoboken, N. J.
ROTATIONAL EXCITATIONS AND TURBULENCE IN LIQUID HELIUM, L. Mead. Project 9751(801A), Grant AF-AFOSR-62-125; SRPP, AFOSR.

In the development of a theory to describe the phenomena of superfluidity and second sound in helium-2, Landau derived a dispersion curve which postulated the existence of quantized rotational energy modes. Recently, a theory was developed from first principles which did not include the existence of rotational energy modes (rotons). The research under this contract is directed towards establishing whether or not the partition function requires the existence of rotons.

16.127

Stromberg-Carlson Co., General Dynamics Corp., Rochester, N. Y.
HIGH-INTENSITY SOUND PROPAGATION, D. T. Blackstock. Project 9781(806A), Contract AF 49(638)-1118; SREM, AFOSR.

This is theoretical and experimental effort aimed at determining the manner in which high-intensity sound is influenced by the effects of viscosity. This requires a solution using the continuity, Navier-Stokes and energy equations, taking into account the boundary conditions of the particular problem, such as the existence of a wall. The initial study is being conducted for the case of a plane finite wave propagated in a tube.

16.128

Systems Research Lab., Dayton, Ohio.
HYPERSONIC TESTING PROBLEMS, J. Wright. Project 7065(806A), Contract AF 33(616)-7987; ARR, ARL.

The purpose of this effort is to supplement the internal program by carrying out a combined analytical and experimental study of the problems associated with the measurement of physical quantities in a high temperature low density hypersonic airstream. Toward this end, the contractor is experimentally investigating the problems of manometry, time lag effects in low pressure measuring systems, techniques for measuring heat transfer rates, wind tunnel calibration instrumentation, etc.

16.129

Technion Research and Development Foundation (Israel).
AERODYNAMICS OF SUPERSONIC WINGS AND BODIES OSCILLATING AT HIGH FREQUENCY, M. Hanin. Project 9781 (806A), Contract AF 61(052)-389; SREM, AFOSR.

The contractor is investigating, theoretically, the unsteady flows and pressures produced by high-frequency oscillations of supersonic wings, bodies and wing-body combinations. The investigations concern mainly three-dimensional configurations, including finite wings, and pointed bodies with small but non-negligible slopes. Study is also being made of the linearized velocity-potential equation governing three-dimensional oscillatory flow perturbations at supersonic as well as subsonic speeds.

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16.130

Technion Research and Development Foundation (Israel).
CROSS STRESSES IN THE FLOW OF DIFFERENT GASES, M. Reiner. Project 9781(806A), Contract AF 61(052)-223; SREM, AFOSR.

Experimental investigations are being performed with suitable apparatus to determine whether or not cross-stresses, such as are known to exist in the flow of high polymer solutions, are present in simple homogeneous liquids and rarefied gas flow. In addition, these investigations shall be further performed in monatomic, diatomic and polyatomic gases.

16.131

Technion Research and Development Foundation (Israel).
WAKE STRUCTURE OF TWO AND THREE DIMENSIONAL BODIES AT SUPER AND HYPERSONIC SPEEDS, J. Rom. Project 7062(806A), Contract AF 61(052)-576; ARM, ARL.

A study of the wake structure behind two and three dimensional bodies at supersonic and hypersonic speeds shall be conducted giving particular attention to heat transfer determinations. The research shall cover both laminar and turbulent boundary layer flow.

16.132

Technische Hochschule, Munich (Germany).
PRACTICAL NUMERICAL METHODS OF THREE DIMENSIONAL FLOWS, R. Sauer. Project 9781(806A), Contract AF 61(052)-377; SREM, AFOSR.

Theoretical investigations are to be expanded for developing practical numerical methods for calculating supersonic flows. The theories and methods shall be extended to the case of hypersonic flows. Specifically, the modifications of the method of characteristics necessary for its application to hypersonic flow problems are to be investigated. Analytic solutions for plane hypersonic flow by using suitable pressure-density-entropy relations are to be obtained.

16.133

Technische Hochschule, Braunschweig (Germany).
CONTROL OF TURBULENT BOUNDARY LAYERS, H. Schlichting. Project 9781(806A), Grant AF-EOAR-61-45; SREM, AFOSR.

The contractor is performing both theoretical and experimental research to determine the most effective suction distribution around an airfoil to obtain maximum lift. In accomplishing this objective he shall establish a convenient approximate method for calculating two dimensional turbulent boundary layers in incompressible flow with continuously distributed suction or blowing. The velocity of suction or blowing may vary along the wall. The theory will be then applied to airfoil sections.

16.134

Technische Hochschule, Aachen (Germany).
STABILITY OF COUETTE FLOW USING CYLINDERS WITH FINITE ECCENTRICITY, F. Schultz-Grunow. Project 7071(806A), Contract AF 61(052)-303; ARM, ARL.

The contractor shall investigate Couette flow between two nonconcentric cylinders, if the inner cylinder is at rest and the outer cylinder rotates. The flow will be calculated as a series expansion with regard to the inertia terms, when the cylinders have finite eccentricity. Stability on the basis of Rayleigh disturbances shall also be considered.

16.135

Technische Hochschule, Stuttgart (Germany).
VORTEX OCCURRENCE AT TRANSITION IN UNSTABLE LAMINAR BOUNDARY LAYERS, A. Weise. Project 9781(806A), Contract AF 61(052)-220; SREM, AFOSR.

An experimental research investigation is being undertaken to confirm Goertler's theory on the instability of the laminar boundary layer for a concave wall. This theory gives a prediction on the behavior of vortices in the boundary layer at concave walls. The axis of these vortices lies in the main direction of flow. A water tunnel will be used to produce a two-dimensional laminar boundary layer of unusually low turbulence and sufficiently high Reynolds number.

16.136

Thermomechanics Research Lab., ARM, ARL, Dayton, Ohio.
INTERNAL VISCOUS FLOW PHENOMENA IN CENTRIFUGAL FORCE FIELDS, L. G. Kehrt. Project 7116(801A), Internal.

This investigation consists of the study of the flow of viscous fluids between moving surfaces; in particular, between rotating disks with the flow entering at the axis of rotation. The goal is to efficiently transfer energy to fluids by viscous forces. One effort in this study is directed toward the analytical description of the flow processes involved. Another effort deals with the visual observation of flow patterns in a transparent chamber containing 2 rotating disks and employs highly viscous fluids and large disk spacings. In a third effort a multi-disk device for studying the performance of a shear force type pump has been designed and built and is presently being tested.

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CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

16.137

Thermomechanics Research Lab., ARN, ARL, Dayton, Ohio.
SUPERSONIC COMPRESSOR BLADING INVESTIGATION, M. O. Lawson. Project 7116(801A), Internal.

This is a theoretical and experimental study for extending present internal viscous flow concepts to low supersonic flow (M = 1.7) conditions.

16.138

Toledo U. Research Foundation, Ohio.
CONSTANT AREA SUPERSONIC FLOW DIFFUSION, A. A. Fejer. Project 7116(801A), Contract AF 33(616)-8271; ARN, ARL.

This recently initiated investigation consists of the experimental determination of the flow details in long constant area supersonic passages in which the entrance flow is decelerated to subsonic flow through a complex system of shock waves and shock wave-boundary layer interactions.

16.139

Toronto U. (Canada).
DYNAMICS OF BODIES ENTERING THE ATMOSPHERE, B. Etkin. Project 9781(806A), Grant AF-AFOSR-62-40; SREM, AFOSR.

The objective of this research is to advance the understanding of the flight dynamics of lifting vehicles at hypersonic speeds in the outer fringes of the atmosphere. Particular attention will be paid to vehicles and flight paths which are suitable for manned flight. This objective is being attacked through studies of two specific problems: (1) the effect of earth's rotation, wind, and variations in atmospheric density profile upon flight path, heating, and acceleration during reentry; and (2) the development of a flight simulator for use in human control studies.

16.140

Toronto U. (Canada).
AERODYNAMICS IN SLIP AND FREE MOLECULAR FLOW, G. N. Patterson. Project 7064(806A), Contract AF 33(616)-6990; ARR, ARL.

A comprehensive state-of-the art survey of free molecular flow and transition from continuum to free molecular flow has been prepared and published. This state-of-the-art survey is being extended to provide more complete information on satellite aerodynamics. Also, experimental work in low density flow is being conducted with the use of a whirling arm apparatus and a low density wind tunnel. An investigation is being made of near-free-molecule flow over a heated flat plate.

16.141

Toronto U. (Canada).
DEVELOPMENT OF AN ELECTRON GUN FOR GAS DENSITY MEASUREMENT, G. N. Patterson. Project 9782(806A), Contract AF 49(638)-281; SRE, AFOSR.

An electron gun is being developed which will operate outside a vacuum with a view to applying it in the investigation of gas flows. In conjunction with the design and calibration of the electron gun, experimental studies will be made of the expanding flow and of the efflux by spectrographic means and conventional probing techniques from a plasma generator. Then, static temperature measurements taken in a plasma jet can be compared and evaluated.

16.142

Toronto U. (Canada).
AERODYNAMICALLY GENERATED SOUND, H. S. Ribner. Project 9781(806A), Grant AF-AFOSR-62-267; SREM, AFOSR.

Theoretical and experimental research into the fundamentals underlying aerodynamically generated sound. The noise emanating from a boundary layer in contact with a rigid wall or a flexible skin will be studied. Also aeolean tones, wake noise, and the flux of noise energy from a region of shock-turbulence interaction will be investigated.

16.143

Toronto U. (Canada).
TRANSFER OF MASS, MOMENTUM AND ENERGY IN FREE MOLECULE SYSTEMS, G. N. Patterson. Project 9783(806A), Grant AF-AFOSR-62-98; SREM, AFOSR.

The basic objective is to develop and apply mathematical methods for treating multiple collision problems in free molecule aerodynamics, that is, problems in which intermolecular collisions may be neglected but multiple collisions between particles and a wall must be taken into account. These calculations will be supported by experiments using a low-density wind tunnel, a low density plasma tunnel, an electron gun technique, and, when possible, free flight tests in the atmosphere. The method or methods developed above will be applied to specific flux configurations. A concentrated effort is being made on internal flux systems, nozzles and diffusers, because of the present uncertainty and lack of information on the accommodation coefficients needed for external aerodynamic shapes. Included in these studies will be the determination of the distributions of mass flux through axially symmetrical systems as well as providing developments on momentum and energy flux.

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RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AERR- Research Division
AFWC- Air Force Special Weapons Center
SWR- Research Directorate
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ESER- Operational Applications Lab

16.144

Training Center for Aerodynamics, Rhode-St. Genese (Belgium).
KINETIC THEORY OF GASES, J. Smolderen. Project 9769 (803A), Grant AF-EOAR-62-46; SRMA, AFOSR.

This research concerns the theoretical study of a system of differential equations which arise from the study of the propagation of an unsteady shock front, and a system which arises in the study of hypersonic rarified flow over a semi-infinite plate.

16.145

Tulane U., New Orleans, La.
CONVECTIVE HEAT TRANSFER PHENOMENA UNDER SEPARATED FLOW CONDITIONS, H. H. Sogin. Project 7063(806A), Contract AF 33(616)-8481; ARM, ARL.

A previous study on convective heat transfer dealt with a flat plate strip oriented normal to an air stream. Additional experiments were performed with the plate at 25- and 65-degree angles of incidence. Other tests were performed with a half circular cylinder at the front of the basic flat plate. The purpose of the present study is to reduce the data obtained from the above-mentioned tests, apply second-order corrections, and further reduce the data to dimensionless form. The results from all tests will then be studied from the viewpoint of reaching any possible generalizations and conclusions.

16.146

University of Southern California, Los Angeles.
HYPERSONIC LOW DENSITY FLOW, L. Chuan. Project 9783 (806A), Contract AF 49(638)-831; SREM, AFOSR.

Theoretical studies are to be performed in conjunction with the experimental work. The following experimental studies are to be performed in the low density wind tunnel: (a) obtain detailed measurements of the flow fields about a flat plate and a thin cylinder with its axis parallel in the hypersonic low density flow; (b) perform shock wave structure studies; (c) obtain measurements of aerodynamic forces on hypervelocity vehicles in conditions of orbit or early re-entry; and (d) conduct studies of gas solid interface phenomena.

16.147

Vermont U., Burlington.
NONLINEAR SONIC PHENOMENA, W. L. Nyborg. Project 9751(801A), Contract AF 49(638)-968; SRPP, AFOSR.

This research is concerned with effects such as mass and heat transfer accompanying acoustic radiation both in continuous and pulsed sonic waves in liquids and at fluid-solid interfaces. The work considers non-linear theories, acoustic streaming, radiation pressure and so on. Extension will be made to microelectric effects accompanying small-scale, localized acoustic field phenomena.

16.148

Washington U., Seattle.
CRYOGENIC PHYSICS, J. G. Dash. Project 9751(801A), Grant AF-AFOSR-62-298; SRPP, AFOSR.

A study of the existence of vortex filaments to describe the specific heat anomally at the transition temperature from liquid helium-I to liquid helium-II. The study will include an experiment to observe the existence of vortex filaments using suspended particles to locate regions of no circulation.

16.149

Washington U., Seattle.
RAREFIED GASDYNAMICS, R. E. Street. Project 9781 (806A), Contract AF 49(638)-440; SRE, AFOSR.

The purpose of this project is to study the effect of introducing first order slip into the boundary conditions for the flow of a laminar boundary layer at large Mach number over a simply defined shape.

16.150

Weizmann Inst. of Science (Israel).
NUMERICAL INTEGRATION OF THE EQUATIONS OF VISCOUS FLUIDS, J. Gillis. Project 9783(806A), Contract AF 61(052)-352; SRE, AFOSR.

The contractor is studying the flow of a viscous liquid between non-parallel plane walls with and without intersection and flow through a straight circular pipe with varying inlet conditions. This work will include the development of analytical methods, notably expansions in Laguerre series.

16.151

Weizmann Inst. of Science (Israel).
THEORY OF TRANSPORT PHENOMENA IN RAREFIED GASES FROM FIRST PRINCIPLES OF GAS DYNAMICS, C. L. Pekeris. Project 7635(770A), Contract AF 61(052)-127; CRZA, AFCRL.

A theory of transport phenomena for rarefied gases using various mechanical gas models is developed starting with the rigid sphere and proceeding to models of considerable sophistication. The standpoint is that of the Boltzmann integral equation. Applications are now being made to problems of sound

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propagation, heat conduction, viscosity, diffusion, and drag as may occur in rarefied gaseous media.

16.152

Yale U., New Haven, Conn.
DENSITY MEASUREMENTS AND SOLID He^3, J. M. Kidder. Project 9751(801A), Grant AF-AFOSR-62-87; SRPP, AFOSR.

He^3 is the only gas which remains a liquid near 0°K and which obeys Fermi statistics. The liquid should have macroscopic properties which are strongly influenced by quantum statistics at these temperatures. Theory predicts the viscosity should vary as $1/T^2$, the thermal conductivity as $1/T$ and the specific heat as T. This work will be aimed at measuring the variation in thermal conductivity and extending the measurements of viscosity down to 0.1°K.

See also: 3.117, 8.4, 8.68, 11.11, 12.8, 12.21, 12.33, 12.51, 12.61, 12.92, 12.128-129, 15.27, 15.32, 15.53, 17.150, 18.28, 19.16, 19.24, 19.45, 19.64, 19.97, 19.106, 24.12, 24.16

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17. MATHEMATICS

Algebra; Differential Equations; Functions of Complex Variables; Geometry; Integral Transforms; Numerical Analysis; Probability; Statistics; Theory of Numbers; Topological Algebraic Structures; Topology; Mathematical Analysis (other); Mathematical Logic.

17.1

Aarhus U. (Denmark).
PROBABILITY THEORY, E. S. Andersen. Project 9752 (801A), Contract AF 61(052)-42; SRMM, AFOSR.

Work under this grant will be directed toward the investigation of decision theory. Andersen is studying the arc-sine line for independent, not identically distributed random variables. The arc-sine law under certain restrictions forms a stationary Markov process with discrete time.

17.2

Aarhus U. (Denmark).
MULTIVARIATE PROBLEMS OF NUMERICAL ANALYSIS, T. Busk. Project 9752(801A), Contract AF 61-(052)-322; SRMA, AFOSR.

This research concerns development of a general interpolation formula in n-variables, derivation of formulas for multiple integration, generalization of relations for orthogonal polynomials, and generalization of Clanshaw's method for solving ordinary differential equations to solving partial differential equations.

17.3

Applied Mathematics Research, Dayton, Ohio.
MATHEMATICAL METHODS IN NUMERICAL PROCESSES, G. Blanch. Project 7071(806A), Internal.

The principal effort consists of investigations of numerical processes wherever such investigations may be needed. Past and present efforts include methods for stepwise integration or ordinary differential equations, methods of using continued fractions and other algorithms with emphasis on error control, study of partial differential equations, and solutions of systems of linear equations. Studies also involve methods of using highspeed equipment for performing computations of particular complexity.

17.4

Applied Mathematics Research Lab., ARH, ARL, Dayton, Ohio.
APPLICATION OF THE CALCULUS OF VARIATIONS TO ENGINEERING PROBLEMS, K. G. Guderley. Project 7071(806A), Internal.

Most of the examples in variational calculus which one finds in the literature refer to problems where the physical laws that govern the particular problem can be represented as the consequence of some variational formulation. One usually talks of minimum principles in mathematical physics. There is a second class of problems which appears immediately in the form of a minimum or maximum problem, i.e., those where for engineering reasons a certain quantity is to be optimized. Strangely, such problems have not received too much attention, perhaps because (1) from a mathematical point of view the question seemed too obvious and (2) once one really writes down the problem, the numerical obstacles seem to be overwhelming. However, using high speed computers, the computation can be brought to tolerable dimensions. Two non-trivial problems of this character are under current investigation. The first is the determination of exhaust nozzles that give maximum thrust at a given surface area. (The constraint of a given surface area can be replaced by other constraints, e.g., some that are connected with the weight of the nozzle; also, the method would be flexible enough to allow the introduction of boundary layer correction). The second is an investigation of the determination of the best predicted orbit from continuous, but not necessarily complete, and somewhat inaccurate measurements. Here it is assumed that the satellite motion is determined solely by the gravitational field.

17.5

Applied Mathematics Research Lab., ARM, ARL, Dayton, Ohio.
MULTIPLE COMPARISONS AND NON-ADDITIVITY, H. L. Harter. Project 7071(806A), Internal.

Work in progress includes: (a) further study of non-additivity; and (b) computation of percentage

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points of the ratio of two normal ranges. The following work is planned: (a) publication of an ARL report on multiple comparisons which have been published in technical journals; and (b) computation of the probability integral of the mean range.

17.6

Applied Mathematics Research Lab., ARH, ARL, Dayton, Ohio.
OPERATIONS RESEARCH STUDIES, H. L. Harter. Project 7071(806A), Internal.

Investigations in the area of operations research with the idea of suggesting or developing better mathematical and statistical methods. The results of work previously performed on circular error probabilities have been published, and work has been completed in the following areas: (a) use of sample ranges in obtaining exact confidence bounds for the standard deviation of a rectangular population and (b) estimating the parameters of negative exponential populations by the use of one or two order statistics. Work is now in progress on the use of sample quasi-range in obtaining exact confidence bounds for the standard deviation of a normal population.

17.7

Applied Mathematics Research Lab., ARH, ARL, Dayton, Ohio.
NUMERICAL METHOD OF ANALYTIC CONTINUATION, H. L. Johnson. Project 7071(806A), Internal.

In the work described here Garabedian's method is applied to the determination of examples for axial symmetric flow patterns with a free stream Mach number one. The initial conditions must be described in a rather special manner in order to obtain a flow field of the desired character.

17.8

Applied Mathematics Research Lab., ARH, ARL, Dayton, Ohio.
ANALYSIS OF VARIANCE AND PROBABILITY, M. D. Lum. Project 7071(806A), Internal.

Effort is directed toward an understanding of fundamental questions in the analysis of variance. Particular emphasis is placed upon the choice of appropriate error terms, the structure of factor levels in an experiment, the nature of replication, and the role of randomization. This includes studies on highly fractionated designs, constrained randomization, and non-additivity of effects. A possible procedure to test for non-additivity is being investigated. Effort is also directed to the development of probabilistic models for applied mathematical problems. For example, in one problem, probability theory is the basis for determining the relative merits of teleprinter codes with respect to character errors for various bit error rates, the mode of reception being ternary rather than the usual binary case. In another problem, a probabilistic mathematical model is developed for determining the accuracy of grain counts in strongly enlarged photographs.

17.9

Arizona State Coll., Tempe.
CONTINUED FRACTIONS AND LINEAR OPERATORS, W. R. Scott. Project 9752(801A), Grant AF-AFOSR-62-310; SRMM, AFOSR.

This is research in modern analysis, in particular, in the theory of functions of complex variables, and their expansion by means of continued fractions. Specific topics include partially bounded linear operators, in particular as they relate to certain continued-fraction concepts, the relations between typically-real functions and continued fractions, and a certain difference scheme for some boundary value problems, again as related to continued fractions.

17.10

Boston U., Mass.
NONPARAMETRIC STATISTICS, G. E. Noether. Project 9783(806A), Grant AF-AFOSR-61-78; SRMM, AFOSR.

Work under this grant is classified as nonparametric methods and order statistics. Noether seeks to develop unified methods of treatment for basic problems of nonparametric statistics. This work often includes topics such as rank test procedures which are applicable when data occurs in a discrete form such as happens in test scores or measurements made on a finite sample of men.

17.11

British Columbia U., Vancouver (Canada).
NUMERICAL INTEGRATIONS OF ORDINARY DIFFERENTIAL EQUATIONS, T. E. Hull. Project 9752(801A), Grant AF-AFOSR-62-264; SRMA, AFOSR.

This research is in the field of contemporary numerical analysis. The investigation concerns the development of a mathematical theory of methods for the numerical integration of ordinary differential equations and the design of optimum methods.

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CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

17.12

British Columbia U., Vancouver (Canada).
MATRIX METHODS IN COMBINATORIAL PROBLEMS, M. Marcus. Project 9769(803A), Grant AF-AFOSR-62-85; SRMM, AFOSR.

This work falls under the general heading of linear algebra. Specifically, Marcus is studying matrices and vectors, the matrices often being doubly stochastic.

17.13

British Columbia U., Vancouver (Canada).
FUNCTIONAL ANALYSIS AND POTENTIAL THEORY, M. Sion. Project 9769(803A), Contract AF-AFOSR-61-90; SRMM, AFOSR.

This research is part of contemporary analysis, in particular of measure and integration, and concerns the theory of measures and capacities in topological spaces which arise from problems in functional analysis and potential theory. Specific topics include the study of analytic sets in topological spaces, the representation of linear functionals and capacities by measures, and the convolution of two measures and of a measure and a function.

17.14

British Columbia U. (Canada).
PROBLEMS ASSOCIATED WITH THE SCHRODINGER OPERATOR, C. A. Swanson. Project 9769(803A), Grant AF-AFOSR-61-89; SRMA, AFOSR.

This research concerns a group of problems associated with the Schrodinger operator, including the study of: problems related to Coulomb's scattering operator; the relations between convergence of a sequence of self-adjoint operators in a Hilbert Space and convergence of their spectral representation; and of the variations of eigenvalues for the Schrodinger operator under certain deformations of the surface.

17.15

Buffalo U., N. Y.
TRANSFORMATIONS USED IN MATHEMATICAL AND APPLIED STATISTICS, C. Severo. Project 7071(806A), Contract AF 33(616)-7619; AMM, ARL.

Investigation of: (a) the convergence to normality of functions of a normal random variable as some function of the parameters tends to a limit; (b) the effects of transformations on tests of hypotheses, using both analytic and Monte Carlo approaches, with the ultimate goal of investigating the effect on the power of the analysis of variance; and (c) the possibility of rigorously defining "robustness" of transformations and determining those situations where the definition may be usefully employed.

17.16

California Inst. of Tech., Pasadena.
NAVIER-STOKES AND RELATED EQUATIONS, P. A. Lagerstrom. Project 9783(806A), Grant AF-AFOSR-62-256; SRMA, AFOSR.

This research concerns the mathematics of motion of viscous fluids, involving the development of new techniques and methods for solving the Navier-Stokes equation, and the application of these techniques to behavior of solutions when both Reynolds number and Mach number tend to limiting values.

17.17

California U., Berkeley.
MODERN GROUP THEORY AND TOPOLOGY, B. Kostant. Project 9752(801A), Contract AF 49(638)-79; SRM, AFOSR.

This research involves two major efforts. The first is in topological algebraic structures, in particular lie groups and algebras, with specific attention to spinors, certain generalizations of the Schubert calculus, in the context of algebraic geometry. The second is in algebraic topology, with specific attention to a certain exact couple whose spectral sequence illuminates a certain group of homotopy classes, and to a study of the group of real vector bundles over the real projective spaces.

17.18

California U., Berkeley.
PARTIAL DIFFERENTIAL EQUATIONS, M. H. Protter. Project 9752(801A), Contract AF 49(638)-398; SRM, AFOSR.

This is research in analysis, in the area of partial differential equations. Specific topics include the asymptotic behavior of hyperbolic inequalities, generalized solutions for hyperbolic equations, including nonlinear ones, lower bounds for eigenvalues of elliptic equations, and certain considerations regarding the maximum principle.

17.19

California U., Berkeley.
ALGEBRAIC TRANSFORMATION GROUPS AND SPACES, M. Rosenlicht. Project 9769(803A), Grant AF-AFOSR-62-57; SRMM, AFOSR.

This research is in modern algebraic geometry, in particular, the theory of algebraic transformations. Specific attention is directed to the classification

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ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARE- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEDR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

of algebraic transformation spaces, including homogeneous spaces and principal fiber bundles, the conditions for the existence of quotient spaces, the classification of all algebraic transformation groups on certain classes of varieties, and some fixed point theorems.

17.20

California U., Berkeley.
MODERN ALGEBRAIC TOPOLOGY, E. H. Spanier. Project 9752(801A), Grant AF-AFOSR-62-354; SRMM, AFOSR.

This is research in algebraic topology, in particular the major concepts of algebraic topology and their application. Specific topics range through questions of homotopy type, the fundamental group, the geometry of simplicial complexes, the homology theory of complexes, through the homotopy groups and combinatorial manifolds.

17.21

California U., Berkeley.
PARTIAL DIFFERENTIAL EQUATIONS, J. F. Treves. Project 9783(806A), Contract AF 49(638)-604; SRM, AFOSR.

This research concerns the theory of partial differential equations, in particular the solution of such equations by distributions with values in variable topological spaces. The investigation examines partial differential operators and the existence of fundamental solutions for elliptic, hypoelliptic, parabolic, and hyperbolic type equations. A major part of the investigation concerns topics related to mixed partial differential problems. The specific goals include the extension of present, mixed-type results to distributions data and distributions solutions (the distribution being a modern generalization of function), and the investigation of general mathematical structures and methods in which such problems may be routinely solved. Such developments depend essentially on the newer functional and topological structures, which will be developed here in the context of these goals.

17.22

California U., Berkeley.
ALGEBRAIC STRUCTURES FOR MODERN FUNCTIONAL ANALYSIS; W. G. Bade. Project 9783(806A), Grant AF-AFOSR-62-140; SRMM, AFOSR.

This is research in topological algebraic structures, in particular in topological vector spaces and functional analysis. Specific topics revolve around the study of continuity properties of general homomorphisms of commutative Banach algebras, including consideration of the Wedderburn decomposition of commutative Banach algebras and the cohomology theory of Hochschild.

17.23

California U., Davis.
INFINITE AND DOUBLY HOMOGENEOUS ALGEBRAS, S. Stein. Project 9752(801A), Grant AF-AFOSR-62-299; SRMM, AFOSR.

This grant was let for research in the area of linear algebra.

17.24

California U., Los Angeles.
PROBLEMS IN POTENTIAL THEORY, J. W. Green. Project 9752(801A), Grant AF-AFOSR-61-14; SRMA, AFOSR.

This research concerns modern potential theory, which employs measures, the energy integral, and capacities, and includes all the developments in contemporary mathematics. The investigation is part of modern analysis, and its relation to physical and probabilistic processes.

17.25

California U., Los Angeles.
REGRESSION CURVES AND STATISTICAL TESTS, P. G. Hoel. Project 9752(801A), Grant AF-AFOSR-62-158; SRMM, AFOSR.

The overall areas covered by investigation under this grant are included in estimation theory. Hoel will study the errors arising in regression theory when an incorrect mathematical model is chosen.

17.26

California U., Los Angeles.
INVARIANTS IN ALGEBRAIC TOPOLOGY, S. T. Hu. Project 9769(803A), Grant AF-AFOSR-62-43; SRMM, AFOSR.

This is research in algebraic topology, in particular of invariants in algebraic topology. Specific attention is directed to the study of outstanding unsolved classical problems in topology, by means of new algebraic isotopy invariants of spaces, more directly, the introduction and investigation of those isotopy invariants which help in investigating the imbedding of a given space in a given Euclidean space and the classification of the spaces of the same homotopy type.

17.27

Inst. of Tech., Pittsburgh, Pa.
CONFORMAL AND VARIATIONAL METHODS, Z. Nehari. Project

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CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

9783(806A), Contract AF 49(638)-227; SRMM, AFOSR.

This research is in modern mathematical analysis, in particular, select topics in the theory of ordinary and partial differential equations. Specific topics include disconjugacy criteria for a certain nth order equation, necessary and sufficient conditions for the existence of proper solutions for a certain nonlinear second order equation, the study of a certain nonlinear wave equation, the study of the relation between Hilbert problems for analytic functions of a complex variable and boundary value problems for elliptic equations, and considerations involving second order linear equations with periodic and almost-periodic coefficients.

17.28

Carnegie Inst. of Tech., Pittsburgh, Pa.
TRANSFORMATIONS IN THE ANALYSIS OF VARIANCE, E. G. Olds. Project 7071(806A), Contract AF 33(616)-8234; ARM, ARL.

Investigation of the following: (a) the theory of various transformations in the analysis of variance, including square-root, logarithmic, and reciprocal; (b) the relative importance of homogeneity of variance and additivity of effects in the analysis of variance; (c) the procedure for the analysis of variance applied to variances, with particular attention given to the transformation required and to the optimum division of the observations into subgroups; (d) the best procedure for the analysis of variance of attributes data (binomially distributed); and (e) transformations to standard normal scores and other transformations designed to bring about normality.

17.29

Case Inst. of Tech., Cleveland, Ohio.
ORDER STATISTICS AND NONPARAMETRIC ANALYSIS, F. C. Leone. Project 9783(806A), Grant AF-AFOSR-62-72; SRMM, AFOSR.

This work falls under the heading of nonparametric methods and order statistics. Leone's principal work during the past several months, has been on the "folded normal" distribution.

17.30

Case Inst. of Tech., Cleveland, Ohio.
ABSTRACT SORTING ALGORITHMS, R. J. Nelson. Project 9752(801A), Grant AF-AFOSR-62-203; SRMA, AFOSR.

This research is concerned with devising a theory which will permit sorting, i.e., decision making, ordering in a more effective manner. Sorting on the usual computers is extremely time-consuming as it is basically an iterative procedure. The results of this investigation show that by use of Turing machines, ordering can be done as a simultaneous procedure.

17.31

Case Inst. of Tech., Cleveland, Ohio.
THEORY OF QUEUES, M. W. Sasieni. Project 7071(806A), Contract AF 33(616)-6446; ARM, ARL.

A literature survey was made and the main techniques which have been used in the analysis of queueing systems were summarized. The following problems were investigated: (a) a two-counter problem, where arrivals join the shorter queue; (b) some numerical methods for determining the transient behavior of finite queues; (c) double queues, with impatient customers and service clerks; (d) the use of Laplace transforms in the analysis of queues; (e) the relation among the mean arrival rate, the mean number in the system, and the mean waiting time; (f) the application of queueing theory to job-shop analysis; and (g) the estimation of system parameters from observations on the behavior of the queue.

17.32

Catholic U. of America, Washington, D. C.
PROBABILITY THEORY AND MATHEMATICAL STATISTICS, E. Lukacs. Project 9752(801A), Grant AF-AFOSR-61-32; SRMM, AFOSR.

This grant is for work in the general area of foundations of mathematics. Work will be done on characteristic functions and their applications.

17.33

Catholic U. of Brazil, Rio de Janeiro.
GENERAL THEORY OF LINEAR SYSTEMS, B. Gross. Project 9783(806A), Contract AF 49(638)-648; SRE, AFOSR.

The contractor motivated by the physical situations underlying such problems as viscoelasticity and other analogous linear systems will: (a) develop a generalized treatment of "classical" linear systems and then, (b) investigate the relations between the "classical" theory of linear systems and the scattering and dispersion theories of quantum field theory, (c) develop a theory of improper functions based on the theory of boundary values of analytic functions, (d) investigate the implications of transfer motion formulae of improper functions, and (e) investigate the relations between the Gross theory of spectra and other existing linear systems theories such as the Laurent Schwartz theory of distributions.

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RAS- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEXR- Research Division
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SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
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17.34

C-E-I-R, Inc., Beverly Hills, Calif.
CRITERIA FOR PEARSON TYPE III AND OTHER DISTRIBUTIONS, M. P. Peisakoff. Project 7071(806A), Contract AF 33 (657)-7900; ARM, ARL.

For the Pearson Type III distribution, a study of criteria shall be made based on certain relations satisfied by the first four moments and/or other criteria, so that it can be determined from samples whether the sample data can reasonably be supposed to have come from a Type III population. The analytical study shall be supplemented, if necessary, by use of Monte Carlo methods. A similar study shall be made for other distributions, especially other members of the Pearson family of frequency distributions.

17.35

Chicago U., Ill.
MATHEMATICS INVESTIGATIONS, A. A. Albert, Project 9752(801A), Contract AF 49(638)-858; SRM, AFOSR.

Two years of concentrated study will take place. The first of these years will be devoted to analysis and the second to linear algebras.

17.36

Chicago U., Ill.
ALGEBRAIC MECHANISM OF FIBER SPACES, S. MacLane. Project 9769(803A), Contract AF 49(638)-568; SRMM, AFOSR.

Research under this contract is classified as homological algebra. It includes group theory, Lie theory, and fiber bundles.

17.37

Chicago U., Ill.
APPLIED MATHEMATICS, M. Shinbrot. Project 9752 (801A), Grant AF-AFOSR-62-136; SRMA, AFOSR.

The research concerns the application of a method for ascertaining solvability of certain classes of integral equations to Latta's method for their solution. This method is constructive and will yield asymptotic expansions for a solution of a wide class of integral equations, e.g., diffraction through a slit, and the capacity of a circular plate condenser.

17.38

Chicago U., Ill.
HILBERT TRANSFORM AND RELATED TOPICS, A. Zygmund. Project 9783(806A), Contract AF 49(638)-451; SRMM, AFOSR.

This research is in mathematical analysis, and in particular, the theory of integral transforms. Specific attention centers around the Hilbert transform and its applications, in particular, problems on real variables and singular integrals concerning the finer structure of real-valued functions, and problems in Fourier series involving the behavior of trigonometric series of positive measure.

17.39

Colorado State U., Fort Collins.
DETERMINATION OF SAMPLE SIZE, F. A. Graybille. Project 9769(803A), Grant AF-AFOSR-61-80; SRMM, AFOSR.

This research falls in the area of design and analysis of experiments. Its objective is to determine the number of samples that are necessary for a specified length confidence interval on parameters of several different statistical distributions.

17.40

Colorado State U., Ft. Collins.
APPROXIMATION USING ORTHOGONAL FUNCTIONS, F. M. Stein. Project 9769(803A), Grant AF-AFOSR-62-219; SRMA, AFOSR.

This research concerns approximating the solutions of differential, integral and integro-differential equations using orthogonal functions in the approximating sum. Also, a search will be made to discover new types of orthogonal functions to use in these approximations.

17.41

Colorado U., Boulder.
CONTINUED FRACTIONS, W. J. Thron. Project 9752 (801A), Contract AF 49(638)-100; SRM, AFOSR.

This research is in mathematical analysis, in particular, the theory of functions of complex variables and their continued fraction expansion. Specific topics include the convergence regions and related value regions for continued fractions, the representations of analytic functions by means of continued fraction expansions, the determination of singular points of functions in terms of the coefficients of their continued fraction expansion, and the convergence behavior of sequences of linear fractional transformations.

17.42

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
MATHEMATICAL THEOREM-PROVING, M. D. Resnik. Project 5632(803A), Internal.

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  - CRBC- Thermal Radiation Lab
  - CREE- Research Instrumentation Lab
  - CREG- Terrestrial Sciences Lab
  - CREM- Meteorological Research Lab
  - CREI- Ionospheric Physics Lab
  - CRER- Sacramento Peak Observatory

Machine theorem proving is being investigated. In order to program computers to successfully prove non-trivial mathematical theorems, various tasks must be carried out. These include the formalization of the various mathematical theories, the investigation of efficient proof procedures, and the actual programming of the machines.

17.43

Connecticut U., Storrs.
TRIGONOMETRIC POLYNOMIALS AND FOURIER SERIES, R. P. Gosselin. Project 9752(801A), Contract AF 49(638)-608; SRM, AFOSR.

This research is in mathematical analysis, in particular, the theory of trigonometric series, including trigonometric polynomials and trigonometric interpolation. Specific topics include convergence considerations involving the Jackson polynomials, translation continuity and trigonometric polynomials, certain localization and uniqueness problems, the relation between certain results in diophantine approximation and the convergence of trigonometric polynomials, and the investigation of special integral inequalities.

17.44

Consejo Superior de Investigaciones Cientificas, Madrid (Spain).
SEMI-ANALYTICAL FUNCTIONS, R. San Juan. Project 9752(801A), Contract AF 61(052)-316; SRM, AFOSR.

This research concerns the theory of semi-analytic functions, their properties and their behavior. The studies include an investigation of semi-analytical classes in convex regions, circular convex domains, and distances in convex regions. Work will be done on the application of these functions for the summation of divergent series as well as in the uniqueness of asymptotic expansions.

17.45

Cornell U., Ithaca, N. Y.
STATISTICAL MULTIPLE DECISION PROCEDURES, R. E. Bechhofer. Project 9752(801A), Contract AF 49(638)-230; SRM, AFOSR.

This contract was let for investigations in the general area of decision theory. Specifically this project is aimed at improving approximation formular in the area of sequential multiple-decision identification and ranking procedures.

17.46

Cornell U., Ithaca, N. Y.
PROBABILITY THEORY AND ANALYSIS, J. Wolfowitz. Project 9752(801A), Contract AF 49(638)-226; SRM, AFOSR.

This contract is let for investigations in the area of stochastic processes. Specific emphasis is given to research in analysis related to probability, statistics, and related fields.

17.47

Cornell U., Ithaca, N. Y.
PROBLEMS IN PROBABILITY, MATHEMATICAL STATISTICS, AND INFORMATION THEORY, J. Wolfowitz. Project 9783(806A), Contract AF 49(638)-830; SRMM, AFOSR.

Stochastic processes are the focal points for these research activities. The work includes study of mathematical statistics, probability theory, and areas of analysis and topology related to them.

17.48

Dartmouth Coll., Hanover, N. H.
FUNCTIONAL ANALYSIS AND PROBABILITY THEORY, J. G. Kemeny. Project 9783(806A), Grant AF-AFOSR-62-4; SRMA, AFOSR.

The research will be in functional analysis, potential theory, graph theory, probability theory, topology, computing machines and logic, and at the same time, adapt modern mathematics to a readily communicable and usable form.

17.49

Dayton U., Ohio.
EMBEDDING THEORY: RIEMAN SUBSPACES IN RIEMANN SPACE, J. L. Nanda. Project 7114(801A), Contract AF 33(657)-7228; ARP, ARL.

This work concerns research into the imbedding theory of a family of m-dimensional holonomic subspaces V_m and of non-holonomic subspaces V_m^n in an n-dimensional Riemann space.

17.50

Directorate of Research Analysis, SRAS, AFOSR, Washington, D. C.
OPTIMIZATION TECHNIQUES, H. A. Malkus. Project 7856(806A), Internal.

This research is directed toward examining proposed optimization schemes or solutions for their efficiency in providing reliable answers in realistic cases. By simulating the flight process under investigation on an analog computer and by comparing various approaches with the devised solution a better insight into the physical nature of the problem can be obtained.

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RAUA- Advanced Development Lab
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APGC- Air Proving Ground Center
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17.51

Documentation Incorporated, Washington, D. C.
STUDIES IN MODAL LOGIC, R. M. Jones. Project 9769 (803A), Contract AF 49(638)-1146; SRI, AFOSR.

This project is for study of various extensions of formal logical operations applicable to computers. The principal studies will be devoted to modal logic.

17.52

Duke U., Durham, N. C.
PARTIAL DIFFERENTIAL EQUATIONS, J. J. Gergen. Project 9752(801A), Grant AF-AFOSR-62-162; SRMA, AFOSR.

This research concerns the existence and properties of the solutions of both hyperbolic and elliptic partial differential equations, Euler-Poisson-Darboux equation, convergence and stability problems in numerical integration of partial differential equations and systems of non-linear differential equations.

17.53

Erlangen U. (Germany).
COMPLEX ANALYSIS, R. Remmert. Project 9752(801A), Grant AF-EOAR-61-50; SRMM, AFOSR.

This research is in mathematical analysis, in particular, the theory of functions of several complex variables. Specific topics include the theory of complex spaces, coherent analytic sheaves and their cohomology groups, the function theory on Stein spaces, holomorphic fiber bundles, and the study of branched coverings of complex spaces.

17.54

Florida State U., Tallahassee.
SERIES IN LINEAR TOPOLOGICAL SPACES AND THEIR APPLICATION, C. W. McArthur. Project 9752(801A), Grant AF-AFOSR-62-27; SRMM, AFOSR.

This is research in topological algebraic structures, in particular in topological vector spaces and functional analysis. Specific topics center around the theory of unconditionally convergent series in linear topological spaces, and include the linear space of unconditionally summable sequences in a linear topological space, Banach spaces with unconditional bases, and some related questions.

17.55

Florida State U., Tallahassee.
NUMERICAL ANALYSIS AND PARTIAL DIFFERENTIAL EQUATIONS, E. P. Miles. Project 9752(801A), Grant AF-AFOSR-61-12; SRM, AFOSR.

This research concerns numerical analysis and the study of polynomial solutions for partial differential equations. The study of numerical methods relates to matrices and the solution of difference equations, to matrix inversion, and to the use of matrix and difference equation methods for the solution of differential equations. The study of polynomial solutions relates to certain classes of polynomials as appropriate for the numerical solution of differential equations (in particular using a high-speed computer), and specially adapted for the solution of boundary value problems. An additional investigation concerns the series expansions of polynomial solutions for differential equations.

17.56

Florida State U., Tallahassee.
TOPOLOGY AND COMPLEX ANALYSIS, F. L. Plunkett. Project 9783(806A), Contract AF 49(638)-598; SRM, AFOSR.

This research concerns the application of general topological methods to mathematical analysis. Specifically, it involves the development of topological analysis, e.g., the topological foundations of function theory, with special emphasis on the differential calculus of functions of a complex variable. The overall aim is to prove basic properties implied by the assumption of differentiability of a complex function in a region, by purely topological techniques. It also includes a topological analysis of the singularities of functions of a complex variable. And it includes the development of a purely topological proof of the classical theorem on the representability of an analytic function in a Taylor series, the possible applications of the techniques of topological analysis to unsolved problems of plane topology, and studies designed to decrease the preparation required for the study of topological analysis.

17.57

Florida U., Gainesville.
SOME PROBLEMS IN MATRIX THEORY, H. Minc. Project 9752(801A), Grant AF-AFOSR-62-168; SRMA, AFOSR.

This research concerns non-negative matrices, double stochastic matrix, the permanent of a matrix and certain theorems concerning characteristic roots of matrices.

17.58

Geneva U. (Switzerland).
FUNCTIONAL EQUATIONS, G. I. Targonski. Project 9783 (806A), Contract AF 61(052)-602; SRMM, AFOSR.

Targonski's work must be classified generally as

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CRRC- Electronic Material Sciences Lab
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CRRI- Astroservaillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRT- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
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CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

analysis with special attention to difference equations and to functional equations. His immediate aim is to produce a dictionary of functional equations.

17.59

Gothenberg U. (Sweden).
NON-NORMAL STATISTICS, H. Hyrenius. Project 9752 (801A), Contract AF 61(052)-459; SRM, AFOSR.

This project is concerned with statistical procedures based on a normal universe and with the effects on these procedures of deviations in the data from this assumption Statistical methods based on the assumption of a normal universe are in very wide use and are often applied without justification. The present investigation should throw light on the condition under which the use of such methods is legitimate, and to show in what cases other methods are called for.

17.60

Grumman Aircraft Engineering Corp., Bethpage, N.Y.
AIR VEHICLE FLIGHT PATH OPTIMIZATION, H. J. Kelley. Project 7856(806A), Contract AF 29(600)-2671; SRAS, AFOSR.

This work is directed toward development of techniques suitable for attacking the flight path optimization problem. Numerical solutions are sought for problems involving minimum fuel, minimum flight time, maximum range and the like. The computational scheme employing the gradient method and the "penalty function" technique -- as devised by Dr. H. Kelley -- is applied to carry out investigations concerned with: (1) assessment of effects due to the linearization introduced by the use of the "steepest descent" technique; (2) examination of computational procedures and computer subroutines for possible efficiency and accuracy improvements; and (3) analyses of characteristic properties of optimal air vehicle trajectories including performance trade-offs.

17.61

Grumman Aircraft Engineering Corp., Bethpage, N.Y.
JACOBI CONJUGATE POINT THEORY, H. J. Kelley. Project 7856(806A), Contract AF 29(600)-2733; SRAS, AFOSR.

This research is directed toward the development of a method of numerical computation of the Jacobi criterion -- a mathematical tool for the appraisal of solutions of a variational problem -- applicable to: (1) extremals of low thrust vehicles in interorbital transfer; (2) the solar sail problem, and (3) other selected variational problems useful in understanding possible conjugate point phenomena.

17.62

General Physics Research Lab., ARP, ARL, Dayton, Ohio.
RIEMANN SPACES, R. P. Kerr. Project 7114(801A), Internal.

Under a prior effort in this project, Dr. J. F. Schell developed a classification of Riemannian spaces in terms of the bivector generators of the infinitesimal-holonomy group (ihg). This approach was shown to be closely related to an earlier classification due to A. Z. Petrov. In this effort we study the three Petrov classes using additional information given by the differential properties of the curvature tensor through the ihg. A study of the relation between the functionally independent scalars of a Riemann space and the group of motions in that space is also in progress.

17.63

Harvard U., Cambridge, Mass.
TOPOLOGY OF LIE GROUPS AND THEIR HOMOGENEOUS SPACES, R. Bott. Project 9783(806A), Contract AF 49(638)-1035; SRMM, AFOSR.

This is research in topological algebraic structures, in particular the topology of Lie groups and their homogeneous spaces. Specific topics include specific geometric methods for symmetric spaces, questions of cohomology and periodicity related to the classical groups, and the analysis of symmetric bounded domains.

17.64

Harvard U., Cambridge, Mass.
PROBABILITY, STATISTICS AND MECHANICS, S. Goldstein. Project 9783(806A), Grant AF-AFOSR-62-74; SRMM, AFOSR.

This grant is classified as foundations of probability. Specifically, manuscripts left by Professor R. Von Mises concerning the theory of probability and statistics are being examined and edited for publishable material.

17.65

Harvard U., Cambridge, Mass.
CLASSICAL ANALYSIS, J. L. Walsh. Project 9769(803A), Contract AF 49(638)-574; SRMM, AFOSR.

This research is in modern mathematical analysis, in particular, the theory of functions of complex variables and approximation theory. Specific topics include the approximation of an analytic function by bounded polynomials, related to approximation,

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ART- Thermomechanics Research Lab
ARH- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAE- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AnCR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

best approximations, least norm approximation, oscillation properties and the location of zeros.

17.66

Harvard U., Cambridge, Mass.
ALGEBRAIC LINEAR SYSTEMS, O. Zariski. Project 9782 (806A), Contract AF 49(638)-494; SRM, AFOSR.

This research concerns studies in algebraic geometry, in particular the reduction of singularities of an algebraic variety, and the establishing of a Riemann-Roch theorem for sufficiently high multiples of a given linear system on an algebraic variety. The first of these topics concerns the general problem of reduction of singularities as part of a general solution of the global problem, and is important for the validity of practically all the basic theorems concerning fields of algebraic functions of several variables. The latter studies are related to the still unsolved fourteenth problem of Hilbert.

17.67

Hebrew U., Jerusalem (Israel).
MATHEMATICAL ANALYSIS, S. Agmon. Project 9752(801A), Contract AF 61(052)-187; SRMM, AFOSR.

This research is an important contemporary areas of mathematical analysis. Specific topics include problems related to convex bodies and rearrangement of series in Banach spaces, elliptic partial differential equations of higher order and related boundary value problems, initial value problems and differential algebra, operators in Hilbert space with applications to differential equations, Toeplitz matrices with applications to probability theory, and Tauberian theorems and summability methods.

17.68

Hebrew U., Jerusalem (Israel).
MATHEMATICAL ANALYSIS, B. Grunbaum. Project 9783 (806A), Contract AF 61(052)-187; SRMM, AFOSR.

This research is in modern geometry, in particular, the theory of convex domains and distance geometries. Specific topics revolve around Helly's theorem on the intersection of convex sets, including intersection by subspaces, intersections of translates, intersections of affine transforms, and intersections of convex sets in spherical spaces, and around the development of the general theory of functionals on convex sets.

17.69

Illinois U., Urbana.
SPACES ADMITTING SIGNIFICANT FIXED POINT INDICES, D. G. Bourgin. Project 9783(806A), Contract AF 49 (638)-543; SRM, AFOSR.

This research concerns fixed point properties of general topology. It has two major directions. The first is the extension of the class of spaces admitting a significant index, to comprise spaces without local connectivity. Spaces introduced are those admitting approximation in some sufficiently uniform way as regards mapping properties, by locally connected spaces admitting a significant index. The exact relation between the spaces so introduced and especially their local topological structures are matters of explicit concern. The second major direction is an investigation of the existence theorems in analysis that can be formulated as fixed point theorems, e.g., in operator theory for both linear and nonlinear operators on not necessarily linear spaces.

17.70

Illinois U., Urbana.
RELATIONSHIP BETWEEN CURVATURE AND HOMOLOGY IN REAL AND COMPLEX MANIFOLDS, S. I. Goldberg. Project 9783 (806A), Grant AF-AFOSR-62-129; SRMM, AFOSR.

This research is in modern differential geometry. Attention is centered on the local and global properties of both real and complex manifolds, in particular, the relationship between the curvature properties of Riemannian manifolds and their global structure, and the effect of curvature and homology on the existence and properties of certain transformation groups of these manifolds.

17.71

Illinois U., Urbana.
CONSTRUCTION OF SMALL FUNCTIONS WITH PRESCRIBED ZEROS, L. A. Rubel. Project 9752(801A), Contract AF 49(638)-517; SRM, AFOSR.

This research concerns an important area of classical analysis, the construction of small functions with prescribed zeros. A large number of classical problems come under this classification, that of constructing the "smallest" function satisfying certain growth and regularity conditions, and vanishing on a given set of complex numbers. In fact, many interpolation, moment, uniqueness and expansion problems are included under this heading.

17.72

Institute for Advanced Study, Princeton, N. J.
ADVANCED MATHEMATICAL RESEARCH, M. Morse. Project 9783(806A), Contract AF 49(638)-253; SRMM, AFOSR.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
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CRRZ- Control Sciences Lab
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These research investigations embrace most of the contemporarily important areas of mathematics, in analysis, functional analysis, topology, geometry and algebra. Distinguished and promising mathematicians are invited to spend an (academic) year at the Institute, by the professors of mathematics at the Institue, and devote their entire attention and energies to outstanding problems of contemporary mathematics. Recent research investigations include important problem areas of analysis and functional analysis, relating to analytic functions and compact groups, the stability of compact submanifolds of complex manifolds, a study of hyperbolic differential equations, including existence proofs for Cauchy's problem and an analysis of the singularities of the elementary solutions, the lattice points in hyperbolic space, the conformal type of surfaces in Euclidean space, and some considerations regarding bounded entire functions of exponential type.

17.73

Instituto de Matematica Pura e Aplicada, Rio de Janeiro (Brazil).
STRUCTURAL STABILITY AND DIFFERENTIAL TOPOLOGY, M. M. Peixoto. Project 9769(803A), Grant AF-AFOSR-61-75; SRMM, AFOSR.

This research is in analysis, in particular in the theory of systems of ordinary differential equations. It is specifically concerned with the topological characterization, in terms of structural stability, of such systems of equations and their solution, in the natural context of the topology of differentiable manifolds.

17.74

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
NUMERICAL ANALYSIS, P. F. Fougere. Project 7601 (770A), Internal.

The in-house effort is concerned with the theoretical aspects of the numerical analysis problem.

17.75

Iowa State Coll., Ames.
ANALYSIS OF VARIANCE PROCEDURES, O. Kempthorne. Project 7071(806A), Contract AF 33(616)-8269; ARM, ARL.

(a) Explore the notion of constrained randomization by comparing randomization tests for the unconstrained situation with those for the constrained situation, also by comparing with other well known non-parametric tests. (b) Investigate the role that random sampling plays in chopping particular fractionally replicated plans from orthogonal arrays. (c) Consider the integration of general linear hypothesis theory and randomization theory. (d) Inquire further into the nature of structures of factors in experimentation. (e) Exhibit the properties of variances and covariances of mean squares. (f) Study missing value techniques and give an account of their practical use.

17.76

Iowa U., Iowa City.
CALCULUS OF VARIATIONS AND BOUNDARY VALUE PROBLEMS, W. T. Reid. Project 9783(806A), Contract AF 49(638)-994; SRMM, AFOSR.

This research is in mathematical analysis, in particular, the theory of ordinary differential equations. Attention centers around variational methods for the solution of such equations, and includes consideration of the spectral theory for boundary value problems, comparison and oscillation theorems for differential systems and single equations of higher order, and the determination of the quantitative nature of the solutions.

17.77

Istanbul U. (Turkey).
CONFORMAL MAPPINGS, A. N. Terzioglu. Project 9783 (806A), Contract AF 61(052)-422; SRM, AFOSR.

In the ordinary application of conformal mapping to airfoil theory, it is necessary to determine a function which transforms a nearly circular domain into a circle. In the usual approximation methods boundary values for integral equations are determined on an electronic computer. One disadvantage of these methods is that the kernels of the equations depend on the domain used. This investigation will be aimed at eliminating this disadvantage and making other improvements such as simplification of computing.

17.78

John Hopkins U., Baltimore, Md.
EXISTENCE AND PROPERTIES OF SOLUTIONS OF DIFFERENTIAL EQUATIONS, P. Hartman. Project 9783(806A), Grant AF-AFOSR-62-45; SRMM, AFOSR.

This research is in mathematical analysis, in particular, in the theory of ordinary and partial differential equations. Specific topics include the generalization of eigenfunction expansions associated with an n-th order ordinary differential equation to a system of n first order equations; certain singular boundary value problems associated with a nonlinear ordinary equation occurring in boundary layer theory; the uniqueness, existence in the large and asymptotic

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RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
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behavior of solutions of certain hyperbolic equations; and a study of a certain maximum principle.

17.79

Lehigh U., Bethlehem, Pa.
RIEMANNIAN AND COMPLEX MANIFOLDS, C. C. Hsiung. Project 9769(803A), Contract AF 49(638)-1009; SRMM, AFOSR.

This research is in modern geometry, in particular, the theory of manifolds and connections. Specific topics include the extension of Minkowski's and other classical uniqueness theorems to the most general form, the study of conditions for a complex manifold with boundary to be flat, and the study of infinitesimal motions on Riemannian or complex manifolds with boundary.

17.80

Liege U. (Belgium).
HYPERBOLIC DIFFERENTIAL EQUATIONS, F. J. Bureau. Project 9752(801A), Contract AF 61(052)-86; SRMM, AFOSR.

This is research in analysis, in particular in the theory of hyperbolic differential equations. Specific topics include the Cauchy problem for partial differential equations or order and number of independent variables greater than 2, linear operators associated with integrals otherwise divergent, and boundary value problems for totally hyperbolic equations in several independent variables.

17.81

Manitoba U. (Canada).
ORTHOGONAL LATIN SQUARES AND RELATED TOPICS, N. S. Mendelsohn. Project 9752(801A), Grant AF-AFOSR-62-235; SRMM, AFOSR

Mendelsohn works in the field of design and analysis of experiments. He will work specifically on design of latin squares, orthogonal designs, and graph and game theory.

17.82

Marquette U., Milwaukee, Wis.
APPLICATIONS OF CONTINUED FRACTIONS TO MATHEMATICAL ANALYSIS, E. P. Markes. Project 9752(801A), Grant AF-AFOSR-61-34; SRMM, AFOSR.

This research is in mathematical analysis, in particular, the theory of functions of complex variables and continued fractions. Specific attention is directed to the relation between continued fractions and the solution of differential equations, the relation between continued fractions and certain typically-real functions, and associated results concerning value region problems and certain Stialtjes transform type representation of functions.

17.83

Maryland U., College Park.
ELLIPTIC, HYPERBOLIC AND PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS, A. Douglis. Project 9783(806A), Contract AF 49(638)-590; SRM, AFOSR.

This research concerns a group of related problems in the theory of partial differential equations, including elliptic types of equations, hypoelliptic operators, hyperbolic equations, and related questions concerning singular integral operators. The investigation of elliptic types of equations includes the development of boundary estimates, and the existence of solutions, for boundary problems of very general elliptic systems. It includes questions of the analytic continuation, and the unique continuation, of such solutions. The investigation of the new type of hypoelliptic operator includes the complete characterization of operators with variable coefficients, the determination of a class of operators which are invariant under coordinate transformations, and the determination of the fundamental solutions of operators with variable coefficients.

17.84

Massachusetts Inst. of Tech., Cambridge.
GEOMETRY OF MANIFOLDS, W. Ambrose. Project 9769 (803A), Contract AF 18(603)-91; SRMM, AFOSR.

This research is in modern geometry, in particular, the theory of manifolds and connections, and some related aspects of mathematical analysis, specifically the theory of partial differential equations. Attention is directed to the investigation of the Jacobi connection of a Riemannian manifold, the analysis of the curvature tensor of a Riemannian manifold, an investigation of the minimizing properties of minimal surfaces, Fourier analysis on symmetric and homogeneous spaces, and considerations regarding the boundary of a domain of holomorphy for complex manifolds.

17.85

Massachusetts Inst. of Tech., Cambridge.
PROBLEMS IN ANALYTIC NUMBER THEORY, H. C. Ankeny. Project 9783(806A), Contract AF 49(638)-76; SRAM, AFOSR.

This research is in modern analytical number theory. Specific topics revolve around the study of definite

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quadratic forms and cubic curves which are locally degenerate, including the application of some new methods and techniques, including geometric ones, to the solution of contemporary problems in these areas.

17.86

Massachusetts Inst. of Tech., Cambridge.
ALGEBRA, ABSTRACT VARIETIES AND POTENTIAL THEORY, W. T. Martin. Project 9769(803A), Contract AF 49(638)-42; SRMM, AFOSR.

Current research topics include certain representations and harmonic analysis of a particular unimodular group, the fundamental groups on a Lorentz manifold, the Lorentz structures on a plane, certain singular integral equations and boundary value problems, commutative boolean algebras of projections, and certain inequalities for statistical metric spaces.

17.87

Massachusetts Inst. of Tech., Cambridge.
NUMERICAL ANALYSIS; P. M. Morse. Project 9783(806A), Grant AF-AFOSR-62-348; SRMA, AFOSR.

Research is in numerical solutions of partial differential equations, numerical techniques for approximation of functions and operators, numerical techniques for problems of optimization, and classical numerical analysis.

17.88 Miami U., Coral Gables, Fla.
ANALYTIC PROPERTIES OF A MARKOV PROCESS, D. G. Austin. Project 9752(801A), Contract AF 49(638)-184; SRMM, AFOSR.

Investigation of Markov processes formed the basis of this contract. A comprehensive study of the analytical properties of a Markov process in both the denumerable state case and the abstract state case was made.

17.89

Miami U., Coral Gables, Fla.
INTERPOLATION WITH POLYNOMIALS TO BOUNDARY VALUES, J. H. Curtiss. Project 9769(803A), Grant AF-AFOSR-62-189; SRMA, AFOSR.

This research investigates the asymptotic properties of harmonic polynomials. Matrix norms are applied to the kernal of a polynomial. Essentially this is a new method of approach making use of Matrix theory in the theory of linear operators.

17.90

Miami U., Coral Gables, Fla.
PROJECTIONS AND EXTENSIONS, A. Sobczyk. Project 9752 (801A), Contract AF 49(638)-1055; SRMM, AFOSR.

This research is in modern algebraic topological structures, in particular, the theory of topological vector spaces and functional analysis. Specific attention is directed to some problems about projections in topological linear spaces and algebras, and the extension or enlargement of linear transformations and algebras, employing geometric, analytic, topological, metric and algebraic approaches.

17.91

Michigan U., Ann Arbor.
SINGULAR INTEGRAL EQUATIONS WITH SPECIAL REFERENCE TO BOUNDARY VALUE PROBLEMS, A. E. Heins. Project 9783 (806A), Grant AF-AFOSR-62-341; SRMA; AFOSR.

This research will apply function theoretic methods to certain integral equations arising in the mathematical theory of diffraction and encompassing such disciplines as acoustics and electromagnetic theory, and mixed boundary value problems. By using the formulation by a representation of Poisson instead of the often used Helmholtz equation, more detailed mathematical results may be obtained.

17.92

Michigan U., Ann Arbor.
BOUNDARIES AND BOUNDARY BEHAVIOR, G. Piranian. Project 9752(801A), Contract AF 49(638)-633; SRM, AFOSR.

The mathematical area embracing this contract is complex analysis, especially behavior on the boundary. More specifically, primary effort will be devoted to the boundary structure of domains and of functions continuous on an open disk.

17.93

Michigan U., Ann Arbor.
THEORY OF SPHEROIDAL AND MATHIEU FUNCTIONS, F. B. Sleator. Project 9783(806A), Grant AF-AFOSR-62-265; SRMA, AFOSR.

This research will endeavor to relate the spheroidal wave functions, arising from scattering and diffraction theory, to spherical functions which involve elliptic equations, and to find explicit expressions for the functions and their coefficients.

17.94

Michigan U., Ann Arbor.
TOPOLOGY AND MODERN ALGEBRA, R. L. Wilder. Project 1783(806A), Contract AF 49(638)-774; SRM, AFOSR.

This research concerns a group of related investigations in general and algebraic topology, and abstract algebra. The topological considerations include an investigation of the applicability of

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"medial" topological properties, in distinction to "local" or "global" properties, to problems such as the extension of local and medial properties of a non-compact space to its various compactifications. They include the extension of recent results on monotone mappings under weakened monoteneity conditions. And they include a study of the space of loops of a topological space and more general spaces, for their homological and cohomological properties as related to the algebraic problem of the multiplicative structure of Hopf algebras. Studies in algebra involve a combination of finite group theory with combinatorial and geometric considerations. In particular the latter considerations allow a knowledge of the structure of groups of certain classes.

17.95

Midwest Research Inst., Kansas City, Mo.
ERROR ESTIMATES ON RATIONAL APPROXIMATIONS TO CERTAIN HIGHER TRANSCENDENTAL FUNCTIONS OF MATHEMATICAL PHYSICS, Y. L. Luke. Project 7071(806A), Contract AF 33(657)-8872; ARM,ARL.

The study of using rational approximations to invert Laplace transforms will be continued including a rigorous study of the error. The solution of a suitable convolution integral equation will be investigated. A rational approximation method will be applied to obtain asymptotic solutions of certain differential equations involving a large parameter.

17.96

Minnesota U., Minneapolis.
ANALYTIC AND COMBINATORIAL PROBABILITY, G. E. Baxter. Project 9752(801A), Grant AF-AFOSR-61-4; SRM, AFOSR.

This research is in modern probability theory. It concerns a study of probabilistic problems of a combinatorial nature dealing with sums of independent random variables, in particular, fluctuation problems of sums of independent, identically distributed random variables. It also concerns a study of analytic problems involving orthogonal polynomials and prediction theory, in particular polynomials defined by a difference system, which can be related to transform theory. Under investigation are contemporary problems concerning random walk processes, i.e., new approaches to fundamental probabilistic questions, and techniques applicable to the solution of differential equations, transform and operator theory.

17.97

Minnesota U., Minneapolis.
FUNCTIONAL ANALYSIS AND STOCHASTIC PROCESSES, R. H. Cameron. Project 9752(801A), Grant AF-AFOSR-62-252; SRMM, AFOSR.

This grant is given for investigations into the area of stochastic processes. Concentration will be directed toward the behavior of sample sequences and development of the theory of prediction for individual sample sequences. The Feynman integral is one of the specific topics studied.

17.98

Minnesota U., Minneapolis.
FLUCTUATION AND MULTIDIMENSIONAL PROBLEMS, M. Dwass. Project 9752(801A), Grant AF-AFOSR-62-107; SRMM, AFOSR.

This grant is let for the study of Markov processes. This study will concentrate on fluctuation theory and its connections with non-parametric statistics. This area includes study of recurrent events with positive, integer-valued waiting times, such as are applicable to a wide range of problems in logistics.

17.99

Minnesota U., Minneapolis.
RIEMANN SURFACES, A. M. Garsia. Project 9783(806A), Contract AF 49(638)-857; SRMM, AFOSR.

This effort falls in the general mathematical area of geometry with the sub-areas of manifolds and connections. Garsia is studying the existence in Euclidean space of smooth models of complete two-dimensional Riemannian manifolds with strictly negative Gaussian curvature.

17.100

Minnesota U., Minneapolis.
COHERENT SHEAVES OVER COMPLEX SPACES, H. Rohrl. Project 9769(803A), Contract AF 49(638)-885, SRMM, AFOSR.

This research is in mathematical analysis, in particular, the theory of functions of complex variables, with direct ties to modern geometric and topological considerations. It is concerned with meromorphic connections on complex manifolds, more specifically, with the fact that the Euler-Poincare characteristic of holomorphic vector bundles is a topological (rather than a holomorphic) invariant, and an investigation of the geometric meaning of certain associated cohomology classes.

17.101

Minnesota U., Minneapolis.
PROBLEMS IN HYDRODYNAMICS AND PARTIAL DIFFERENTIAL EQUATIONS, J. B. Serrin. Project 9769(803A), Grant AF AFOSR-62-101, SRMA, AFOSR.

Research concerns variational calculus, linear and

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CREM- Meteorological Research Lab
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CRER- Sacramento Peak Observatory

non-linear partial differential equations and Navier-Stokes equation with emphasis on conditions guaranteeing lower semi-continuity of integrals and conditions under which an extremal will furnish an absolute minimum.

17.102

Minnesota U., Minneapolis.
QUASI-CONFORMAL MAPPINGS, D. A. Storvick. Project 9752(801A), Contract AF 49(638)-863; SRM, AFOSR.

Storvick will study quasi-conformal functions within the overall area of complex analysis. Specifically, his main effort will be the study of the boundary behavior of analytic functions and quasi-conformal mappings.

17.103

Minnesota U., Minneapolis.
CURVATURE OF TRANSFORMATIONS, H. W. Guggenheimer. Project 9769(803A), Grant AF-AFOSR-62-93; SRMM, AFOSR.

Differential geometry covers most of the work to be done under this grant. The chief investigator will attempt to apply algebraic methods to the fiber space approach to differential geometry.

17.104

Minnesota U., Minneapolis.
ERGODIC AND RENEWAL THEOREMS, S. Orey. Project 9752 (801A), Contract AF 49(638)-617; SRM, AFOSR.

This contract is concerned primarily with studies of Markov processes. Boundary theory of stochastic processes, measures connected with Markov processes, and the topological dynamics of point transformations are more specific areas of concern. Markov chains include Brownian motion, birth and death processes, queueing processes, and random walks.

17.105

Missouri U., Columbus.
PROBABILITY; DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS, W. R. Utz. Project 9769(803A), Contract AF 49(638)-754; SRMM, AFOSR.

This research should be classified under ordinary differential equations. It is specifically concerned with the theory of growth especially in the case of competition between species.

17.106

Missouri U., Columbus.
NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS, M. D. George. Project 9752(801A), Grant AF-AFOSR 62-97; SRMM, AFOSR.

This research is in mathematical analysis, in particular, the theory of partial differential equations. Specific attention is directed to the solution of nonlinear partial differential equations by difference equation approximation, in particular the use of a general energy inequality procedure, for a large class of equations and boundary value problems.

17.107

National Bureau of Standards, Washington, D. C.
BOUNDS FOR EIGENVALUES AND EIGENVECTORS OF SELF-ADJOINT OPERATORS, N. Bazley. Project 7071(806A), Contract DO(33-657)-62-354;ARM, ARL.

A theoretical study is to be conducted to develop additional procedures for obtaining lower bounds for eigenvalues and improved error estimates for eigenvectors. These procedures are to be applied to the estimation of eigenvalues and eigenvectors in unsolved linear eigenvalue problems in the areas of atomic, molecular, and nuclear physics and the buckling and vibration of membranes, bars and plates.

17.108

Nebraska U., Lincoln.
BOUNDARY VALUE PROBLEMS FOR NONLINEAR DIFFERENTIAL EQUATIONS, L. E. Jackson. Project 9783(806A), Grant AF-AFOSR-61-37; SRMM, AFOSR.

This research is in mathematical analysis, in particular, the theory of elliptic partial differential equations and certain ordinary differential equations. Specific attention is directed to the study of subfunction techniques for such equations, to the question of equicontinuity of bounded collections of solutions of quasi-linear elliptic equations, and in particular to existence theorems for non-convex bounded domains.

17.109

New York U., N. Y.
RANDOMIZATION PROCEDURES AND FACTORIAL EXPERIMENTS, S. Ehrenfeld. Project 9752(801A) , Grant AF-AFOSR-62-153; SRMA, AFOSR.

This research is in the area of design of experiments. It will compare existing randomization procedures with other possible randomized fractional factorial schemes, the elaboration and detailed study of randomized procedures suited to statistical control, and the development of optimum procedures.

17.110

New York U., N. Y.
SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS, SPECIAL FUNCTIONS AND EXISTENCE THEOREMS, M. Kline. Project 9769(803A), Contract AF 49(638)-229; SRMM, AFOSR.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESWR- Operational Applications Lab

This group is working in ordinary differential equations. Their special interest is in uniqueness and boundary value problems arising in theory of electromagnetic waves.

17.111

North Carolina U., Chapel Hill.
DESIGN OF EXPERIMENTS AND DECISION RULES, R. C. Bose. Project 9752(801A), Contract AF 49(638)-213; SRM, AFOSR.

These studies fall in the area of design and analysis of experiments. More specifically, investigations are being made in the properties of test procedures, including factorial designs, generalization of the analysis of variance, confidence bounds, and the construction of error correcting codes for computers and communications systems.

17.112

North Carolina U., Chapel Hill.
BOUNDS FOR CHARACTERISTIC ROOTS OF MATRICES, A. T. Brauer. Project 9783(806A), Grant AF-AFOSR-62-149; SRMA, AFOSR.

This research concerns the location of the characteristic roots of matrices, and the roots of polynomials, especially adapted for computer technology. These techniques have application to the determination of small regions of the complex plane which contain one or all of the characteristic roots of a given numerical matrix, important in flutter calculation, aircraft design, etc.

17.113

North Carolina U., Chapel Hill.
NONPARAMETRIC STATISTICAL INFERENCE, W. Hoeffding. Project 9769(803A), Contract AF 49(638)-261, SRMM, AFOSR.

Hoeffding is studying non-parametric methods and order statistics. He seeks to develop statistical decision rules for non-parametric problems; to unify the treatment of parametric and non-parametric cases; and to develop sequential decision procedures for non-parametric problems.

17.114

North Carolina U., Chapel Hill.
STATISTICAL THEORY OF LINEAR MIXED MODELS, G. E. Nicholson. Project 9783(806A), Contract AF 49(638)-929; SRMM, AFOSR.

This research lies in the area of applications of probability theory and statistics. The contract covers work in analysis of variance, design of experiments, development of statistical models for missile trajectories, mathematical and statistical problems encountered in data processing, tracking error analysis and the like.

17.115

Northrop Aircraft, Inc., Hawthorne, Calif.
METHODS OF CHARACTERISTICS FOR SOLUTION OF NON-LINEAR HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS, L. R. Fowell. Project 7071(806A), Contract AF 33(657)-7326; ARM, AFOSR.

A study of the method of characteristics as a means of solving non-linear hyperbolic partial differential equations (relating to the "smooth body" flow field) will be made. An analysis of the general field point solution and the general body point solution will be made utilizing a high-speed digital computer. An operational procedure from these analyses will be prepared for a specific class of three dimensional configurations.

17. 116

Northwestern U., Evanston, Ill.
MARKOV CHAINS AND SAMPLE FUNCTION STRUCTURE, D. G. Austin. Project 9752(801A), Grant AF-AFOSR-62-350; SRMM, AFOSR.

This grant is let for the study of Markov processes. Investigation of the analytic properties of transition functions and of sample function structure will be stressed.

17.117

Northwestern U., Evanston, Ill.
MULTIDIMENSIONAL PROBLEMS IN PROBABILITY THEORY, M. Dwass. Project 9752(801A), Contract AF 49(638)-877; SRM, AFOSR.

Markov processes were studies under this project. Areas of emphasis included the study of renewal theory, convolutions, and characteristic functions from the multidimensional viewpoint.

17.118

Northwestern U., Evanston, Ill.
FOURIER INTEGRALS AND RELATED TRANSFORMS, R. R. Goldberg. Project 9783(806A), Contract AF 49(638)-383; SRM, AFOSR.

This research concerns Fourier integrals and related transformations, and the investigation of mapping under which certain properties of classes of functions remain invariant. The mappings include the Kronig-Kramers transform, and the properties investigated include various considerations related to Fourier transforms. Further studies include the analogous discrete problem which concerns classes of matrices under which

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

under which sequences of Fourier coefficients for certain classes of functions remain in the same class.

17.119

Northwestern U., Evanston, Ill.
CONTINUED FRACTIONS AND DIFFERENTIAL EQUATIONS, W. F. Scott. Project 9752(801A), Contract AF 49(638)-888; SRM, AFOSR.

This research is part of modern mathematical analysis and approximation theory. It comprises a thorough investigation of the relation between analytic functions, certain of their continued fraction expansions and Stieltjes-transform representation, and a study of continued fraction expansions as the solution of certain differential equations, integral equations, and the approximation and numerical calculation of solutions to applied problems.

17.120

Ohio State U., Columbus.
NONLINEAR OSCILLATIONS, E. Kreyszig. Project 9752 (801A), Contract AF 49(638)-990; SRMM, AFOSR.

This research is in analysis, in particular, the theory of ordinary differential equations. The study centers around the systematic investigation of nonlinear ordinary differential equations governing certain oscillations of practical importance, with particular attention to self-sustained oscillations, and the development of numerical methods.

17.121

Oklahoma U., Norman.
MISSILE TRAJECTORY OPTIMIZATION PROBLEMS, G. M. Ewing. Project 9769(803A), Contract AF 49(638)-1058; SRMM, AFOSR.

Mathematically this contract might be classified as applications of the calculus of variations. Specific objectives include extending calculus of variations to cover problems encountered in optimization of missile trajectories.

17.122

Oregon U., Eugene.
SEVERAL SAMPLE TESTS, F. C. Andrews. Project 9769 (803A), Contract AF 49(638)-1057, SRMM, AFOSR.

The general area under investigation here is distribution theory. Andrews is extending and generalizing techniques and methods known to be valid for large samples to small samples.

17.123

Oregon U., Eugene.
APPLICATIONS OF LAPLACE OPERATORS, V. L. Shapiro. Project 9752(801A), Contract AF 49(638)-988;SRMM, AFOSR.

This work falls under the general classification of analysis and under the subheading of integral transforms. The primary effort is devoted to application of Laplace operators to series of sherical harmonics and multiple trigonometric series.

17.124

Oregon U., Eugene.
ORDERED TOPOLOGICAL LATTICES, L. E. Ward. Project 9752(806A), Contract AF 49(638)-889;SRM, AFOSR.

This research is in topological algebraic structures, in particular in topological lattices. Specific topics are related to the theory of partially ordered topological spaces, including the inherent partial order structure of connected topological spaces and the development of a theory of topological lattices, semilattices and related continuous order structures.

17.125

Parke Mathematical Labs., Inc., Carlisle, Mass.
STUDY OF THE PROPERTIES OF MATTER USING DIFFERENTIAL GEOMETRIC METHODS, H. G. Parke. Project 4608(760E), Contract AF 19(604)-7316; CRRC, AFCRL.

This contract provides a source of information concerning mathematical literature that may be used to solve theoretical physics or engineering problems. Primary emphasis is upon literature in the field of differential geometry. A graded bibliography is being prepared to indicate the probable value of each reference in solving selected problems. Extensions and applications of the mathematical theory are made in those areas considered to be of most value to solid state electronics.

17.126

Pennsylvania U., Philadelphia.
TRANSFORMATION GROUPS, R. Ellis. Project 9783(806A), Contract AF 49(638)-889; SRMM, AFOSR.

This research is in algebraic topology, in particular, the theory of transformation groups. Specific topics include a study of the structure of certain universal minimal compact Hausdorff phase spaces under certain transformation groups, the equicontinuity of the phase group of a transformation group,

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ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRME- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESWR- Operational Applications Lab

and some related questions.

17.127

Pennsylvania U., Philadelphia.
ELLIPTIC BOUNDARY VALUE PROBLEMS, W. Koppelman. Project 9783(806A), Grant AF-AFOSR-62-166;SRMM, AFOSR.

This research is in mathematical analysis, in particular the theory of linear boundary value problems for partial differential equations. Specific attention is directed to linear boundary value problems for complex functions on Rieman surfaces, precisely, to a general classification of elliptic boundary value problems for general elliptic systems in two independent variables.

17.128

Pennsylvania State U., University Park.
SINGULARITIES OF SOLUTIONS OF LINEAR PARTIAL DIFFERENTIAL EQUATIONS, J. M. Mitchell. Project 9752(801A), Contract AF 49(638)-826; SRMM, AFOSR.

This research is in analysis, in particular, the theory of the solution of partial differential equations. Specific topics include the properties of the solutions of linear equations in two and three real variables, as well as of systems of such equations, using the integral operator methods of Bergman, certain function-theoretic properties of harmonic functions, and properties of more general-type equations and systems of equations.

17.129

Physics, Engineering and Chemistry (PEC) Corp., Boulder, Colo.
NUMBER THEORY, L. J. Mordell. Project 9783(806A), Contract AF 49(638)-1154; SRMM, AFOSR.

This effort is expended in the general theory of numbers and in the study of diophantine equations. Mordell is concerned chiefly with the number of imaginary quadratic fields whose class number is one, Goldbach's conjecture, and geometry of numbers.

17.130

Pisa U. (Italy).
COMPLEX MANIFOLDS WITH BOUNDARY, A. Andreotti. Project 9783(806A), Grant AF -EOAR-62-35; SRMM, AFOSR.

This research is in the area of modern geometry, in particular, the theory of complex manifolds. Specific topics include the study of compact complex manifolds with boundary, with particular reference to the dimension of some associated groups, to the theory of automorphic functions, to rigidity theorems for submanifolds of a given manifold, to the investigation of vector bundles and their deformations, and to the convexity of the boundary.

17.131

Polytechnic Inst. of Brooklyn, N. Y.
TOPOLOGICAL SOLUTION OF DIFFERENTIAL EQUATIONS, J. C. Scanlon. Project 9752(801A), Contract AF 49(638)-981; SRMM, AFOSR.

This is research in algebraic topology, in particular, in fixed point theory and topological degree in nonlinear analysis. Specific attention is directed to topological techniques in Euclidean space, their application to ordinary differential equations, to topological techniques in function space, and their application to functional (integral and partial differential) equations.

17.132

Princeton U., N. J.
CONNECTIONS BETWEEN HARMONIC ANALYSIS AND THE THEORY OF PROBABILITY, S. Bochner. Project 9769(803A), Contract AF 49(638)-578, SRMM, AFOSR.

The area being investigated is measure and integration. Specific topics of study include aspects of harmonic analysis related to the analytical theory of probability, Dirichlet Series, and partial differential equations.

17.133

Princeton U., N. J.
TOPOLOGICAL SPACES, B. Harris. Project 9752(801A), Contract AF 49(638)-919; SRM, AFOSR.

This research is part of modern algebraic topology, in particular, the topology of group spaces. The cohomology ring of a space which is a topological group may be studied directly by means of the product operation in the group. The present investigation studies, in a similar fashion, the homology and homotopy properties of a class of homogeneous spaces in which a certain product can be introduced. A similar method, also under investigation here, applied to the relative cohomology algebra of Lie algebras modulo certain subalgebras.

17.134

Princeton U., N. J.
CLASSICAL RING STRUCTURES, J. F. Jans. Project 9783 (806A), Contract AF 49(638)-921; SRM, AFOSR.

This investigation is concerned with studies in the field of algebra; particularly the structure of rings. This study includes classical ring structure, topological rings, and homological algebra.

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SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

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CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRR- Geophysics Research Directorate
CRRA- Photochemistry Lab
CRRC- Thermal Radiation Lab
CRRE- Research Instrumentation Lab
CRRG- Terrestrial Sciences Lab
CRRM- Meteorological Research Lab
CRRI- Ionospheric Physics Lab
CRRR- Sacramento Peak Observatory

Topological rings will be approached from the viewpoint of classical ring theory. Homological algebra will be studied primarily along its interface with ring theory.

17.135

Princeton U., N. J.
APPLICATIONS OF METHODS OF MODERN TOPOLOGY, J. C. Moore. Project 9769(803A), Contract AF 49(638)-431; SRMM, AFOSR.

This research is in algebraic topology, and in the applications of algebra to topology. Specific topics include further organization and development of the theory of cohomology operations, with further applications to geometric problems such as embedding problems, and further development of that part of homological algebra which finds applications in topology, related to the problem of attempting to determine the structure of topological groups with finitely generated homology groups.

17.136

Purdue U., Lafayette, Ind.
NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS, D. Greenspan. Project 9752(801A), Contract AF 49 (638)-844; SRM, AFOSR.

This research concerns the numerical solution of partial differential equations and associated boundary value problems (i.e., suitably restricted solutions to partial differential equations). The exact technique involves the determination of such solutions at special points of the surface or space under consideration, in particular at the points of an overlapping "grid", and suitable refinements so that a "general solution" is finally obtained. The refinement techniques are of special mathematical importance and are an important part of the proposed research. An important point is that some of the considerations relate to both linear and non-linear phenomena.

17.137

Purdue U., Lafayette, Ind.
MATRICES AND RELATED TOPICS, C. R. Putnam. Project 9752(801A), Contract AF 18(603)-139; SRM, AFOSR.

This research is in topological algebraic structures, in particular, in topological vector spaces and functional analysis. Specific attention is directed to the study of commutators and linear operators. Topics include the stability intervals of the Hill equations, square roots and logarithms of self-adjoint operators, stability in incompressible systems, the numerical ranges of commutators, and some attention to bounded matrices with non-negative elements.

17.138

Rensselaer Polytechnic Inst., Troy, N. Y.
PHYSICAL PHENOMENA FOR LOGICAL FUNCTIONS, W. R. Beam. Project 9769(803A), Grant AF-AFOSR-62-194; SRI, AFOSR.

The pressure of demand has created a traditionalism in computer circuit design to fit established Boolean combinatorial techniques. This effort seeks to investigate the logic-function possibilities inherent in a variety of discrete-state physical phenomena, especially various domain phenomena, and to seek mathematical symbolisms which would be helpful in the synthesis of logical systems using such non-elementary functions. Specific studies will be made for the phenomenological requirements for a complete set of logical operations and the logical properties of domains and domain boundaries.

17.139

Research Triangle Inst., Durham, N. C.
CLASSIFICATORY; RANKING AND SCALING TECHNIQUES, W. S. Connor. Project 9752(801A), Grant AF-AFOSR-62-209; SRMM, AFOSR.

This project is concerned with the study of non-parametric methods and order statistics. Development of statistical techniques applicable to classified, ranked or scaled data should result from these investigations.

17.140

RIAS, Inc., Baltimore, Md.
NONLINEAR MECHANICS, S. Lefschetz. Project 9783 (806A), Contract AF 49(638)-382, SRMM, AFOSR.

This research is directed toward the study and development of non-linear analytical techniques which are applicable to mechanical and electromechanical dynamic systems, both conservative and dissapative. The contractor will develop methods and techniques for the effective quantitative and qualitative analysis of these physical systems whose behavior can be described by systems of ordinary differential equations. Non-linear mathematical techniques with applications to such problems as missile control systems, engineering mechanics, dynamics, nonlinear vibrations and nonlinear oscillatory circuits and empirical and analog studies of nonlinear systems are to be stressed. Also included in this research is the development of mathematical theory for the optimization of control systems and the theory of delay differential systems such as found in communication problems in space.

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PGMR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

17.141

Rice Inst., Houston, Tex.
POTENTIAL THEORY AND PROBABILITY THEORY RELATIONSHIPS, G. Johnson. Project 9783(806A), Grant AF-AFOSR-62-234; SRMM, AFOSR.

Harmonic functions and convex functions are the two areas of analysis with which Johnson is occupied. He hopes to extend the decomposition theorem for continuous parameter stochastic processes to larger classes to establish the Gauss inversion integral for the class of subharmonic functions.

17.142

Rice Inst., Houston, Tex.
MATHEMATICAL TECHNIQUES FOR ELECTRIC POTENTIAL PROBLEMS, G. R. MacLane. Project 9769(803A), Grant AF-AFOSR-62-94; SRMM, AFOSR.

Mathematically this work would be classified as meromorphic functions in the field of complex analysis. It involves the study of growth and behavior of functions of a complex variable.

17.143

Rochester U., N.Y.
INTEGRATION IN FUNCTION SPACES, J. J. Yeh. Project 9769(803A), Contract AF 49(638)-1046; SRMM, AFOSR.

The study of measure and of integration in the general area of analysis describes this contract in general terms. Specifically Yeh seeks to prove the Cameron-Martin translation theorems for the Wiener measure.

17.144

Rocketdyne, Canoga Park, Calif.
STATISTICAL DESIGN OF COMPLEX EXPERIMENTAL PROGRAMS, J. M. Zimmerman. Project 7071(806A), Contract AF 33(616)-7372; ARM, ARL.

Generalization of design optimization methods to include designs useful in multivariate analysis and response surface designs. Generalization of recently developed techniques to non-linear regression models and non-linear response surface designs. Extension of optimum allocation technique to permit simultaneous allocation of effort quantities such as cost, time, and number of tests. Use of new methods to perform the final optimum selection of a set of experimental designs for a complex program.

17.145

Stanford U., Calif.
APPLIED MATHEMATICS AND STATISTICS, H. Chernoff. Project 9769(803A), Contract MIPR-61-13; SRM, AFOSR.

This contract falls in the area of applied statistics. Examples of problems being worked on currently are accelerated life testing, design of biological experiments, a classification problem for the school of Aviation Medicine, and a satellite tracking problem.

17.146

Stanford U., Calif.
FUNCTION-THEORETIC METHODS IN STOCHASTIC PROCESSES, K. L. Chung. Project 9783(806A), Grant AF-AFOSR-62-243; SRMM, AFOSR.

Chung works in the area of stochastic processes. He will employ the direct approach to sample functions, and will investigate the function-theoretic aspects of Markov processes and martingales.

17.147

Stanford U., Calif.
FUNCTIONAL ANALYSIS AND ALGEBRAIC STRUCTURES, K. DeLeeuw. Project 9783(806A), Contract AF 49(638)-294; SRMM, AFOSR.

This research is in topological algebraic structures, in particular, in topological vector spaces and functional analysis, with emphasis of function spaces and algebras on groups. Specific topics include algebras and linear spaces of functions on compact groups, spectral analysis and synthesis, algebras of functions on locally compact abelian groups, almost periodic functions on semigroups, and semigroups on operators on Banach spaces.

17.148

Stanford U., Calif.
APPLICATIONS OF PROBABILITY THEORY TO PROBLEMS IN SCIENTIFIC METHODOLOGY, R. C. Jeffrey. Project 9769(803A), Contract AF 49(638)-950; SRIR, AFOSR.

This work represents a formal logical approach to the construction of a probabilistic model of the relation between theoretical constructs and observables in science where the observables exhibit a probabilistic behavior.

17.149

Stanford U., Calif.
ANALYSIS AND PROBABILITY THEORY, S. Karlin. Project 9769(803A), Grant 61-1; SRI, AFOSR.

This research in analysis and probability theory concerns problems of probability theory and statistics developed by analytical methods. Specifically, the theory of totally positive kernels (types of

analytic expressions) are to be investigated, with a view to their applications as regards diffusion processes (heat conduction, neutron diffusion), birth and death probabilistic processes, non-parametric statistical methods, and areas of biology, physics, economics and mechanics. The interrelations of "total Positivity" and the structure of certain Markov processes will be developed, including processes whose path functions are continuous and whose transition probability functions satisfy a certain diffusion equation. The theory of total positivity will be precisely developed in reference to non-parametric statistical applications.

17.150

Stanford U., Calif.
DIFFERENTIAL EQUATIONS AND BOUNDARY VALUE PROBLEMS, G. E. Latta. Project 9752(801A), Contract AF 49(638)-1045; SRMM, AFOSR.

This research is in mathematical analysis, in particular, the theory of ordinary and partial differential equations. Specific topics revolve around singular perturbation problems for ordinary and partial differential equations, scalars and systems and their boundary value problems, the type of expansion useful for asymptotic representations, including boundary layer phenomena, interior discontinuities (e.g., shocks), and the behavior at singular points.

17.151

Stevens Inst. of Tech., Hoboken, N. J.
NONLINEAR DIFFERENTIAL EQUATIONS, A. H. Diamond. Project 9752(801A), Contract AF 49(638)-878; SRMM, AFOSR.

This contract is classified under ordinary differential equations in the general field of analysis. It is mostly concerned with the study of non-linear differential equations.

17.152

Syracuse U., N. Y.
MARKOV CHAINS, PROBABILITY THEORY AND NON-PARAMETRIC STATISTICS, K. L. Chung. Project 9783(806A), Contract AF 49(638)-265; SRMM, AFOSR.

This research concerns the investigation of Markov chains and related processes, and includes studies of the non-denumerable case of the strong Markov property for general Markov processes, the ramification problem or "theory of boundaries" as exhibited in connection with the strong Markov property, and the extension of previous results to vector-valued Markov chain random variables as utilized by statisticians. Studies concerning the boundary theory of continuous parameter Markov chains entail investigations of the martingale and semigroup theory approaches, as well as further extension of previous results of the contractor based on the strong Markov property.

17.153

Syracuse U., N. Y.
PROBLEMS ON MEROMORPHIC FUNCTIONS, A. Edrei. Project 9783(806A), Contract AF 49(638)-571; SRM, AFOSR.

This research concerns a group of related questions in the theory of meromorphic functions. These concern the growth properties of meromorphic functions possessing several values, the invariance of deficiencies under change of origin, the number of deficient values and certain connections with differential equations. Particular problems include the existence of meromorphic functions of order less than one with infinitely many deficient values and the existence of entire functions of order less than one with two finite deficient values. They also include a thorough study of the logarithmic derivative and the formulation of problems and development of methods to make possible the application of certain aspects of Nevanlinna's theory to the study of suitable types of differential equations.

17.154

Syracuse U., N. Y.
APPROXIMATION BY POLYNOMINALS, SPACES OF FUNCTIONS, AND OTHER PROBLEMS, G. G. Lorentz. Project 9752 (801A), Grant AF-AFOSR-62-138; SRMA, AFOSR.

This research covers the study of three areas of analysis, i.e.: (1) spaces of functions and sequences, (2) problems in number theory, and (3) polynomial approximation.

17.155

Technion Research and Development Foundation, (Israel)
PHYSICAL TENSOR AND APPLICATIONS, Z. Karni. Project 9752(801A), Grant AF-EOAR-62-57; SRMA, AFOSR.

This research concerns the development of a consistent tensor concept based on curvilinear derivatives and physical Christoffel symbols. It will be shown that tensor equations expressed in Cartesian coordinates can automatically be written in any curvilinear coordinates when all rectilinear derivatives have curvilinear derivatives.

17.156

Technische Hochschule, Munich (Germany)
PRACTICAL NUMERICAL METHODS OF THREE-DIMENSIONAL SUPERSONIC FLOWS, R. Sauer. Project 9781(806A), Grant AF-EOAR-61-21; SRMM, AFOSR.

Theoretical investigations are to be expanded for developing practical numerical methods for non-linear hyperbolic systems in two and three independent variables and methods for equations of the mixed type in two independent variables.

17.157

Trieste U. (Italy).
NAVIER-STOKES EQUATIONS, G. Prodi. Project 9769(803A), Contract AF 61(052)-414; SRMA, AFOSR.

Research consists of an analytic study of the Navier-Stokes equations including regularization of solutions, existence of solutions under established boundary conditions, and study of stability problems in the 2-dimensional case. Certain aspects of the 3-dimensional case will be studied.

17.158

Virginia U., Charlottesville.
TOPOLOGY AND MATHEMATICAL ANALYSIS, G. T. Whyburn. Project 9783(806A), Contract AF 49(638)-72; SRMM, AFOSR.

This research is in topology, in particular, the relation between topology and mathematical analysis. Specific topics include fixed point free involutions and equivariant maps, the monotoneity of limit mappings, a study of compressibility and uniform convergence, differentiable periodic maps, and contemporary developments in topological analysis.

17.159

Washington U., St. Louis, Mo.
PROBLEMS IN MATHEMATICAL ANALYSIS, F. Haimo. Project 9783(806A), Contract AF 49(638)-218; SRMM, AFOSR.

This contract is let for studies in complex analysis with particular attention devoted to power series. It hinges around a study of the relation between a certain centerless group and groups of formal power series.

17.160

Wisconsin U., Madison.
PROBABILITY AND ERGODIC THEORY, A. Beck. Project 9769 (803A), Contract AF 49(638)-868; SRMM, AFOSR.

The area under investigation is stochastic processes. This contract was let for a detailed study of the inter-relationships between probability theory, statistical theory, information theory, and topology.

17.161

Yale U., New Haven, Conn.
FUNCTIONAL EQUATIONS AND SPECTRAL OPERATORS, E. Hille. Project 9752(801A), Grant AF-AFOSR-62-20; SRMM, AFOSR

This research is in topological algebraic structures, in particular, in modern functional analysis and the theory of topological vector spaces. Specific attention is centered around contemporary problems in functional equations and spectral theory, which includes a study of the initial value and boundary value problem for certain classes of functional equations, research in the theory of spectral operators, and in the applications of functional analysis to problems in probability theory.

17.162

Yale U., New Haven, Conn.
RESEARCH IN ALGEBRA, N. Jacobson. Project 9783 (806A), Grant AF-AFOSR-61-29; SRMM, AFOSR.

This work may be classified mathematically under groups and generalizations. Jacobson is seeking to determine the main outlines of the theory of non-associative algebras and will investigate exceptional linear groups.

17.163

Yeshiva U., N. Y.
MATHEMATICAL PROOF PROCEDURES AND COMPUTABILITY, M. Davis. Project 9783(806A), Contract AF 49 (638)-995; SRMM, AFOSR.

Work under this contract falls under the mathematical areas of theory of sets, logic, and foundations. Davis is engaged in the problems of employing computers for finding mathematical theorems and of finding an algorithm for determining whether a given formula in quantification theory is valid.

17.164

Yeshiva U., N.Y.
SYMBOLIC LOGIC AND RECURSIVE FUNCTION THEORY, M. Smullyan. Project 9769(803A), Grant AF-AFOSR-62-232; SRI, AFOSR.

This effort is for an investigation of applications of the theory of computable (or recursive) functions to computing machines and finite automata. Stronger results are expected to be obtained on the relation between recursive function theory and the provability of certain sentences in systems of symbolic logic.

See also: 3.8, 3.68, 3.91, 4.35, 6.9, 6.67, 6.91, 6.100, 6.138, 7.37, 7.41, 7.52, 7.70-71, 7.99, 8.1-2, 8.4, 8.26, 8.29-30, 8.44-46, 8.54, 8.56, 8.65-67, 8.76, 8.79, 10.12, 10.15, 10.32, 10.37, 11.31, 12.104, 13.1, 13.25, 13.27, 13.32, 13.45, 13.47, 13.54, 15.52, 16.7, 16.15, 16.71, 16.132, 16.144, 16.150, 20.15, 20.17, 20.21, 20.49, 20.56, 20.72, 20.82, 20.86, 22.3, 22.29, 22.33, 23.4, 24.9, 24.50

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18. EARTH PHYSICS

Geodesy; Geology; Mineralogy; Geomagnetism; Gravitational Field Measurements; Ice; Oceanography; Permafrost; Seismology.

18.1

Aeroneutronics, Space Technology Operations, Newport Beach, Calif.
ORBITAL PERTURBATIONS OF ARTIFICIAL EARTH, S. Herrick. Project 8607(804A), Contract AF 19(604)-7253; CRZE, AFCRL.

This contractor is performing research into the mathematical relationships needed to describe an improved physical model linking the departures of the earth's gravity field from spherical symmetry to the orbital motion of an artificial earth satellite. Progressing from computations of Δg, this effort will be directed toward the development, by statistical methods, of the entire surface gravity field and toward research into methods for integrating several methods into a unified presentation of surface and external gravity.

18.2

Alaska U., College.
TELLURICS IN AURORAL ZONE, P. Hessler. Project 8601(804A), AF 19(604)-3075; CRZI, AFCRL.

The objective of this research is to obtain additional information on the rapid fluctuations of earth potentials in and near the auroral zone and their relationship to magnetic disturbance and aurorae. Studies to date have been chiefly limited to periods longer than 10 seconds. Instrumentation to extend the upper frequency limit of the recordings to about 3 cps is being investigated in order to obtain data on hydromagnetic phenomena in the 0.1 to 3 cps range at the auroral zone stations.

18.3

Alaska U., College.
HYDROMAGNETIC ORIGINS, M. Sugiura. Project 8601(804A), Contract AF 19(604)-7988; CRZI, AFCRL.

The objective of this research is to investigate the application of hydromagnetic theory to the ionosphere and exosphere. Magnetic records are obtained from other sources, chiefly the IGY data centers. The characteristics of various phenomena such as SSC's (storm sudden commencements) are then critically examined to determine their relationship to predictions that may be extracted from the theory. Application of the theory to data from College, Alaska, and the approximate geomagnetic conjugate point has produced what is probably the most positive identification yet made of a specific hydromagnetic oscillation.

18.4

Arctic Inst. of North America, Washington, D. C.
ARCTIC ICE PROPERTIES, J. C. Reed. Project 8623(804A), Contract AF 19(604)-7403; CRZG, AFCRL.

Theoretical studies of the effects of the heterogeneity and anisotropy of sea on the elastic constants and the dispersion of surface waves are being conducted. Analysis to date has shown why the simple theory of air coupled flexural waves has given incorrect thicknesses of a floating plate, and the appropriate changes have been incorporated in the general theory of the investigator. Assuming the successful development of a complete theory of wave propagation through sea ice, it should be possible to determine its strength by seismic means. Further studies are being made both in the field and laboratory on the nature, growth, and deterioration of candled lake ice, including petrofabrics, boundary relationships, and visco-elastic behavior.

18.5

Arctic Inst. of North America, Washington, D. C.
ARCTIC TERRAIN STUDIES, J. C. Reed. Project 8623(804A), Contract AF 19(604)-8343; CRZG, AFCRL.

Conduct studies on ice samples obtained from the Ward Hunt Ice Shelf. Laboratory research will be directed toward determining the age of its formation, and its subsequent history. This research will be accomplished by such techniques as textural, particulate, and chemical analyses.

18.6

Barkley and Dexter Labs., Inc., Fitchburg, Mass.
TECHNIQUES RESEARCH, W. L. Barry. Project 7600(770A), Contract AF 19(604)-8852; CRZG, AFCRL.

The contractor has concentrated on devising new means for handling the unusually large matrices necessary for geodetic computer programs. This study has resulted in the completion of one promising program employing this matrix-inversion principle. The program is now undergoing "debugging" with test data.

18.7

Barkley and Dexter Labs., Inc., Fitchburg, Mass.
ABSOLUTE GRAVITY EXPERIMENT, T. Moran. Project 8607 (804A), Contract AF 19(604)-7223; CRZG, AFCRL.

The contractor performed a research design study of a method and apparatus for measuring absolute gravity. Based on this design study, the contractor fabricated the apparatus, and is now proceeding with the actual experiment of measuring absolute gravity.

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18.8

Barkley and Dexter Labs., Inc., Fitchburg, Mass.
GLOBAL GRAVITY RESEARCH, J. Moran. Project 7600(770A), Contract AF 19(604)-7220; CRZG, AFCRL.

The contractor has established a new gravity calibration line between Washington, D.C. and L. G. Hanscom Field, Bedford, Massachusetts. The contractor will now be required to make field observations with the relative pendulum apparatus fabricated under another contract. These observations will be made at ground stations over which the airborne gravimetry experiments will be flown.

18.9

Boston Coll., Mass.
ELF MAGNETIC FLUCTUATIONS, D. J. Linehan. Project 8601 (804A), Contract AF 19(628)-211; CRZI, AFCRL.

The objective is the study of geomagnetic fluctuations in the frequency range 0.01 to 3 cps, particularly those of hydromagnetic origin in the 0.1 to 3 cps range. Instrumentation has been developed and procured for recording 3-components of the fluctuations. A specially designed 7-channel magnetic tape recorder provides 40 db dynamic range for recording at a tape speed of 0.1 inch/second and makes continuous field recording feasible. Two recording channels for each horizontal component will provide a dynamic range of 80 db to allow for the large signal levels encountered during magnetic storms. A few recordings were made at the old GRD field site at Ft. Devens, Mass., but interference from increased military activity had made the site unsuitable for obtaining continuous reliable recordings. A new site has therefore been instrumented at Strawberry Hill, Concord, Mass., with concrete piers for the detector coils, etc. Preliminary recording was begun at the new site on 11 December 1961. Improvement of the installation to attain a sub-microvolt instrument noise level is still underway. Analysis of the records has been initiated.

18.10

Columbia U., New York, N. Y.
CLAY MINERALOGY OF GLOBAL ENVIRONMENTS, P. F. Kerr. Project 8623(804A), Contract AF 19(604)-8387; CRZI, AFCRL.

Research directed toward understanding clay mineralogy in all environments with a view toward relating mineralogy to physical properties, and subsequent variations therein due to meteorologic and hydrologic fluctuations. Current investigations are concerned with high latitude clay development, marine quick clay deposits, and playa mineralogy.

18.11

Dartmouth Coll., Hanover, N. H.
ICE SHELF CHARACTERISTICS, J. B. Lyons. Project 8623 (804A), Contract AF 19(604)-8366; CRZG, AFCRL.

Research is directed toward an understanding of the origin and history of the ice shelf along the north coast of Ellesmere Island, Canada. The results of this research will be correlated with previously obtained information on the origin, formation and history of Fletcher's Ice Island (T-3). Implications of past climates will be investigated. Field work at the ice-shelf has included the study of surface features; the accumulation of temperature gradient data; and the collection of sample ice cores for extensive boratory examination. The studies of surface morphol..., structural features and stratigraphy of the ice shelf have been completed. Work in progress includes a study of the implications of varying temperature gradients in the ice-shelf and laboratory investigations of the composition and internal structure of the ice.

18.12

Denver U. Research Inst., Colo.
ELF MAGNETIC FLUCTUATIONS, G. Mason. Project 8601(804A), Contract AF 19(628)-204; CRZI, AFCRL.

The major effort is on the reduction and analysis of the extensive collection of 3-component tape recordings of the 1 to 50 cps fluctuations previously obtained under a joint program with GRD, and a good start has been made on the octave frequency band reduction of the recordings. The discovery in the early reduced data of 1.5 cps magnetic fluctuations associated with meteor showers prompted a recording program at Shickley, Nebraska, which is directly under the midpoint of a 50 mc. cw meteor-scatter transmission path operated simultaneously by CRPL, NBS. The recording program will be completed in January 1962. The octave frequency band reduction is being continued, and narrow-band filters ($\Delta f/f = 0.15$) are being developed for use in the same semi-automatic data reduction system. Emphasis will be on ionospheric phenomena such as the meteor effects. Detailed information on the resonant modes of the earth-ionosphere cavity will also result. Theoretical calculations on attenuation of hydromagnetic waves in the lower ionosphere will also be made.

18.13

Durham U. (Gt. Brit.).
TEMPORAL EM EFFECTS, Dr. F. J. Lowes. Project 7601(770A), Contract AF 61(052)-213; CRZI, AFCRL.

The work being done at King's College is a modification of Bullard's model. Herzenberg assumed the existence and maintenance of some specified motion in the core, and was able to show rigorously that in the steady state the system would be a self-acting dynamo. The motions assumed by Herzenberg, unlike those of Bullard, are capable of reproduction experimentally. Lowes is investigating experimentally the existence and stability of a self-maintaining dynamo in a homogeneous conductor. The design is based on the model shown theoretically by Herzenberg to be self-maintaining, assuming a stable state exists.

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RAUA- Advanced Development Lab
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AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

18.14

Edgerton, Germeshausen & Grier, Inc., Boston, Mass.
GEODETIC FLASHING LIGHT, V. Tyler. Project 7600(770A), Contract AF 19(604)-6132; CRZG, AFCRL.

The contractor is performing research directed toward the design and fabrication of a flashing light package suitable for use in a satellite as an optical beacon.

18.15

Emmanuel Coll., Boston, Mass.
MAGNETIC VARIATION STUDY, M. P. Hagan. Project 8601(804A), Contract AF 19(604)2192; CRZI, AFCRL.

This research on magnetic and solar variations provides information for the in-house program to derive and evaluate correlations between magnetic, geophysical, solar and lunar parameters. One approach is that of evaluating existing, and also newly developed, magnetic activity indices in terms of their diurnal, lunar, seasonal disturbances, and other periodic or aperiodic changes. Computation of an activity index for Huancayo, of factors associated with the onset of magnetic disturbances and associated analyses, has been undertaken. Preliminary assessment of the variable-area magnetograms is under way. Collection of standard magnetic observatory data for investigation of special events is accomplished.

18.16

Emmanuel Coll., Boston, Mass.
SPHERICAL HARMONIC ANALYSIS, M. P. Hagan. Project 8601 (804A), Contract AF 19(604)-7300; CRZI, AFCRL.

This research is directed toward the collection, preparation, charting and study of magnetic data and toward the support of project SHAME (spherical harmonic analysis of the magnetic field of the earth.)

18.17

Geological Survey, Washington, D.C.
REGION TERRAIN ASSESSMENT, D. H. Dow. Project 7628 (770A), Contract PRO 61-534, PRO 62-523; CRZG, AFCRL.

Research on the various types of geomorphic features in the north polar region and arid to semi-arid climatic environment in the middle east for the purpose of investigating potential siting facilities of importance to the Air Force global mission. Field studies of natural terrain features will supplement in-house research to determine, the nature of the materials within the geomorphic feature, origin and process of formation, comparison to analogous areas in the U. S. and the world, and valid prediction of the support capacity of soil conditions in remote or uninhabited areas. The geophysical factors and physical properties are assessed for a detailed evaluation of individual sites.

18.18

Geological Survey, Washington, D.C.
PERMAFROST, A. H. Lachenbruch. Project 8623 (804A), Contract PRO-62-530; CRZG, AFCRL.

Basic research in the physical properties of permafrost materials, geothermal methods of investigation, effect of frozen moisture on insulating properties of natural soil types, correlation of temperature with geomorphic and climatological factors, and development of thermal laws for permafrost by applying the physical theory of heat transfer. Field measurements are obtained to formulate theories accordingly.

18.19

Institute of Science and Technology, Michigan U., Ann Arbor.
SPECTRAL CHARACTERISTICS OF SEISMIC WAVES, J. T. Wilson. Project 7639(720A), Contract AF 19(604)6642; CRZG, AFCRL.

Existing records and new data from earthquakes, quarry blasts, and other chemical and nuclear explosions will be subjected to frequency analysis by digital and/or analog methods to obtain Fourier transforms and power spectral density estimates of seismic signals as a function of distance, magnitude, and type of source.

18.20

Instituto Geofisico de Huancayo, Peru.
EQUATORIAL ACTIVITY, A. A. Giesecke. Project 8601(804A), Contract AF 66(290)2; CRZI, AFCRL.

Measurements of the variations of the horizontal component of the earth's field are being made at two locations near the geomagnetic equator (Huancayo and Cusco, Peru) using variometers which produce variable-area film recordings. These stations form a portion of a chain along the 75° W meridian.

18.21

Instrument Corp. of Florida, Melbourne.
DATA REDUCTION RESEARCH, D. Brown. Project 7600(770A), Contract AF 19(604)8493; CRZG, AFCRL.

The contractor is performing research directed toward the development of new, faster techniques for reducing the voluminous data which is generated in geodetic photogrammetry. A major portion of this work will be the "near-automation" of reducing plate coordinates to geodetic or geocentric space positions in one computer pass. Portions of the necessary programs have been designed and will be tested with actual data in January 1962.

18.22

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
GEOMAGNETIC ACTIVITY, E. J. Chernosky. Project 8601 (804A), Internal.

The objective is to develop information on geomagnetic time variations as to their nature, mechanisms, and solar or terrestrial origins. One approach is through the

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detailed statistical study of magnetic activity and its latitudinal changes. Effort this past period has been made on consultation on the design of the film scanner and data analyser for reduction of the variable-area records and on the instrumentations for the Cusco, Peru, and Ellsworth, Antarctica, magnetograph installations. The scanner-analyser has been essentially completed, and the magnetograph installations are under way.

18.23

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
SPHERICAL HARMONIC ANALYSIS, P. F. Fougere. Project 8601(804A), Internal.

The in-house effort is concerned with the development and evaluation of methods for carrying out all phases of a spherical harmonic analysis of the earth's main magnetic field and its secular variation.

18.24

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
SHORT-PERIOD FLUCTUATIONS, E. Maple. Project 8601 (804A), Internal.

The objective is increased knowledge of the geomagnetic fluctuations in the frequency range 0.01 to 50 cps. During the past year, the principal efforts have been (1) the analysis of 1 to 50 cps data now being reduced from tape recordings by the University of Denver, and (2) consultation on techniques and instrumentation for data reduction by the University of Denver and for field recording by Boston College. Early studies of the octave-bandwidth reduction of the 1 to 50 cps data showed that most of the fluctuations could be attributed to the world-wide distribution of thunderstorm activity and offered strong but not conclusive evidence for Schumann-type resonant modes in the earth-ionosphere cavity. Narrow-bandwidth reduction of small data samples at GRD has confirmed this by resolving the individual modes, but the fine structure of the records is considerably more complicated than expected. Correlation between the 1.5 cps data and meteor activity has also been studied.

18.25

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
THEORETICAL EM STUDIES, J. F. McClay. Project 7601 (770A), Internal.

At the present time, a quantitative survey is being made of all hypotheses concerning the interaction of solar plasma and the geomagnetic field. Using these results as well as the contractual results, the interpretation of all experimental data is being reevaluated.

18.26

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
INTERPLANETARY MAGNETIC FIELD, B. M. Shuman. Project 7601(770A), Internal.

Surveying existing instrumentation for measuring magnetic fields, and adapting from these a device that would fit the experimental conditions; maintaining liaison with Lockheed Missile and Space Division to keep up with design changes of the vehicles; determination of adequate checkout procedure that will provide known corrections for vehicle magnetism, and participation in the required field measurements; analysis of collected data in terms of the most up-to-date description of the earth's magnetic field.

18.27

ITEK Corp., Lexington, Mass.
OPTICAL TERRAIN STUDY, D. E. Macdonald. Project 7628 (770A), Contract AF 19(628)277; CRZG, AFCRL.

Enhance the feasibility of optical photogrammetric techniques and airborne spectrography to determine the properties of natural terrain suitable for aircraft operations by detailed analysis of basic stereo photogrammetry, color film and filter combinations and interpretation techniques to achieve optimum accuracy of surface microrelief identification; study of application of airborne spectrographs and band spectral cameras for photointerpretation γ data recommendations of instrumentation and techniques for optimum airborne terrain reconnaissance program.

18.28

Lamont Geological Observatory, Palisades, N. Y.
ARCTIC OCEAN GEOPHYSICS, K. Hunkins, W. Farrand. Project 8623(804A), Contract AF 19(604)7442; CRZG, AFCRL.

Research in the Arctic Ocean has included studies of the ocean bottom, sound propagation in the ocean, ocean currents, ocean depths, wave motion in an ice-covered ocean, physical properties of sea ice, the earth's magnetic field, seismicity of the Arctic Ocean region, and numerous related investigations. Data reduction and analysis remains to be done on wave motion studies conducted in the period April to September 1961. This study covered a wide range of periods and utilized a variety of instruments for measuring sea-level changes, seismic surface waves, microseisms, atmospheric pressure changes, and ice oscillations. In addition, Ice Age climatic studies associated with data obtained in the Arctic are being supported through this contract.

18.29

Lockheed Aircraft Corp., Palo Alto, Calif.
THEORETICAL EM STUDIES, F. Johnson. Project 7601 (770A), Contract AF 19(604)7989; CRZI, AFCRL.

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For carrying out the first order calculations for a ring current, it is postulated that the currents result from trapped particles. These currents are separated into two types: a current from true transport of charge associated with the drift motion; and a magnetization current arising from the spiraling motion. In spherical coordinates, since the flow is normal to the plane ϕ = constant, the total current flowing in the belt is simply the integral of the current density over the area of the plane. Dessler is now concerned with assembling all the elements necessary to compute this current density, the elements being based on available experimental evidence.

18.30

Massachusetts Inst. of Tech., Cambridge.
ICE AND SNOW PHYSICS, W. D. Kingery. Project 8623 (804A), Contract AF 19(604)5994; CRZG, AFCRL.

Theoretical and laboratory research is directed toward deriving further basic knowledge of the growth of ice and snow aggregates, the determination of their physical properties, and the possibilities of improving these properties. Studies include those of the nature of the solidification of two and three-component solutions, surface characteristics, modes of crystal boundary and salt migration, and creep-rupture properties. Results since the last reporting period have included the quantitative determination of interface energies in multi-component systems, an analysis and quantification of the elastic-plastic behavior of ice under constant strain, the evolution of a technique to grow ice particles under precisely controlled temperatures and vapor pressures, and the establishment of the overwhelming importance of gravity drainage of brine migration as opposed to that of temperature gradients. Comparisons of saline ice with hydrogen-bonded crystalline solids and ionic solids and metals show that many ice properties are similar to those of high-temperature metals.

18.31

Maryland U., College Park.
DETECTION AND GENERATION OF GRAVITY WAVES, J. Weber, Project 9751(801A), Grant AF-AFOSR 62-143; SRPM, AFOSR.

Theoretical and experimental studies are being conducted to determine the feasibility of detecting and generating gravity waves. Methods investigated include collective oscillation in plasmas and solids and the radiation from the interior of stars. An experiment has been devised using crystal oscillation to drive a solid cylinder of aluminum with another cylinder acting as a detector of the gravity waves. The sensitivity and acoustical isolation have been tested and the experiment should be performed soon to study post Newtonian effect in the near field.

18.32

McGill U., Canada.
ARCTIC HEAT EXCHANGE, S. Orvig. Project 8623(804A), Contract AF 19(604)7415, CRZG, AFCRL.

Research is directed toward an understanding of heat transfer between air and ice, sea-water and ice, and air and permafrost in arctic regions in order to understand conditions leading to an ice-covered or ice-free Arctic Ocean and the resulting effects on climate. The initial phase of the research has consisted of a literature search resulting in the accumulation of all available pertinent data. Consolidation and analysis of the data will result in numerous detailed reports, two of which have now been completed. Field studies and data collection at selected locations will follow as needed to fill critical gaps or to validate conclusions.

18.33

McGill U., Montreal, Canada.
ELECTRO-PROPERTIES OF ICE, E. R. Pounder. Project 8623(804A), Contract AF 19(604)8375; CRZG, AFCRL.

Laboratory and theoretical research is directed toward establishing suitable techniques for determining various electrical and electromagnetic properties of saline ice at various temperatures and frequencies varying from DC to those in the microwave radar range. Under investigation are conductivities, dielectric coefficients, and loss factors, utilizing suitably modified standard potentiometric, capacitive, and wave guided techniques. Laboratory work to date has been directed toward solving the problems of creating saline ice having uniform electrical properties.

18.34

Melpar Inc., Watertown, Mass.
MAGNETOMETER DATA RECORDING AND REDUCTION SYSTEM FOR STUDY OF HYDROMAGNETIC ACTIVITY, R. Barnes. Project 7601(770A), Contract AF 19(604)7451; CRZI, AFCRL.

A trailer-mounted magnetometer data recording and reduction system has been constructed to provide for a real time read out and display of the telemetered signal from a rocket-borne Rb85 vapor magnetometer. Provision has been made to provide for real time display of all modulating frequencies (hydromagnetic waves) from .02 to 90 cps over a dynamic range of 120 db. after suitable filtering. The unit will be air-shipped to each proposed firing site, as documented in the Test and Evaluation section, and operated by the contractor. The end

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product will be a series of contiguous half-octave power spectra over the range of interest.

18.35

Ohio State U. Research Foundation, Columbus.
GRAVITY RESEARCH, W. A. Heiskanen. Project 7600 (770A), Contract AF 19(604)6201; CRZG, AFCRL.

Under this task, the contractor has performed research directed toward the development of techniques for computing the upward continuation of gravity from normal surface gravity values. The computer programs for normal gravity continuations are complete, and the contractor will next develop the computations for actual gravity.

18.36

Picatinny Arsenal, Dover, N. J.
PYROTECHNICS RESEARCH, B. Quass. Project 7600(770A), Contract PRO 62-514; CRZG, AFCRL.

The contractor is performing research directed toward the design of an "ideal" pyrotechnic photoflash cartridge for use in rocket flash triangulation experiments. A considerable amount of the recent investigation has been in areas of weight reduction of the package and novel methods of sequential ignition control of the flash cartridges. A very novel, small package of cartridges underwent a field test in Dec. 1961.

18.37

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
BOUNDARY PROBLEMS BY ANALOGY, N. Stone. Project 5631 (803A), Internal.

Investigating the nature of boundaries on the propagation of geomagnetic pulsations considered as an electromagnetic wave. To solve the problems of oblique incidence, a new approach to coupling problems developed by the investigator is being used.

18.38

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
NEW APPROACHES TO DEVELOPMENT OF GEODETIC POSITION, O. W. Williams. Project 8607(804A), Internal.

Research efforts under this task are directed toward new approaches to the problem of establishing geodetic positions. We are exploring various techniques for making physical measurements to see if they have geodetic possibilities. One effect has been considering tangential velocity measurements as a means toward developing geodetic positions. Another new effort has as its goal development of geodetic position with a combination of speed, accuracy, and mobility of equipment.

18.39

Stanford U., Calif.
REMANENT MAGNETISM IN ROCKS, G. A. Thompson. Project 8623(804A), Contract AF 19(604)8043; CRZG, AFCRL.

Objective of research is to obtain basic information on remanent magnetism in Cenozoic rocks as an indicator of the location of previous geographic poles; to interpret reversal of geomagnetic polarity; and to determine the effect of volcanic flow on the magnetism of rocks. The study is pertinent to a knowledge of the causes of ice ages; causes of crustal shifting; and an understanding of the origin and evaluation of the earth's geomagnetic field. To date, field work has resulted in the collection of 205 oriented samples of volcanic rock of the Eocene to Miocene age. Laboratory studies in progress have tentatively indicated a sequence of polar wandering. It is hoped that the collection of additional samples and the refinement of results will give more conclusive results.

18.40

St. Louis U., Mo.
SEISMIC BACKGROUND NOISE, R. R. Heinrich. Project 7639 (720A), Contract AF 19(604)8001; CRZG, AFCRL.

Determine the spectral characteristics of earth noise and of seismic signals from blasts and earthquakes in three different tectonic provinces of midcontinent United States.

18.41

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
ARCTIC STUDIES, V. C. Bushnell. Project 8623(804A), Internal.

Data reduction and analysis of geophysical data obtained in the Arctic. Coordination of Arctic research with other federal and civil agencies and the programming of geophysical studies on Arctic ice islands.

18.42

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
GLACIER TERMINUS ICE FLOW, R. L. Cameron. Project 8623(804A), Internal.

Glaciers issuing from a valley onto an open plain develop expanded foot or bulb type termini. These features have been described from many areas of the world, but the mechanics of the ice flow occurring during this expansion has not as yet been studied. Such a study would contribute to the understanding of the flow of ice. Moraines in front of the expanded foot would contribute in-

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formation relative to the former extent and motion pattern of the ice. Detailed measurements of movement direction and rates, ice thickness, and slope angles would be measured. This work will be undertaken in Schuchert Dal, East Greenland.

18.43

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
THERMAL PROPERTIES OF ICE, R. L. Cameron. Project 8623(804A), Internal.

Research in the field and laboratory to determine thermal diffusivity and thermal conductivity values for various types of natural ice. Emphasis will be placed on developing techniques for field and laboratory tests. The objectives of these studies is to determine a relationship between the thermal properties and the density of various ice types.

18.44

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
CRUSTAL REFLECTIONS, N. A. Haskell. Project 7639 (720A), Internal.

The effect of crustal layering on the motion of the free surface due to plane P, SV, and SH waves incident at any angle at the base of the crust will be investigated theoretically and programmed for machine computation.

18.45

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
SURFACE WAVES FROM COUPLES, N. A. Haskell. Project 7639(720A), Internal.

A theoretical description will be developed for the radiation of surface waves from a point source represented by a single or double couple. The resulting amplitudes and phase radiation pattern will be compared with available data from actual earthquake sources.

18.46

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
INSTRUMENTATION DEVELOPMENT, D. W. Klick. Project 7628(770A), Internal.

The correlation of two types of soil penetrometers is being investigated so that accumulated soil strength data from both types can be accurately compared. Field data for two homogeneous soil types has been obtained, and an effort is being made to test several other types so that a correlation over a broad range of values can be determined. This study will evaluate the usefulness of each instrument and will indicate necessary modifications or new developments. A report on the development of an austere airfield marking kit is being prepared and a patent application for a specific type of marker will be submitted.

18.47

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
PROJECT ICE WAY, D. W. Klick. Project 7628(770A), Internal.

ICE WAY is a field project of research and engineering studies on natural and processed sea ice which was jointly sponsored with the Naval Civil Engineering Laboratory at Thule AB in Greenland. As Project Officer, Capt. Klick has primary responsibility for the conduct of the research program and for the overall coordination of all phases of the project. Field studies were completed in June 1961 and data reduction and analysis have been done since then. A summary scientific report has been completed and is being printed. A preliminary post-operation report describing accomplishments and significant results has been published. Production of a film documentary has begun and its completion will terminate this effort.

18.48

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
SURFACE EFFECTS ON OPERATIONS, D. W. Klick. Project 7628(770A), Internal.

The potential utilization of natural terrain for aircraft operations depends primarily upon the extent of resultant rutting from traffic and the degree of microrelief. Studies to determine the factors of influence for both conditions have been initiated and a survey of existing information is almost complete. A small amount of work has been done by others to determine the fatigue level for aircraft operating on irregular surfaces, but only rough pavements have been studied, with no correlation to natural terrain. Little is known about the mechanics of rutting and a theoretical study of this problem is planned.

18.49

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
WEATHER AND CONDITION OF SNOW SURFACE, L. S. Koenig. Project 8623(804A), Internal.

Task will attempt to correlate surface conditions of the snow cover of the Greenland Ice Sheet and the prevailing meteorological

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parameters. Routine weather observations are often the only operational information received from remote sites on the ice sheet. Studies will involve taking routine meteorological observations and special snow observations at Camp Century for a period of one or two years. Similar observations on a reduced scale may be made at Dye 2 and Dye 3 in southern Greenland.

18.50

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
ENVIRONMENTAL MODIFICATION, J. T. Neal. Project 7628(770A), Internal.

Research directed toward determining fundamental physical nature of terrestrial materials and processes with a view toward relating this knowledge to means of efficient alteration of natural materials by constructive and destructive means. Studies are concerned with geodynamics (earth movements), soil and rock minerals and structure, terrestrial heat sources, and problem field cases. Specific investigations are concerned with clay mineralogy and groundwater alteration.

18.51

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
GEOCHEMISTRY OF SEDIMENTARY IRON-FORMATIONS, J. T. Neal. Project 8623(804A), Internal.

Research directed toward explaining geochemistry and development of sedimentary iron-formations. Studies currently involve examination of mineralogy in the Temiscamie Iron-Formation, Lake Albanel, Quebec, with an attempt to explain absence of magnetite ($FeO \cdot Fe_2O_3$) in zones where magnetite would normally be expected to occur.

18.52

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
PLAYAS, J. T. Neal. Project 8623(804A), Internal.

Geomorphological studies are being made of playas to determine their genesis, structure and present physical state. Polygonal surface fractures or cracks on the surface of these playas are also being investigated to determine their mode of origin.

18.53

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
TERRAIN QUANTIFICATION, J. T. Neal. Project 7628 (770A), Internal.

Quantitative methods for expressing terrain configuration are being assessed. Related fields such as meteorology are being reviewed in order to determine similar problem solutions for handling large amounts of data. Adaptations of existing terrain classification concepts are being evaluated.

18.54

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
ELECTRICAL RESISTIVITY OF SOILS, S. M. Needleman. Project 8623(804A), Internal.

(1) Refine ability to differentiate, locate and identify soil types within the active permafrost zone by surface resistivity methods; (2) refine and/or develop technique to readily identify the upper level of permafrost; (3) develop technique for locating usable sources of perched ground water above the permafrost table; (4) develop technique to differentiate, locate and identify soil materials in frozen state (permafrost) with emphasis on moisture content and soluble salts in the uppermost permafrost layer; (5) develop a rapid method of determining the moisture content and mineral salts concentration in thawed and frozen materials of a soil profile and for determining the true level of the top of the permafrost table; (6) comparison of resistivity in the lowest level of the active zone (thaw zone) and upper portion of the permafrost table; (7) models of typical soil profiles will be constructed and tested in cold room facilities under controlled conditions; (8) refinement of instrumentation to improve accuracy of measurement, anomalous currents, and portability for field use.

18.55

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
REGION TERRAIN ASSESSMENT, S. M. Needleman. Project 7628(770A), Internal.

The effort is subdivided into five areas: (1) Continental United States and Alaska, (2) AFCRL participation in US Army TC Operation Desert Rat in Iran and Pakistan, (3) Middle East Group (Syria, Lebanon, Iraq, Jordan, Israel, Kuwait, and Afghanistan), (4) analogous sites study #1 of Iran, Turkey and Pakistan selected for test and evaluation in the United States, and (5) analogous sites study #2 of group in (3) for test and evaluation in the United States. The studies will include research on the identification and classification of various types of natural geomorphic features in all environments for potential sites of possible importance to

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the Air Force. Research techniques will be refined to determine the nature of the materials contained within the identified geomorphic feature, their origin and process of formation, comparison to analogous areas in the world, and valid prediction of load-bearing strength and support capacity of soil conditions in remote areas. Geophysical factors and salient physical parameters for terrain assessment of the areas under study (1-5) will be determined from studies of geomorphology, geology (engineering, glacial, and military), climatology, soil and foundation conditions, grading, approach hazards, accessibility, water supply, availability of local construction materials, and related technical information pertinent to a detailed evaluation of an austere airfield site or other type of facility.

18.56

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
MID-ATLANTIC RIDGE STUDY, H. A. Ossing. Project 7639 (720A), Internal.

Materials used will be seismograms recorded at Weston Observatory, Weston, Mass., from earthquakes whose epicenters are in such locations that the surface wave paths to Weston include a substantial portion along the Mid-Atlantic Ridge. Group velocity dispersion curves for surface waves obtained from this data will be compared with similar curves for typical deep ocean basin structure. From the differences an attempt will be made to infer the structure of the Mid-Atlantic Ridge.

18.57

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
GRAVITY DATA EVALUATION, B. Szabo. Project 7600 (770A), Internal.

The in-house effort under this task consists of a comprehensive research of various methods of computing the values for the upward continuation of gravity from surface gravity values. A computer program for computing Δg has been completed and tested. Further effort has been directed toward the new "telluroid" methods of expressing gravity force directions, with results showing the premise that this new surface may become as basic to gravimetric computations as the geoid.

18.58

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
RESEARCH INTO GRAVITY EFFECTS, B. Szabo. Project 7600(770A), Internal.

This in-house research has investigated the effect on missile CEP's from uncertainty in the accuracy of geodetic parameters (i.e., radius and flattening of reference ellipsoid, deflection of the vertical, inter-datum relationships). This investigation has shown the significance of the total geodetic error on missile CEP's, and will now be directed toward the study of the nature and interaction of these errors, and to determine which errors are systematic, random and/or compensating. There will also be an in-house effort to develop statistical procedures to derive gravimetric and other requirements for different weapons systems (i.e., what is the qualitative and quantitative gravity information necessary for the guidance of any given weapons system?)

18.59

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
EXPLORATORY GEODESY, M. S. Tavenner. Project 7600(770A), Internal.

The in-house research under this task is made up of two distinct efforts, both dealing with exploratory geodesy. The first of these, under Capt. Tavenner's direction, is the completion of the final line-crossing tests necessary to prove out the long-line azimuth technique. This will consist of having an aircraft carry a high-intensity strobe light at different altitudes between mutually non-intervisible points, from which photographic observations will be made. Relative positions of the stations, and therefore, relative directions, will be established from reduction of the photographic data. The second in-house effort, under Mr. Mancini's direction, is the research required for the Air Force's participation in a geodetic satellite experiment. The Air Force has the responsibility for furnishing a suitable flashing light for the satellite and this work is being performed contractually.

18.60

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
ABSOLUTE GRAVITY EXPERIMENT, L. G. D. Thompson. Project 8607(804A), Internal.

Research is performed to originate and investigate new and better techniques, methods, and instrumentation for measuring absolute gravity. A surveillance of all work in this field is maintained to insure an integrated program. As new techniques are finalized, the work is continued under contract with coordination with the in-house effort. An absolute gravity experiment is currently being performed contractually and in-house.

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18.61

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
AIRBORNE GRAVIMETRY, L. G. D. Thompson. Project 7600(770A), Internal.

The airborne gravity network is very nearly completed. A gravity calibration line has been established between Loring AFB, Maine and Miami, Florida. The prototype gravity meter has been rebuilt and laboratory tested, and the Askania-Graf Gravimeter has been laboratory tested. Both gravimetric systems are now awaiting airborne tests.

18.62

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
GRAVIMETRIC TECHNIQUES, L. G. D. Thompson. Project 7600(770A), Internal.

This effort will continue the establishment of airbase calibration stations to the completion of the network, and will also expand the effort in the laboratory and field testing of new gravimetric techniques.

18.63

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
NUCLEAR GRAVITY METER, L. G. D. Thompson. Project 8607(804A), Internal.

New principles of physics, techniques, and instrumentation are investigated for possible application to gravity measurements. Proposals from contractors are also reviewed with the same objective. Decision is made as to whether a technique is potentially sound or not. Contractual work is monitored by and coordinated with the in-house effort.

18.64

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
GEODETIC TECHNIQUES, O. W. Williams. Project 7600 (770A), Internal.

Work will continue on a polishing of the rocket-flash triangulation technique, on further field research into novel geodetic optical signals and into instrument research into geodetic optical linearity tests.

18.65

Texas Instruments, Inc., Dallas.
RADAR TERRAIN ANALYSIS, A. M. Feder. Project 7628 (770A), Contract MIPR 61-715, MIPR 62-711; CRZG, AFCRL.

Analysis of pertinent characteristics of radar equipment for measurement of terrain and soil properties; selection, modification, and calibration of promising equipment and techniques, laboratory measurements of the reflective characteristics of representative soils and their relationship with properties such as density, moisture content, surface roughness, thickness, etc., establishment of catalogs of radar and correlated sensor returns suitable for airborne measurement of terrain properties.

18.66

Texas Instruments, Inc., Dallas.
TERRAIN DATA COLLECTION, A. M. Feder. Project 7628(770A), Contract AF 19(604)8858; CRZG, AFCRL.

Survey of methods of obtaining geophysical data on surface and sub-surface terrain properties. Evaluation of all active and passive sensors applicable on soil, ice, snow and water surfaces, including capabilities and limitations of resolution, response, and sensitivity for both airborne and ground use. Recommendations for development and use of both presently available instrumentation and techniques and sensors proposed or in state of research and development.

18.67

Texas Instruments, Inc., Dallas.
GRAVIMETRIC DETERMINATION OF SUBTERRANEAN VOIDS, F. Romberg. Project 8607(804A), Contract AF 19 (604)8348; CRZE, AFCRL.

Under this effort, the contractor is required to perform research into the development of a gravimetric technique for detecting subterranean voids. Should such a technique prove feasible, this will be a novel advance of the use of gravimetric techniques and will expand existing knowledge of the evaluation of negative gravity anomalies.

18.68

U. Uppsala, Sweden.
WAVE DISPERSION, E. Tengstrom. Project 7600 (770A), Contract AF 61(052)226; CRZG, AFCRL.

This contractor is performing research directed toward the development of new techniques and instrumentation for more accurately measuring the dispersion of optical light sources as used in terrestrial angle measurements. Present research has produced the design (and now the fabrication) of a promising instrument for measuring dispersion of different wave-lengths of light from a single source. This instrumentation should lead to a new technique for

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terrestrial angle measurements, by enabling far more accurate evaluation of light diffraction than hitherto possible.

18.69

Wolf Research & Development Corp., Boston, Mass. GEODETIC COMPUTER RESEARCH, R. Jenny. Project 7600 (770A), Contract AF 19(604)8065; CRZG, AFCRL.

The contractor has recently embarked on research leading toward a calibration and test system of range-range rate systems with optical satellite systems.

See also: 3.50, 8.25, 8.29, 8.32, 8.37, 8.51, 8.63, 8.70, 8.72, 8.75-76, 8.78, 14.6, 23.102

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19. ATMOSPHERIC PHYSICS AND METEOROLOGY

Atmospheric Circulation; Atmospheric Ozone; Clouds; Fallout; Precipitation; Thunderstorms; Wind and Temperature; Airglow; Upper Atmosphere Phenomena; Aurorae.

19.1

Allied Research Associates, Inc., Boston, Mass.
CLOUD PARAMETERS, A. Glaser. Project 8620(804A), Contract AF 19(604)-5500; CRZH, AFCRL.

Cloud pass data can be combined in many ways and more sophisticated results obtained, such as purer spectra of temperature, humidity, and water content in clouds. machine data will make possible the calculation of flux of heat and water and allow the determination of the heat and water budget of clouds and cloud groups.

19.2

Allied Research Associates, Inc., Boston, Mass.
OPERATIONAL AND SYSTEMS ANALYSIS, A. Glaser. Project 6698(770A), Contract AF 19(604)-5582; CRZH, AFCRL.

Perform and participate in feasibility, pilot, diagnostic and verification studies and analyses related to satellite meteorological observational methods, data reduction and processing, data analysis, and the development of forecasting techniques. Develop and refine operational techniques for use at readout stations for location and extraction of picture data. Develop, for research purposes, procedures, both manual and automated, for accurate picture location and gridding. Prepare manuals for use by the field forecaster to optimize the utility of satellite data.

19.3

Allied Research Associates, Boston, Mass.
IR APPLICATIONS, R. Wexler. Project 6698(770A), Contract AF 19(604)-5968; CRZH, AFCRL.

Research studies on use of satellite radiation observations in determining various radiation patterns under various meteorological conditions and applications of these results to weather analysis and forecasting.

19.4

Allied Research Associates, Inc., Boston, Mass.
PHYSICS AND DYNAMICS OF PRECIPITATION, R. Wexler. Project 8620(804A), Contract AF 19(604)-5204; CRZH, AFCRL.

This is a fundamental study of the physical-dynamics of precipitation, including convective cells and has the object of specifying the associated moisture budgets and fields of motion. All of the events such as updraft, condensation, accretion, and coagulation which lead ultimately to precipitation at the ground are considered, especially in the light of radar observations of natural clouds and precipitation.

19.5

American Geographical Society, New York.
THULE FIELD PROGRAM, W. A. Wood. Project 7661(770A), Contract AF 19(604)-5878; CRZI, AFCRL.

This is a comprehensive field program collecting geophysical data at this uniquely located geographic and geomagnatic site. The data consists of petrol spectrograph, all-sky camera, riometer, mu meson telescope, satellite tracking, neutron monitor and atmospheric aerosol collector.

19.6

Arizona State Coll., Flagstaff.
INFRARED ATMOSPHERIC SPECTROSCOPY, A. Adel. Project 7670(770A), Contract AF 19(628)-301; CRZC, AFCRL.

Professor Adel is studying the distribution of various gases in the atmosphere by obtaining the absorption spectra of these gases with the sun as a source and the scattering of sunlight in the atmosphere. Presently he is studying scattering near the sun's limb and continuing his observations of the infrared and ultraviolet parameters of atmospheric ozone. He has also made measurements of the atmospheric "windows" at 6.3μ and 16 to 24 microns.

19.7

Arizona U., Tucson.
NATURAL AEROPHYSICS PROCESSES, R. Kassander. Project 8620(804A), Contract AF 19(604)-5700; CRZH, AFCRL.

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ESNR- Operational Applications Lab

Basic research directed toward a more detailed and factual understanding of the natural aerophysics processes.

19.8

Arizona U., Tucson.
DENDROCLIMATOLOGICAL STUDY OF THE CLOUDCROFT SITE, W. G. McGinnis. Project 8602(804A), Contract AF 19 (604)-7474; CRZE, AFCRL.

The past climatology of the Cloudcroft Observatory Site will be determined by means of the examination of tree rings. The effect of short-term (30 years) climatic cycles on recent climatological data will be determined.

19.9

Centrale Meteorologica Svizzera (Switzerland).
THUNDERSTORM PROCESSES, J. C. Thams. Project 8620 (804A), Contract AF 61(052)-559; CRZH, AFCRL.

Experimental and analytical investigation will be made of the physical processes in thunderstorms, both in the natural state and under the influence of artificial nucleation. These investigations will be associated with "Large Scale Experiment No. III for Hail Prevention in the Tessin." The research will include observational studies with radar of cloud particles and precipitation processes under natural and seeded conditions.

19.10

Chicago U., Ill.
CLOUD PHYSICS, R. R. Braham. Project 8620(804A), Contract AF 19(604)-7217; CRZH, AFCRL.

Research directed toward obtaining new information concerning the cloud physics processes.

19.11

Chicago U., Ill.
CHARGE GENERATION IN CUMULUS CLOUDS, H. R. Byers. Project 8620(804A), Contract AF 19(604)-2189; CRZH, AFCRL.

The process of electrical charge production and separation within developing cumulus clouds will be investigated. The experimental procedure will consist of flying in the vicinity of developing cumulus clouds, making a complete set of electrical, meteorological, and radar observations as required to understand the charging phenomena. The data obtained in flight will be analyzed and interpreted so as to provide a basis for a definitive theory of thunderstorm electricity.

19.12

Chicago U., Ill.
MESOSCALE ASPECTS OF CUMULUS CONVECTION, T. Fujita. Project 8620(804A), Project AF 19(604)-7259; CRZH, AFCRL.

Contractor will conduct mesoscale meteorological measurements at the Project High Cue field site at Flagstaff, Arizona. Measurements will be made at several stations of a variety of atmospheric parameters to determine their relation to the over-all study of the development of convective activity. A number of analyses and studies have been completed by this contractor. Analysis of mesoscale data for Project High Cue 1961 is now proceeding in close coordination with in-house laboratory analysis.

19.13

Chicago U., Ill.
HYDRODYNAMICAL MODELS, D. Fultz. Project 8604 (804A), Contract AF 19(604)-8361; CRZH, AFCRL.

The objective of this research is to construct hydrodynamical analogues of atmospheric behavior in order to ascertain the mechanism and cause of fluctuations in the general circulation of the earth's and other planetary atmospheres; to study under the controlled conditions of the laboratory the effects of different physical parameters on the large-scale behavior of the atmosphere; and to develop new techniques of experimentation where necessary to carry out the above aims. The results of this research will provide a deeper understanding of the dynamics of the general circulation of the atmosphere.

19.14

Chicago U., Ill.
HARMONIC INTEGRATION, G. Platzman. Project 8604 (804A), Contract AF 19(604)-7266; CRZH, AFCRL.

To investigate the motion of a mean atmosphere subjected to the topographic forces as they exist on the earth and to conduct numerical studies of the large-scale circulation making use of the hydrodynamical equations in spectral form.

19.15

Colorado State U., Fort Collins.
UMKEHR OZONE MEASUREMENTS, L. R. Weber. Project 8604(804A), Contract AF 19(604)-7303; CRZH, AFCRL.

Systematic measurements of total amount of ozone as well as estimates of the vertical distribution

of ozone by the Umkehr method will be made. Resultant ozone data will be analyzed in relation to atmospheric circulation processes with particular emphasis on mountain wave situations.

19.16

Colorado U., Boulder.
DYNAMICS OF UPPER ATMOSPHERE, B. Haurwitz. Project 8604(804A), Contract AF 19(604)-5488; CRZH, AFCRL.

The objective of this research is to study the hydrodynamics stability of different types of vertical and horizontal distributions of wind and temperature in the upper atmosphere; to investigate possible interactions between different atmospheric layers, to study the response of the upper atmosphere to extraterrestrial stimuli.

19.17

Colorado U., Boulder.
STUDY OF THE SOLAR SPECTRUM BELOW 3000Å AT RELATIVELY HIGH DISPERSION BY PHOTOGRAPHIC MEANS FROM ROCKETS, W. A. Rense, F. Wilshusen. Project 8627(804A), Contract AF 19(628)-287; CRZA, AFCRL.

Research under this contract will be directed to a study of the solar spectrum below 3000Å at relatively high dispersion by photographic means from rockets, and to a study leading to the development of rocket-borne spectrographic instrumentation for the purpose of obtaining data on absorption of solar ultraviolet radiation by molecular and atomic constituents of the upper atmosphere.

19.18

Denver U., Colo.
HIGH ALTITUDE TRANSMISSION, D. Murcray. Project 7670(770A), Contract AF 19(604)-7429; CRZC, AFCRL.

The purpose of this effort would be to use balloon-borne spectrometers to obtain high altitude infrared slant path transmission using the sun as a source and with these data to obtain measurements of the amounts of water vapor and other infra-active gases as a function of altitude. In addition, these balloons may be equipped with spectrometers to look up and down and obtain the flux divergence and upward flux (IR background) of the atmosphere.

19.19

Dublin Institute for Advanced Study (Ireland).
POLYDISPERSE AEROSOLS, L. W. Pollak. Project 8620 (804A), Contract AF 61(052)-26; AFCRL, CRZH.

Research on the physical characteristics and nature of occurrence of natural and artificial polydisperse aerosols.

19.20

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
BALL LIGHTNING EXPERIMENT, E. M. Dewan, M. Stiglitz. Project 5635(803A), Internal.

In-house experiments to investigate ball lightning will include (1) duplication of older German work involving D.C. discharges at high voltage through certain very lean mixtures of combustible gases, and (2) investigation of electromagnetic interaction of plasmas in a high voltage D.C. field (conditions in some way duplicating natural ones).

19.21

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
BALL LIGHTNING OBSERVATIONS, E. Dewan. Project 5635 (803A), Internal.

A literature search, a search for eye witness accounts, and an investigation of possible theories of ball lightning will continue. The eyewitness accounts will be analyzed for consistent strains of information and theoretical work is planned in connection with the ball lightning experiments.

19.22

General Electric Co., Richland, Wash.
DIFFUSION EXPERIMENTATION, J. J. Fuquay. Project 8604(804A), Contract PRO 62-537; CRZH, AFCRL.

The conduct and analysis of field experiments of diffusion to determine total dosages and ground deposition downwind from a continuous source at ground level and continuous sources at two heights simultaneously.

19.23

Georgia Inst. of Tech., Atlanta.
STUDY OF THE ALTERATION OF WATER DROPLET SUPERCOLLING BY FOREIGN VAPORS, C. Orr. Project 8620 (804A), Contract AF 19(604)-4970; CRZH, AFCRL.

Research on the influence of various atmospheric contaminants on the rate of freezing and extent of supercooling of water droplets and the nature of atmospheric contaminants that affect droplet supercooling.

19.24

Hawaii U., Honolulu.
SEA BREEZE STUDIES, M. A. Estoque. Project 7655 (770A), Contract AF 19(604)-7484; CRZH, AFCRL.

Perform numerical computations using boundary layer

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ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

parameters as well as synoptic scale measurements, in order to test methods of forecasting the sea breeze and other meso-scale phenomena.

19.25

Hawaii U., Honolulu.
TROPICAL METEOROLOGICAL USE OF SATELLITE DATA, C. S. Ramage. Project 6698(770A), Contract AF 19(604)-6156; CRZH, AFCRL.

Research on the utilization of meteorological satellite data for tropical weather analysis and forecasting. A study is being made of monsoon surges.

19.26

Howell, Wallace E., Associates, Inc., Lexington, Mass.
STUDY OF CLOUD PATTERNS, W. E. Howell. Project 6698 (770A), Contract AF 19(604)-7281; CRZH, AFCRL.

The relationship between cloud patterns and the associated dynamic states of the atmosphere is being investigated through the use of stereo photography, airplane soundings, and high altitude aerial photography.

19.27

Imperial Coll. of Science and Tech., London (Gt. Brit.).
HAIL FORMATION MECHANISMS, F. H. Ludlam. Project 8620(804A), Contract AF 61(052)-254; CRZH, AFCRL.

The work consists of studies of the life cycle of thunderstorms and the mechanisms by which they produce hail. Theoretical studies are supported by field investigations carried out with radar, aircraft, cloud cameras, a surface observational network, and other meteorological instrumentation. The work is presently being performed in England, but may also take place in other localities especially subject to severe hailstorms. An interpretation of hail formation and growth is to be sought in terms of a dynamically consistent model of the air motion within a cumulonimbus cloud in interaction with environmental wind, moisture, and temperature fields.

19.28

Imperial Coll. of Science and Tech., London (Gt. Brit.).
INFRARED ATMOSPHERIC EMISSION STUDIES, P. A. Sheppard. Project 8603(804A), Contract AF 61(052)-84; CRZC, AFCRL.

This is a study of the emission of the atmosphere in the near-infrared (1 - 20 microns), as a function of air mass, time of day, time of year, and ambient meteorological conditions.

19.29

Instituto Geofisico de Huancayo (Peru).
INVESTIGATION OF NIGHT AIRGLOW, A. Giesecke. Project 8627(804A), Contract AF 19(604)-7213; CRZA, AFCRL.

The contractor is making continuous measurements of the intensity of three lines in the night airglow spectrum, 5577 A OI, 6300 A OI and 5893 A NaI; the contractor is also reducing the data obtained and making correlations with other geophysical parameters measured at Huancayo. Such phenomena as the zodiacal light can be studied to best advantage at the high altitude equatorial station.

19.30

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
ATMOSPHERIC CONSTITUENTS, A. L. Carrigan. Project 8605(804A), Internal.

Theoretical investigations will be undertaken to determine the temperature of the atmospheric auroral emitting layer, the composition of the atmosphere, and the excitation processes involved. Emphasis will be given to the determination of auroral and airglow spectra as a function of height and geographic distribution, and the time resolution of hydrogen emissions.

19.31

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
AURORAL VARIATIONS, A. L. Carrigan. Project 7661 (770A), Internal.

Data from patrol and high dispersion spectrographs and all-sky cameras are organized into a form suitable for correlation studies on all aspects of aurorae occurring in the northern and southern hemispheres. Detailed analyses will be undertaken utilizing automatic computers.

19.32

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
AURORAL SPECTRA, T. P. Markham. Project 7661(770A), Internal.

Direct environmental spectral observations of the U.V. auroral emissions is accomplished through use

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SRP- Directorate of Physical Sciences

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of rocket-borne spectrometers and photometers.

19.33

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
RADIO-AURORA STUDIES, K. Toman. Project 7661(770A), Internal.

Theoretical and experimental investigations concerning the radio aurora.

19.34

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
STUDIES ON SPACE ENVIRONMENT USING DEEP SPACE ROCKET PROBES AND SATELLITES, J. C. Ulwick. Project 8605 (804A), Internal.

Studies of space beyond the height of the F-layer using deep space rocket probes and satellites. These studies are conducted to obtain information concerning the composition, density and physical state of the environment from the F-layer out into planetary space.

19.35

Johns Hopkins U., Baltimore, Md.
RADIATIVE FLUX MEASUREMENTS IN THE ATMOSPHERE, J. Strong. Project 8603(804A), Contract AF 19(604)-6174; CRZC, AFCRL.

Measurement of radiative flux and flux divergence in the far-infrared region as a function of altitude, latitude, azimuth angle and wavelength. Balloon-borne instrumentation is used to probe the atmosphere to altitudes of 100,000 ft.

19.36

Kiruna Geophysical Observatory (Sweden).
NORTHERN LATITUDE PROPAGATION, B. Hultqvist. Project 5631(803A), Contract AF 61(514)-1314; CRRK, AFCRL.

This work will consist of two phases: (a) continued operation of an ELF spectrometer, supplied by AFCRL, for the following main purposes: (1) investigation of the existence of proton gyro radiation in the auroral zone; (2) study of the natural background radiation in the frequency range 10 c/s to 10 kc/s; (b) construction of equipment and recording of variations in the earth's electromagnetic field in the frequency band 1-10 c/s. This will mean an extension of the previously studied frequencies down into a range where very few measurements exist.

19.37

Kiruna Geophysical Observatory (Sweden).
PHOTOMETRIC STUDIES, B. Hultqvist. Project 7661 (770A), Contract AF 61(052)-288; CRZI, AFCRL.

These studies consist of spectrophotometric observations of several auroral emissions which are extremely rapid in intensity variations. The highly transitory nature of auroral emission fluctuations are yet to be explained. With resolution times of 1/100 sec. this photometric system uniquely approaches the problem of determining the nature of the auroral fluctuations or wave motions.

19.38

Liege U. (Belgium).
HIGH RESOLUTION INFRARED STUDIES, M. V. Migeotte. Project 8603(804A), Contract AF 61(514)-962; CRZC, AFCRL.

This contract supports three separate subgroups of the University of Liege. One group is working at Arosa, Switzerland, on infrared problems associated with atmospheric ozone. Another small group is working at the University of Liege on high resolution infrared problems, and the main group works at the Jungfraujoch Scientific Station in Switzerland. At the Joch studies are underway on the IR spectra of sunspots, on interferometry in the near and far infrared, and on high resolution solar spectrum studies. The main efforts at the Joch have involved the extension of the well-known Solar Atlas by this group to wavelengths shorter than 2,7μ, into the PbS spectral region (1.2 to 2.7μ). In addition the infrared emission of the atmosphere has been studied with an interferometer and this same interferometer used to obtain infrared spectra of the planets.

19.39

Lightclimatic Observatory, Arosa (Switzerland).
GROUND-BASED MEASUREMENTS, H. U. Dütsch. Project 8604(804A), Grant AF-EOAR 61-18; CRZH, AFCRL.

Systematic measurement of the vertical distribution of atmospheric ozone by the Umkehr method. Analysis of the seasonal and short-term variability of ozone in relation to atmospheric processes.

19.40

Maryland U., College Park.
SHOCK WAVE PHENOMENA IN THE AURORAL REGION, S. F. Singer. Project 8605(804A), Contract AF 19(604)-3861; CRZI, AFCRL.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
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ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
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ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
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RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
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Investigate by means of balloon experiments, shock wave phenomena penetrating through the auroral region into the lower atmosphere for the purpose of verifying a new model of the aurora. Conduct experimental investigations of the ambient electron densities in the ionosphere and of the charge of rocket vehicles by means of probe devices mounted in rocket vehicles.

19.41

Massachusetts Inst. of Tech., Cambridge, Mass.
STUDIES OF SKY NOISE, S. Briggs. Project 8603(804A), Contract AF 19(604)-4547; CRZC, AFCRL.

This is a study of the time-dependent component of infrared atmospheric emission. The region of primary interest is 1-15 microns. Phenomena such as stellar scintillation in the infrared, auroral fluctuations and variations in sky glow in the infrared are being quantitatively observed.

19.42

Massachusetts Inst. of Tech., Cambridge.
STUDY OF ABSORPTION BAND MODELS, L. Kaplan. Project 8603(804A), Contract AF 19(604)-7995; CRZC, AFCRL.

This effort involves the theoretical study and calculation of line shapes and intensities and the development of theoretical models for describing infrared absorption bands.

19.43

Massachusetts Inst. of Tech., Cambridge.
CLOUD DROP SIZE DATA FROM M.I.T. CLOUD DROP SIZING INSTRUMENTS, D. P. Keily. Project 8620(804A), Contract AF 19(604)-7495; CRZH, AFCRL.

Basic research to investigate the techniques of measuring cloud and drizzle drop sizes and numbers from an aircraft platform by means of a charged electric probe.

19.44

Massachusetts Inst. of Tech., Cambridge.
PHOTOGRAMMETRIC SYSTEMS FOR OBTAINING METEOROLOGICAL DATA, C. L. Miller. Project 8620(804A), Contract AF 19(604)-4973; CRZH, AFCRL.

The contractor will engage in a study of data reduction problems associated with the analysis of aerial and terrestrial photography of cloud formation in a determination of the most feasible (technically and economically) method of data reduction. He will make pilot studies of the general problem of a special purpose photogrammetric system for cloud physics data procurement and undertake development of a prototype. The development of a 35mm cine stereo analyzer has been shown to be feasible. The construction of a prototype is now planned.

19.45

Massachusetts Inst. of Tech., Cambridge.
DIFFUSION THEORY, R. E. Rosensweig. Project 8604 (804A), Contract AF 19(604)-618; CRZH, AFCRL.

Theoretical and experimental investigations of the fundamental physical processes by which homogeneous, steady-state turbulence leads to relative dispersion of particles emitted into a fluid, and extension of theory to include such factors as buoyancy, shear flow and surface roughness.

19.46

McGill U. (Canada).
CIRCULATION DYNAMICS, B. W. Boville. Project 8604 (804A), Contract AF 19(604)-8431; CRZH, AFCRL.

Research into the circulation of the stratosphere and lower mesosphere as follows: (1) to undertake synoptic-dynamic studies of the 1958-1960 stratospheric circulation, laying special stress on energetics and stratospheric-tropospheric dynamical linkages; (2) to attempt an extension of this approach to the highest available observational levels, especially to the 10-millibar surface, and to the results obtained through the rocket soundings now being undertaken at upper stratospheric and mesospheric levels; and (3) to extend cross-section analysis to the tropical stratospheric easterlies and the higher parts of the Ferrel and mesospheric westerlies; and to consider the nature of stratospheric-tropospheric exchange processes revealed by such studies.

19.47

McGill U. (Canada).
PRECIPITATION PHYSICS, J. S. Marshall. Project 8620(804A), Contract AF 19(628)-249; CRZH, AFCRL.

This is a series of related fundamental studies of the physical structure and dynamics of precipitation elements. Included are investigations of precipitation streamers and their relation to the generating mechanisms; study of constant-altitude radar weather displays to determine the causes for the formation of various types of precipitation ranging from arrays of discrete generating cells to large areas of diffuse echo; study of the physics of hailstorms and inferences of quantitative radar measurements of such storms on hailstone growth and fallout detail; theoretical studies of the

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microphysical growth of cloud particles under various conditions of temperature, pressure, and humidity; and statistical studies of reflectivity distributions and attenuation by precipitation.

19.48

Meteorological Development Lab., CRZ, AFCRL, Bedford, Mass.
HURRICANE MODEL, L. Berkofsky. Project 8604(804A), Internal.

To carry out numerical integrations of the finite difference equations relating to a mathematical model of hurricane formation.

19.49

Meteorological Development Lab., CRZ, AFCRL, Bedford, Mass.
DETAILED WIND BALLOON, J. B. Wright. Project 6670 (770A), Internal.

An investigation of techniques to obtain a very detailed profile of wind will be continued. In particular, the technique of tracking a super-pressured metallized mylar sphere with the AN/FPS-16 radar will be evaluated. An analysis of recent flights made using a helium-filled, two-meter, half-mil mylar sphere will be made to help determine optimum design for obtaining accurate wind data to at least 75,000 feet over 100 feet height intervals. Further field flights are planned.

19.50

Meteorological Development Lab., CRZ, AFCRL.
ROBIN PROGRAM DEVELOPMENT, J. B. Wright. Project 6670(770A), Internal.

The purpose of this in-house effort is to coordinate the various aspects and different efforts of the Robin task. Further, to study the system as a whole and determine limitations and errors before final standardization of the system is considered. Future efforts will be devoted to publishing a comprehensive AFCRL report covering all phases of the Robin.

19.51

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
ANGELS AND LIGHTNING ECHOES, D. Atlas. Project 8620 (804A), Internal.

This is a fundamental study, both experimental and theoretical, of the refractive properties of the atmosphere which are capable of detection and measurement by radar. The aim is the development of new information on atmospheric properties and meteorological processes given by adequate interpretation of echoes, particularly from non-particulate sources.

19.52

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
PRECIPITATION PHYSICS, D. Atlas. Project 8620 (804A), Internal.

This is a basic investigation of the physics of precipitation in all types of weather systems, using advanced radar instrumentation and experimental techniques of measurement and analysis. The observations may be conducted on-base or on field trips to take advantage of special meteorological situations. The objective is the detailed study of the life cycle (or portion) of a meteorological process, using radar in association with other meteorological instruments. From these measurements deductions will be made of the physical processes that contribute in the maintenance of the storm as an engine for the transformation of energy and moisture.

19.53

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
CLOUD MICROPHYSICS, S. J. Birstein. Project 8620 (804A), Internal.

An investigation of the formation and growth of cloud droplets, ice crystals, and precipitation elements at the scale of the individual particles or cluster of particles for air-aqueous and gas-nonaqueous systems.

19.54

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
CLOUD INTERPRETATION, J. H. Conover. Project 6698 (770A), Internal.

By means of direct comparison between satellite pictures and simultaneous ground observations, aerial cloud photography and radar weather information, guides to the interpretation of cloud pictures are being prepared. The significance of meso-scale cloud patterns is being investigated.

19.55

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.

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PGMR- Ballistics Directorate
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CLOUD EFFECTS ON RADIO REFRACTIVE INDEX, R. M. Cunningham. Project 8620(804A), Internal.

Radio refractive index is a function of the pressure, temperature, and water vapor content of the air. This investigation explores the effects of clouds, as producers of large moisture anomalies in the atmosphere, on radio refractive index. Instrumentation is used to measure this quantity directly and very rapidly. The effort at the present time largely consists of completion of a series of six reports on cloud refractive index. Special studies are also being conducted on cloud refractive index effects for certain areas and times of particular interest.

19.56

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
CLOUD PROBING AND ANALYSIS, R. M. Cunningham. Project 8620(804A), Internal.

Probing of individual clouds and cloud groups by extensively instrumented aircraft. Measurement of cloud parameters; i.e., water content, drop sizes, particle types, temperature, humidity, etc. Measurement of ambient values of temperature and humidity. Analysis of partially digested data (the raw data are converted to usable form by contract) to form a detailed conception of the structure and dynamics of clouds and the associated air properties and circulations. The reasons for the growth or decay of clouds are sought as well as for the formation, or lack of formation, of precipitation. The effect of clouds on the ambient atmosphere is studied as well as the reverse.

19.57

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
STORM MEASUREMENT AND ANALYSIS, R. M. Cunningham. Project 8620(804A), Internal.

Measurement of the parameters involved in the formation and growth of clouds and precipitation in large storms or over meso-synoptic scale areas. These measurements are made using a highly instrumented aircraft (C-130). Airborne and ground weather radars are utilized and many cloud photographs are taken. Convective and storm models are drawn from these data after a preliminary analysis of the raw data is accomplished on contract. The water budget, the efficiency of various precipitation mechanisms, the nature and scale of air motions and their effect on the growth of cloud and precipitation are all studied.

19.58

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
FOG STUDIES, W. P. Elliott. Project 7655(770A), Internal.

Determine the relative importance of various micrometeorological parameters to the fog formation and dissipation processes. Particular emphasis will be placed on the role of infrared radiation flux divergence in the cooling process.

19.59

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
FOREST MICROMETEOROLOGY, W. P. Elliott. Project 8604(804A), Internal.

Data collected at Eglin Air Force Base are used to study the differences in wind and temperature profiles in forested and cleared areas.

19.60

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
TEMPERATURE CHANGE THROUGH RADIATIVE PROCESSES, W. P. Elliott. Project 8604(804A), Internal.

A theoretical and analytical investigation of the effect of radiative processes on the heat budget in the lower atmosphere.

19.61

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
THUNDERSTORM ELECTRICITY, D. R. Fitzgerald. Project 8620(804A), Internal.

Electrostatic, radar, photographic, and other cloud physics measurements are made from aircraft and ground stations in the vicinity of and within developing convective clouds. The research objective is to determine the electrical charge structure in growing cumulus clouds and thunderstorms so as to provide the observational basis for a definitive theory of thunderstorm electricity. An additional objective is to assess the utility of electrostatic techniques for avoiding regions of hail or graupel when storm penetrations are necessary.

19.62

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USE OF PHOTOGRAMMETRY TO INVESTIGATE THE DYNAMICS OF CUMULUS CLOUD DEVELOPMENT, M. Glass. Project 8620(804A), Internal.

Stereo time lapse photographs of developing cumulus clouds are taken from ground based T-11 mapping cameras to provide highly accurate measurements of the rate of growth of such clouds. The variations in the vertical velocity, diameter, and horizontal position with time of cloud and cloud elements will give an insight into the dynamics of convective cloud development.

19.63

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
ATMOSPHERIC TURBULENCE, D. A. Haugen. Project 7655 (770A), Internal.

Analysis of turbulent wind spectra and determination of the relationships between these spectra and average values of various meteorological parameters.

19.64

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
SURFACE OZONE ANALYSIS, W. S. Hering. Project 8604 (804A), Internal.

Work is directed toward a better understanding of the rate of ozone destruction due to direct contact with the earth's surface or with aerosols near the surface. High resolution measurements of the vertical ozone profile in the boundary layer will be used to investigate in detail the ozone budget of the lower atmosphere.

19.65

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
WIND, TEMPERATURE PROFILES, Y. Izumi. Project 8604 (804A), Internal.

A theoretical and analytical study of the development and decay of the nocturnal low-level jet with observational data collected on Cedar Hill Tower and other sources.

19.66

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
VERTICAL WIND SPECTRA, J. C. Kaimal. Project 8604 (804A), Internal.

An observational and analytical investigation of the variations of vertical wind spectra computed using sonic anemometers mounted on the Cedar Hill Tower.

19.67

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
CIRCULATIONS ABOVE 100,000 FEET, T. J. Keegan. Project 8604(804A), Internal.

Development of a basic description of the variation of atmospheric circulations in the altitude range of 100,000 ft. to 300,000 ft. through detailed analysis of rocket soundings, meteor observations, radiofade measurements, etc. Special attention is given to investigations of the variation of the atmospheric circulation and associated thermal regimes and the relationships between various atmospheric layers.

19.68

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
RADAR RESEARCH IN PRECIPITATION PHYSICS, E. Kessler. Project 8620(804A), Internal.

This is a fundamental study whose ultimate aim is to relate three dimensional distributions of radar reflectivity to the associated fields of air motions. Because distributions of water substance may be observed by radar, and are closely related to the wind field, quantitative radar measurements may be the basis for determination of the wind field, especially the important vertical component. The relations among water and wind distributions for model distributions of the wind are determined by study of equations of continuity for water substance. Relations with radar reflectivity are deduced from considerations of model distributions of particles resembling those common to real rain or snow. Radar reflectivity maps, recording precipitation gauges, and other meteorological data are evaluated with reference to the model distributions in order to learn of the three dimensional wind fields which occur in nature.

19.69

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
MESO-SCALE CIRCULATIONS, H. E. Klieforth. Project 8604(804A), Internal.

An observational and analytical investigation of meso-scale meteorological phenomena based on measurements by instrumented aircraft and supplemented by synoptic upper air and surface weather observations.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNR- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

19.70

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
PHYSICS OF CLOUD SYSTEMS, V. G. Plank. Project 8620 (804A), Internal.

Analyses are being performed to establish the three dimensional characteristics of the fields of cloudiness, precipitation, humidity, temperature, and motion which are associated with particular cloud systems and with particular cumulus cloud populations. Attempts are being made to ascertain the relationships that exist among these various fields and to account for the observations on theoretical grounds. The basic data for these investigations are obtained from aircraft measurements, aerial photography, and radar observations.

19.71

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
TROPICAL APPLICATION OF SATELLITE METEOROLOGICAL DATA, J. C. Sadler. Project 6698(770A), Internal.

The meteorological satellite data have considerable application in the data-sparse regions of the tropics. In this homogeneous atmosphere, the cloud patterns mirror the circulation patterns and weather systems. TIROS data will be utilized in studying such features as (1) the generation, movement, and dissipation of low level tropical storms; (2) the organization and fluctuations of the intertropical convergence zones; (3) the structure and extent of the upper tropospheric cold trough and its role in the development of low level tropical storms; and (4) the surge, extent and fluctuation of the monsoonal systems. NIMBUS gives promise of being able to map and study these features on a global basis for the first time.

19.72

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
IR RESEARCH, F. R. Valovcin. Project 6698(770A), Internal.

Development of weather analysis and forecasting techniques through the use of satellite and/or aircraft IR observations. Investigate the relationship of solar and terrestrial radiation patterns under various meteorological conditions.

19.73

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
DIABATIC FORCING, F. W. Ward. Project 8604(804A), Internal.

Study of the effects of diabatic forcing of the large-scale circulations through the investigation of previous climatic variations.

19.74

Michigan Coll. of Mining and Technology, Houghton.
IONOSPHERIC WIND ANALYSIS, D. G. Yerg. Project 8605 (804A), Contract AF 19(604)-8337; CRZI, AFCRL.

Conduct a computational program in which extensive numbers of experimental ionospheric wind records obtained from the D and F ionospheric regions will be analyzed for statistical quantities such as random velocities and average normal departure speeds. Conduct theoretical analysis of these statistical wind parameters.

19.75

Michigan U., Ann Arbor.
CLOUD PHYSICS, A. M. Dingle. Project 8620(804A), Contract AF 19(604)-6143; CRZH, AFCRL.

Research into the effect of atmospheric turbulent air motions in natural clouds on the collision, coalescence and collection efficiencies of cloud and precipitation particles. Analysis of radar data obtained by the University of Michigan during summers of 1959 and 1960.

19.76

Munich U. (Germany).
INFRARED SKY EMISSION STUDIES, F. Müller. Project 8603(804A), Contract AF 61(052)-488; CRZC, AFCRL.

Studies of the infrared emission of the atmosphere in the 5 to 25 micron region, with consideration of pressure, temperature, and humidity effects. The data obtained at S. Agata, Italy, is being reduced on the IR emission of the sky under various atmospheric conditions and over sea, terrain and town. Also the radiative flux from ground and sea to sky has been investigated. These sky emission measurements have been recently repeated at the Jungfraujoch, Switzerland.

19.77

New York U., N. Y.
ATMOSPHERIC OZONE, J. London. Project 8604(804A), Contract AF 19(604)-5492; CRZN, AFCRL.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

Theoretical investigation of the combined effects of photochemistry, diffusion and vertical motion in the distribution of atmospheric ozone, and investigation of the energetics of the upper atmosphere. Work will be based on observational data previously gathered.

19.78

New York U., N. Y.
COLLISION AND COALESCENCE EFFICIENCY, R. Schotland. Project 8620(804A), Contract AF 19(604)-6145; CRZH, AFCRL.

Research into basic mechanisms that govern the collision, coalescence, and collection efficiences of cloud and precipitation particles as they fall through the atmosphere under various environmental conditions. Research primarily accomplished by laboratory modeling techniques.

19.79

Northeastern U., Boston, Mass.
INVESTIGATION OF DAY AND NIGHT AIRGLOW, L. Nardone. Project 8627(804A), Contract AF 19(604)-7307; CRZA, AFCRL.

Intensification of effort to design, build and calibrate the electronic and optical instrumentation for rocket measurements of day and night airglow. The contractor also furnishes assistance in the analysis and reduction of data for studies of special phenomena which have been observed in the chain of airglow stations.

19.80

Northeast Weather Services, Boston, Mass.
WEATHER CHARTS, J. E. Wallace. Project 6665(850A), Contract AF 19(628)-973; CRZE, AFCRL.

Contractor delivers daily plots of atmospheric winds at 50 mb and 30 mb levels. These maps are used for planning laboratory schedules, and for monitoring balloon flights. The completed maps form the raw material for the scientific analysis of stratospheric flow patterns.

19.81

Ohio State U., Columbus.
ATMOSPHERIC TRANSMISSION, H. H. Nielsen, D. Williams. Project 7670(770A), Contract AF 19(604)-6141; CRZC, AFCRL.

This effort involves a study of the infrared properties and composition of the atmosphere including laboratory measurements of the infrared absorption of gases over long paths using multiple-traversal absorption cells, measurements of composition using infrared absorption bands, high-resolution detailed studies of selected absorption bands, and development of various instrumental techniques.

19.82

Oslo U. (Norway).
AURORAL RESEARCH, L. Harang. Project 7661(770A), Contract AF 61(052)-252; CRZI, AFCRL.

This effort consists essentially of photometric observations of the rapidly varying emissions in the aurora. These data are correlated with other auroral and geomagnetic data. Selected auroral emissions are studied to determine their height profiles and variation with time and auroral form.

19.83

Oxford U. (Gt. Brit.).
NIGHT SKY EMISSIONS, M. F. Ingham. Project 8605 (804A), Grant AF-EOARDC-61-9; CRZI, AFCRL.

Observational measurements of night sky emissions using a very high dispersion spectrograph to determine band structure of the molecular transections.

19.84

Pennsylvania State U., University Park.
HEAT AND MOMENTUM FLUX IN THE PLANETARY BOUNDARY LAYER, A. K. Blackadar. Project 7655(770A), Contract AF 19(604)-6641; CRZH, AFCRL.

Development of methods for predicting the surface wind stress and the variances and spectra of turbulence from synoptic scale parameters such as geostrophic winds, horizontal temperature gradient and cloudiness. Evaluation of Blackadar's model of the low level jet using data from the Dallas tower.

19.85

Pennsylvania State U., University Park.
LOWER IONOSPHERE, A. A. Waynick. Project 8605 (804A), Contract AF 19(604)-4563; CRZI, AFCRL.

Theoretical and experimental investigations of the physics, dynamics, characteristics and general properties of the conducting and absorbing regions of the earth's atmosphere as well as the ionized regions of other planetary atmospheres.

19.86

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
ABSORPTION SPECTRA OF THE UPPER ATMOSPHERE, A. S. Jursa. Project 8627(804A), Internal.

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ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

AFD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab

RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

This research is primarily concerned with the determination of the structure of the upper atmosphere. This involves the detection of and distribution of the upper atmospheric constituents with respect to altitude. The research is conducted with rocket-borne instrumentation such as photographic type spectrographs and the technique involved is the observation of the effect of atmospheric absorption on the spectrum of the sun in the wavelength region below 3000 Å. The data obtained from the rocket-borne experiments is compared with detailed laboratory data consisting of absorption spectra of atmospheric gas molecules in order to determine the presence of and distribution of these molecules in the upper atmosphere.

19.87

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass. UPPER ATMOSPHERE PERTURBATION-IONIZATION, H. W. Rosenberg. Project 7635(770A), Internal.

To design and execute field experiments for performing artificial upper atmosphere perturbations, producing ionization. A study is made of missile trails, of nuclear events, and of controlled chemical releases by appropriate optical sensors to provide definition of responsible processes and assessment of problems caused thereby.

19.88

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass. UPPER ATMOSPHERE PERTURBATION-LUMINESCENCE, H. W. Rosenberg. Project 7635(770A), Internal.

To design and execute field experiments for performing artificial upper atmosphere perturbation, producing luminescence. A study is made of missile trails, of nuclear events, and of controlled chemical releases by appropriate optical sensors to provide definition of responsible process, and assessment of problems caused thereby.

19.89

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass. CHARGE DENSITIES, R. C. Sagalyn. Project 8617 (804A), Internal.

The principal objective is to obtain basic data on electrical phenomena of the upper atmosphere and the interplanetary gas. This includes determination of charge densities and their energy distributions, current electric force fields and conductivities. The spatial and time variations of these properties are determined with instruments installed on rockets and satellites.

19.90

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass. INVESTIGATION OF DAY AIRGLOW, S. Silverman. Project 8627(804A), Internal.

It is the purpose of this work to investigate the emission spectra of the upper atmosphere during daylight. Because of the high intensity of scattered sunlight during daylight hours this must be done, at the present time, by the use of rocket-borne instrumentation. A grating instrument is presently being tested for a flight in early 1962. It is anticipated that theoretical studies of the mechanisms for the production of the dayglow will supplement the experimental work.

19.91

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass. INVESTIGATION OF NIGHT AIRGLOW, S. Silverman. Project 8627(804A), Internal.

The purpose of this work is the establishment of the physical processes responsible for the emission spectra of the upper atmosphere, and the relationship between these processes and other geophysical parameters. Airglow data collected from a chain of stations in the northern and southern hemispheres are being analyzed for correlations with other phenomena. New instrumentation is being designed for the regular measurement of lines other than the three lines now being measured.

19.92

Physical-Meteorological Observatory (Switzerland). HIGH RESOLUTION INFRARED STUDIES, W. Morikofer, P. Bener. Project 8603(804A), Contract AF 61(052)-54, EO 2-5(60); CRZC, AFCRL.

This contract supports a group at the Physikalisch-Meteorologisches Observatorium investigating the following: (a) directly, the spectral distribution of atmospheric radiation of 2900 to 3600 Angstroms from the sky and the sun; (b) indirectly, the disposition and effects of ozone, temperature, humidity, turbidity, and cloudiness and their influence on the thermal radiation region from the UV deep into the infrared. The pertinent atmospheric parameters are easily sensed by ultraviolet sensitometry and the magnitudes of these parameters are applied to the theoretical computations of visible and IR scattering and absorption in the atmosphere by the mathematical methods of Chandrasekhar.

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CRZR- Sacramento Peak Observatory

19.93

Queen's U., Belfast (Gt. Brit.).
PHYSICS OF THE UPPER ATMOSPHERE, D. R. Bates. Project 7635(770A), Contract AF 61(052)-131; Grant AF-EOARDC 61-16; CRZA, AFCRL.

Considerable progress has been made in the theoretical study of atomic polarizabilities. Calculations have been completed on a comparison study of atomic excitation induced by proton and electron impact. The scanning interferometer used for the study of the OI green and red lines in the aurora, twilight, and nightglow has been made operational, and observational results should be forthcoming shortly.

19.94

Regis Coll. for Women, Weston, Mass.
ATMOSPHERIC OZONE, Mary Leonarda, Sister. Projects 8604(804A), 7655(770A), Contract AF 19(604)-7247; CRZH, AFCRL.

Processing of raw meteorological, mathematical and statistical data and conversion to forms suitable for scientific analysis.

19.95

Regis Coll. for Women, Weston, Mass.
PRELIMINARY ANALYSIS OF CLOUD PATTERNS, Mary Leonarda, Sister. Project 8620(804A), Contract AF 19(628)-216; CRZ, AFCRL.

Preliminary analysis of cloud photographs and determination of scale, cloud, and cloud group size distributions. Relating in time and space low level cloud measurements and photographs with the high level ones from high altitude aircraft or satellites. Design, construction, and utilization of simple analysis aids for handling this data.

19.96

Rensselaer Polytechnic Inst., Troy, N. Y.
UPPER ATMOSPHERE CHEMISTRY, P. Harteck. Project 7635(770A), Contract AF 19(604)-6128; CRZA, AFCRL.

Investigation of light intensity, spectral distribution, reaction order and mechanism of reactions of carbon disulfide and sulfur for possible use in rocket chemical release experiment. Research into methods for studying atmospheric reactions at low pressures where rates are not as rapid. Research into reactions producing missile trails in the atmosphere. Study of spectral distribution from excited molecules produced by surface catalyzed excitation, and exploitation of this technique for kinetics studies.

19.97

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
FLIGHT OPERATIONS RESEARCH, S. B. Solot. Project 6665(850A), Internal.

In order to continually improve the methods of stratospheric analysis and trajectory forecasting for balloons, mathematical models of the instantaneous circulation patterns over the Northern Hemisphere are prepared using data and techniques supplied by the Northeast Weather Service and other contractors. These models are divided into large scale and medium scale flows and provide the basis for calculating thermal circulation between levels and vertical wind shears. Information theory techniques are used to represent the individual parameters of the model as nonredundant information about the state of the circulation. Balloon observations are introduced into the model to provide information on the nongeostrophic components of flow. As required, these techniques are used to prepare optimum flight operations plans for specific flights.

19.98

Saskatchewan U., (Canada).
AURORAL OBSERVATIONS, B. W. Currie. Project 7661 (770A), Contract AF 19(604)-7265; CRZI, AFCRL.

Auroral optical observations are made with constantly improving instrumentation. These spectral and optical data are utilized in advancing auroral theories of excitation mechanisms, temperatures, and state of the atmosphere at auroral heights. During periods of no auroral activity, night sky and twilight sky are studied.

19.99

Southwestern Coll., Memphis, Tenn.
MOLECULAR ABSORPTION, J. Taylor, H. Hanson. Project 7670(770A), Contract AF 19(604)-4953; CRZC, AFCRL.

The purpose of the work is to carry out experimentally and theoretically studies of the mechanism of absorption of infrared radiation by molecules. The theoretical studies involve spectral line intensities in vibration-rotation bands. The experimental efforts are toward determining relaxation rates of excited molecules and the measurements of atmospheric slant path absorption using the sun as a source. Much of the recent effort has been the reduction of the solar spectra obtained in Florida in conjunction with high-altitude seeding experiments.

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PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESRR- Operational Applications Lab

19.100

Stanford Research Inst., Menlo Park, Calif.
IR RESEARCH, M. M. Holl. Project 6698(770A), Contract AF 19(604)-5965; CRZH, AFCRL.

Evaluation and refinement of expressions of radiative heat gains and losses by use of actual radiation observations from TIROS series of meteorological satellites. Also a comparative study relating the measured with the computed values of the radiation of the atmosphere.

19.101

Stanford Research Inst., Menlo Park, Calif.
RADAR AND SATELLITE CLOUD OBSERVATIONS, M. G. H. Ligda. Project 6698(770A), Contract AF 19(604)-5982; CRZH, AFCRL.

Compare satellite pictures with radarscope pictures on meso-scale. Compare moisture trajectories, echo development, and motion with pictures. Collect new radar data, at times simultaneously with satellite pictures.

19.102

Technical Operations, Inc., Burlington, Mass.
AIRBORNE, LIGHT-SCATTERING INSTRUMENTATION FOR DETERMINING RAINDROP SIZES AND NUMBERS, E. T. Clark. Project 8620(804A), Contract AF 19(604)-6661; CRZH, AFCRL.

The work involves the design development and testing of a right-angle, light-scattering instrument for the measurement, from aircraft platforms, of the number and sizes of raindrops in the atmosphere. An experimental instrument has been designed which is to be housed in an aircraft wing-tank. At the present time, this instrument is being "adjusted" and calibrated. Future plans call for wind tunnel and airborne tests of this instrument and for the design of a suitable recording system. The placing of several other cloud measuring equipments in the wing tank is to be studied.

19.103

Technische Hochschule, Darmstadt (Germany).
MACRO-SCALE TURBULENCE, F. Wippermann. Project 8604(804A), Contract AF 61(052)-366; CRZH, AFCRL.

To study the nature of macro-scale turbulence in the atmosphere and to investigate, by means of mathematical models, the non-adiabatic effects of heating and friction on the large-scale circulations.

19.104

Texas A and M Research Foundation, College Station.
SUBTROPICAL CLOUD AND WEATHER SYSTEMS, A. H. Thompson. Project 6698(770A), Contract AF 19 (604)-8450; CRZH, AFCRL.

Cloud patterns near the Texas area as seen from satellites will be studied for cases of coastal fog and stratus, on and off shore circulations, air mass cumulus and cumulonimbus, middle and high cloud mass patterns, and in particular those of a non-frontal nature, sharp well-defined cold fronts and pre-frontal squall lines developing stages of storms. Dallas Tower data may be used.

19.105

Texas U., Austin.
RADIATION FOG, J. Gerhardt. Project 7655(770A), Contract AF 19(604)-7279; CRZH, AFCRL.

Investigate the physical parameters involved in fog formation with particular emphasis on micrometeorological parameters. Assist in conduct of proposed field investigation of fog and analysis of data acquired.

19.106

Texas U., Auston.
WIND AND TEMPERATURE PROFILES OBTAINED FROM TALL TV TOWER, J. R. Gerhardt. Project 8604(804A), Contract AF 19(604)-5556; CRZH, AFCRL.

The contractor will operate and maintain the meteorological measurement system built for the purpose of gathering wind and temperature data at several levels in the atmospheric boundary layer. Data obtained under this contract will serve to extend and increase knowledge of physical processes in the atmospheric boundary layer.

19.107

Texas U., Austin.
MAGNETOMETER OBSERVATIONS, A. W. Straiton. Project 5633(803A), Contract AF 19(604)-8513; CRRI, AFCRL.

This work comprises a measurement of hydromagnetic emissions of the ionosphere during natural and manmade events. In particular measurements are to be made during the launch of rocket vehicles. Data are recorded and sent to AFCRL (CRRI) for analysis.

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CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

19.108

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
IR ATMOSPHERIC ABSORPTION AND EMISSION, J. N. Howard. Project 7670(770A), Internal.

Under this in-house effort, laboratory infrared spectral data on atmospheric molecules are correlated with such parameters as path length, temperature and pressure to obtain empirical expressions for infrared atmospheric transmission and related problems.

19.109

C. W. Thornthwaite Associates, Elmer, N. J.
CLIMATIC AND HYDROLOGIC FACTORS AFFECTING THE REDISTRIBUTION OF Sr^{90} IN SOILS, C. W. Thornthwaite. Project 9774(804A), Contract AF 49(638)-887; SRPN, AFOSR.

A basic study will be made of the relation between the dispersion of radioactive particles, particularly Sr^{90}, in the soil and the waters of the earth, and various climatic, hydrologic and edaphic factors. Determinations of the exact effect of these factors in the action of radioactive contamination will be attempted as well as a determination of a geographic pattern of the fallout and resultant radioactivity on the basis of present climatologic knowledge. The results of investigations carried on by other agencies and measurements of radioactivity currently being reported will be analyzed from the standpoint of interpretation in terms of the physical factors of the soil and vegetation environment.

19.110

Uppsala U. (Sweden).
ELECTRIC AND MAGNETIC FIELD VARIATIONS FROM LIGHTNING DISCHARGES, H. Norinder. Project 5631(803A), Contract AF 61(052)-171; CRRK, AFCRL.

The electromagnetic field variations of lighting discharges are being compared with photographs of the discharge channels in order to improve the understanding of the discharge mechanism, and the properties of the radiation field.

19.111

Utah U., Salt Lake City.
IMPEDANCE PROBE IONOSPHERIC MEASUREMENTS, O. Haycock. Project 8653(710A), Contract AF 19(604)-5515; CRZI, AFCRL.

Theoretical studies and experimental investigations are conducted for the determination of electron densities and collisional frequency in the ionosphere by measuring the impedance of rocket antennas at different frequencies with respect to height.

19.112

Weather Services, Inc., Boston, Mass.
COMPUTER ANALYSIS OF CLOUD PARAMETERS, M. Hogan. Project 8620(804A), Contract AF 19(604)-6616; CRZH, AFCRL.

Conversion of analog flight records using semiautomatic processing to a form usable for final analysis. After digital tape system is in use, programming the computer for the data handling processes, editing in format converter of the raw data tape and presenting data from computer in form suitable for final analysis.

19.113

Yerkes Observatory, Williams Bay, Wisc.
AURORAL RADIATIONS, J. W. Chamberlain. Projects 7661(770A) and 8605(804A), Contract AF 19(604)-3044; CRZI, AFCRL.

Theoretical studies are undertaken on the origin of the aurora and airglow. Associated observational programs of photometry and spectroscopy are conducted to provide some of the fundamental data necessary to the theoretical program. Information on atmospheric energy sources are applied to other planetary atmospheres.

See also: 3.3, 3.5, 3.11, 3.46, 3.61, 3.78, 3.93, 5.35, 6.65, 6.130, 7.11, 7.35, 7.53, 7.65, 7.76, 7.83, 8.9, 8.58, 11.3, 11.64, 11.72, 11.94, 11.111, 11.117, 12.27, 14.5, 16.80, 18.3, 18.24, 20.4, 20.14, 20.16, 20.38-39, 20.81, 23.22, 23.44, 23.48, 23.62, 23.66, 23.72, 23.110, 23.114, 24.51

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PGWR- Ballistics Directorate
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20. SPACE PHYSICS

Astropyhsics; Celestial Mechanics; Lunar Studies; Meteor Physics; Planetary Studies; Radar Astronomy; Radio Astronomy; Solar Physics.

20.1

Applied Mathematics Research Lab., ARM, ARL, Dayton, Ohio.
OPTIMAL SOLUTIONS FOR SPACE TRAVEL (AND NAVIGATION), C. A. Traenkle. Project 7071(806A), Internal.

Interplanetary space travel is determined to a vast extent by the available propulsion systems. Taking the capabilities of the available propulsion systems as the premise, one can investigate a wide variety of questions, including trajectories, the launch phases, the approach and landing maneuvers, and the launch at target planets. The results of the computations are compared with regard to propellant and time requirements.

20.2

Arizona U., Tucson.
SELENODETIC CONTROL STUDY, G. P. Kuiper. Project 8654(804A), Contract AF 19(604)-8064; CRZG, AFCRL.

A controlled selenodatic investigation is being performed utilising lunar photography. Photographic plates of the moon are being evaluated, measured and reduced, which will result in the determination of a best fitting geometrical figure of the moon as well as a system of lunar control points to be used for lunar charting purposes.

20.3

Asiago Observatory, Padova U. (Italy).
FLARE STARS AND NEBULAR VARIABLES, L. Rosino. Project 8635(804A), Contract AF 61(052)-360; CRZI, AFCRL.

Finding the relation of low luminosity variables to peculiar objects like Herbig-Haro objects, knots, globules, etc. and the spectroscopic and photometric changes and evolution of peculiar objects in diffuse nebulae and toward the study of physical processes in low luminosity stars.

20.4

Athens U. (Greece).
COLLECTION AND ANALYSIS OF RIOMETER DATA, M. Anastassiades. Project 5631(803A), Contract AF 61 (052)-261; CRRK, AFCRL.

This project is for the measurement of ionospheric absorption by utilising cosmic noise as the signal source and a riometer as the receiver. Depressions in the normal amplitude characteristic are indicative of upper atmosphere absorption and this is to be correlated with geophysical and solar phenomena for a better understanding of the upper atmosphere, that is, the various propagation parameters.

20.5

Bern U. (Switzerland).
RADIATION EFFECTS IN SPACE, F. G. Houtermans. Project 9774(804A), Grant AF-EOAR-61-51; SRPN, AFOSR.

Thermoluminescence curves of meteoritic samples are examined to determine the total radiation dose and dose rate to which the meteorites have been subjected. The meteoritic samples will also be examined for ablation. Through this, and glow curve studies, it may be possible to determine the temperatures the meteors have been subjected to upon entering the atmosphere. Nuclear emulsions which have been flown to high altitudes will be examined to learn about the energy spectrum and composition of the primary cosmic radiation.

20.6

California Inst. of Tech., Pasadena.
STELLAR COMPOSITIONS AND PROCESSES, J. Greenstein. Project 9774(804A), Contract AF 49(638)-21; SRPP, AFOSR.

Studies are being made on element formation, abundances and evolution for normal and abnormal classes of stars of red-giant and white-dwarf classes. Studies are also being made on EM discharges in stellar plasmas, growing plasma waves and the shock wave sequences leading to giant stellar explosions. The role of intense magnetic fields of magnetic stars on particle acceleration such as occurs in sun prominences is receiving particular consideration.

20.7

California U., Berkeley.
COMPUTATIONAL RESEARCH IN ASTROPHYSICS, L. G. Henyey. Project 9774(804A), Contract AF 49(638)-299; SRPP, AFOSR.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
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ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARY- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNR- Electronics Technology Lab
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RAS- Directorate of Engineering
RAUA- Advanced Development Lab
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Studies will be made of two stages of stellar evolution models. The first involves the influences of an outer convective shell and stellar rotation on the stellar atmosphere and its electromagnetic radiation for these quiet, older stars. Concurrently, computational studies of hydrodynamic phenomena will be made for models of pulsating stars to relate atmospheric variational events observed with phenomena occurring at some depth in the stellar interior. Evolution studies will then be extended to main sequence stars and globular clusters including the effects of anisotropic mass distribution.

20.8

California U., Berkeley.
KINEMATICS OF THE GALAXY, H. F. Weaver. Project 8635 (804A), Contract AF 19(604)-6170; CRZI, AFCRL.

The work is aimed at determining and understanding the motions of stars and of interstellar gas in the galaxy including a definitive determination of the kinematical constants of galactic rotation. To achieve these ends the contractor is gathering together definitive data of a number of different kinds and where critical types of data are weak or missing he organizes and conducts an intensive observing and/or computing program to obtain them.

20.9

California U., Los Angeles.
HIGH PRECISION GEOCENTRIC AND INTERPLANETARY ORBITS, S. Herrick. Project 9783(806A), Contract AF 49(638)-498; SRE, AFOSR.

This is a theoretical study of theories and procedures pertaining to the precise computation of geocentric orbits appropriate to ballistic missiles, earth-launched satellites and satelloids. Emphasis will be placed on the development of optional procedures for computing perturbations, including the effect of variable drag and the development of corrective theory for improving approximately known orbits to a higher degree of accuracy. Methods will also be developed for determining, precisely, the trajectories (orbits) of existing satellites from minimum observations.

20.10

Centro Microonde, Florence U. (Italy).
SATELLITE AND ECLIPSE STUDIES, N. Carrara. Project 5631(803A), Contract AF 61(052)-498; CRR, AFCRL.

The work to be performed by Centro Microonde may be divided into three phases. The first phase would include the holding of a conference in Florence, Italy pertaining to joint satellite observations taken by 6 European stations. These joint observations would constitute a correlated study of propagation effects on satellite transmissions. Centro Microonde would be responsible for writing a summary report of the conclusions reached at this conference. The second phase will consist of the making of amplitude recordings of satellite transmissions at 20 Mc. These recordings will cover periods specifically designated by AFCRL and will help to advance our study of the propagation effect on satellite transmissions. The third phase will be the performance of riometer experiments during the eclipse period centered around 15 February 1961.

20.11

Chicago U., Ill.
PLANETARY SPECTRA, G. P. Kuiper. Project 8602(804A), Contract AF 19(604)-7260; CRZE, AFCRL.

Contractor is studying the possible compositions of the atmospheres of Venus, Mars, Uranus and Jupiter, and the possible absorption spectra to be associated with these.

20.12

Colorado School of Mines Research Foundation, Inc., Golden.
ENVIRONMENTAL INFLUENCE ON THE COMPOSITION OF LUNAR AND TERRESTRIAL IGNEOUS SPECIES, F. L. Smith. Project 6886(802A), Contract AF 29(600)-2878; SRAS, AFOSR.

This contract provides expert opinion in geological sciences necessary to support in-house work on the feasibility of using the solar furnace to provide useful materials such as water from igneous rock surrounding a manned lunar station. On the basis of accumulated knowledge, the contractor will provide recommendations and carry out tests on methods of extracting elements and compounds from rocks which are anticipated to exist on the moon and which will assist in the operation of manned lunar stations.

20.13

Colorado U., Boulder.
PLANETARY RADIATION, J. Warwick. Project 5629(803A), Contract AF 19(628)-224; CRRK, AFCRL.

This work will consist of two phases. The first will be a study of the ionospheric effects on radio signals from extraterrestrial sources through analysis of the refraction and scintillation data taken in the range of 7.5 - 41 Mcs. This study will lead to a better understanding of communication possibilities through studying the media through which this transmission would be conducted. The second phase would be a study of solar bursts which reveals valuable information concerning geomagnetic disturbances and the resulting effects on communication, and also a study of Jupiter radiation which would provide information on our own atmosphere, Jupiter's atmosphere, some solar system parameters, and information of the sun's outer corona,

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all important in the study of communication and space navigation.

20.14

Columbia U., New York.
RADIO ASTRONOMY AT MILLIMETER WAVELENGTHS, P. Kusch. Project 9768(803A), Grant AF-AFOSR-62-50; SRPP, AFOSR.

This research covers radiometry and radio astronomy in the low millimeter wavelength region, especially research on microwave absorption and analysis of the high atmosphere, including certain components of the sun's corona, and millimeter wave radio astronomy generally. Use will be made of a high accuracy parabolic antenna available at Columbia University, in conjunction with radiometry equipment and a maser amplifier for the millimeter wavelength region developed under this contract.

20.15

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
STABILITY OF DIFFERENTIAL EQUATIONS, R. H. Urbano. Project 5632(803A), Internal.

Investigate relatively short term stability of the differential equations of the n-body problem [illegible] computer methods. Particular emphasis will be placed on mathematical simulation of stable orbits about the moon and about those planets which do not have natural satellites in an effort to determine which perturbative forces are too strong to permit such satellites.

20.16

Cornell U., Ithaca, N. Y.
SOLAR SYSTEM MAGNETOHYDRODYNAMICS, T. Gold. Project 9768(803A), Grant AF-AFOSR-62-191; SRPP, AFOSR.

This research will cover the following: origin of solar systems, cosmology, solar system magnetohydrodynamics, theory of auroras and magnetic storms, mechanism of generation of radio noise, and stellar constitution and evolution. This work is intended to provide a closer research relationship between problems of radio astronomy and astrophysics.

20.17

Cornell U., Ithaca, N. Y.
MATHEMATICS OF CELESTIAL MECHANICS, H. Pollard. Project 9783(806A), Grant AF-AFOSR-61-17; SRM, AFOSR.

This research in celestial mechanics concerns the restricted three-body problem, a variant of it (i.e., the introduction of a fourth body), and an inverse problem in the theory of differential equations. Precisely, it concerns the stability of the libration points in the restricted three-body problem, with possible reference to their use in the earth-moon system for the location of a space buoy. It concerns the same situation with consideration of the additional effect of the sun, which should furnish clues to the theory of the restricted four-body problem. And it concerns the inverse problem in the theory of differential equations, which asks under what initial conditions can pre-assigned values of a function (e.g. "positions") be achieved at some future time, a problem that arises in the launching of space vehicles.

20.18

Directorate of Research Analysis, SRL, AFOSR, Washington, D. C.
FLIGHT PATH OPTIMIZATION, J. R. Foote. Project 7856(806A), Internal.

A study of methods for computing optimal flight paths has been initiated, based on direct and indirect approaches of the calculus of variation. To try out the methods proposed for their workability, schemes employing the gradient method and the "penalty function" technique, as devised by Dr. H. Kelley, will be applied to concrete cases, using the PACE analog computer at Holloman.

20.19

Dudley Observatory, Albany, N. Y.
METEOR PARTICLE STUDY, C. Hemenway. Project 6694 (750F), Contract AF 19(604)-5885; CRZA, AFCRL.

Analysis of particulate matter collected on rocket flight. Design and construction of experimental devices to trap particles in free space.

20.20

Florence U. (Italy).
SCATTERING FROM METEOR TRAILS, M. Carrara. Project 5631(803A), Contract AF 61(052)-477; CRRK, AFCRL.

Follow up the theoretical meteor investigations already completed by employing the radar equipment to accomplish the following: (a) evaluate the true velocity distribution of the meteors; (b) evaluate the average volume density of radio echoes in the case of forward scatter; (c) monitor a linkage by means of the radar apparatus; and (d) observe meteor echoes by radar.

20.21

General Electric Co., Philadelphia, Pa.
ANALYSIS OF THE N-BODY PROBLEM FOR TRAJECTORY DETERMINATIONS, V. G. Szebehely. Project 9783(806A), Contract AF 49(638)-814; SRE, AFOSR.

The contractor shall seek the coordinate transformation which satisfy the following requirements: (1)

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the resulting differential equations describing the motion of a particle in the force field of n bodies have no singularities except the 1/22 type, i.e., no singularities are introduced by the new generalized variables in addition to those singularities present if Cartesian rectangular coordinates are used; (2) the new generalized coordinates have the property that if the particle is moving on any conic section, the new coordinates assume constant values; (3) the new set of differential equations should allow one to find new particular solutions or at least to find certain simplifications along analytical lines; and (4) the new differential equations together with the associated transformation formulae should be well suited for digital computer solution techniques.

20.22

General Electric Co., Philadelphia, Pa.
LUNAR TRAJECTORY STUDIES, V. Szebehely. Project 5632 (803A), Contract AF 19(604)-5863; CRRB, AFCRL.

A high accuracy, three dimensional interplanetary trajectory program has been written for the IBM 7090 which will predict future position and velocity of a vehicle in the solar system from present position and velocity under the gravitational influence of the moon and sun and any number of planets. The earth's oblateness is also included and provisions for including oblateness of other bodies have been made.

20.23

Hamburg U. (Germany).
GALACTIC NEBULAR STUDIES, K. Wurm. Project 8635(804A), Contract AF 61(052)-259; CRZI, AFCRL.

The chief aim of the work consists in providing new spectrophotometric and spectroscopic observational material for a theoretical study of the physical state of the ionized gas (plasma) within the interstellar clouds that form the galactic nebulae (planetary nebulae as well as diffuse nebulae). Particular attention is being given to the mixed cloudy-filamentary structure of these objects as revealed by photographs, but there is no understanding of how such structure could originate. These investigations will certainly involve m-g-d. In future the studies will be extended to other galaxies. Monochromatic photographs of the nebulae in each of a number of different emission lines are obtained by means of narrow band pass filters, which are of a new kind and consist of suitable liquid dye solutions in large flat pyrex-glass cells. The observational work is carried out at the Observatory of Asiago, Italy, with a 48-inch reflector and a wide-field, f/2.5 16-inch Schmidt telescope that can be used with an objective prism and/or the liquid filters.

20.24

Harvard U., Cambridge, Mass.
ASTROPHYSICAL IONIZED GAS, M. Krook. Project 8635 (804A), Contract AF 19(604)-4545; CRZI, AFCRL.

A theoretical study in plasma physics and magneto-hydrodynamics and its astrophysical applications is being made. Studies are undertaken to determine the nature of the dissipative mechanisms in ionized gases associated with fluctuations in the plasma. In line with this study, the dynamic effects of particle correlation are being investigated. Methods have been found for handling the non-gray atmosphere problem, applicable to the early type stars. Observations of astrophysical plasma sources (H II regions) and other galactic nebulae will be undertaken using a Czerny-Turner (modified Ebert) type spectrometer and a Fabry-Perot type interferometer singly, and in series. The Cassegrain focus at the 61-inch reflector of the Harvard Observatory at Agassiz Station, Harvard, Mass. will be used in a joint program with in-house scientists. The spectrometer used alone will give stellar spectral energy curves of mutual interest, and from which any photometric system may be devised by proper choice of wavelength intervals.

20.25

Harvard U., Cambridge, Mass.
EXTRATERRESTRIAL RADIO NOISE, A. E. Lilley. Project 8605(804A), Contract AF 19(604)-6120; CRZI, AFCRL.

Experimental and theoretical investigations of the ionospheric regions above the maximum of the F-layer by utilizing observations of extraterrestrial radio noise to be made in high altitude rockets and satellites.

20.26

Harvard Coll. Observatory, Cambridge, Mass.
AERIOGRAPHIC STUDIES, D. H. Menzel. Project 7698 (770A), Contract AF 19(604)-7461; CRZE, AFCRL.

Contractor will make a collection of the best photography of Mars from observatories all over the world. He will copy these photographs in composite, perform an analysis of surface features apparent, and from the information so gleaned, produce a series of maps for each of the recent favorable oppositions.

20.27

Harvard U., Cambridge, Mass.
SOLAR PATROL, D. H. Menzel. Project 7649(770A), Contract AF 19(604)-4961; CRZR, AFCRL.

Operate the optical solar patrol at the Sacramento Peak Observatory. This includes observation of all forms of solar activity in white light, monochromatic light of hydrogen (HX), and the light of other elements on a daily schedule. Also performs non-routine studies of solar phenomena by special observations and their interpretation in terms of physical conditions

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on the sun and their influence on the atmosphere of the earth.

20.28

Harvard U., Cambridge, Mass.
SOLAR PHENOMENA, D. H. Menzel. Project 7649(770A), Contract AF 19(604)-4962; CRZR, AFCRL.

To conduct research at the Harvard College Observatory on the physical state of the sun and its influence on the earth, by studies of observational data from the Sacramento Peak Observatory and other available sources, by purely theoretical research into solar and solar-terrestrial problems.

20.29

Harvard U., Cambridge, Mass.
SOLAR RADIO SPECTRUM, D. H. Menzel. Project 7649(770A), Contract AF 19(604)-8380; CRZR, AFCRL.

To develop and operate equipment for quantitative observations over an extended range of the radio frequency spectrum of the sun. This work will also include a program for daily observations in this frequency range and interpretation of the resultant data as compared with solar optical data.

20.30

Harvard U., Cambridge, Mass.
METEOR PROCESS RESEARCH, F. Whipple. Project 6694 (750F), Contract AF 19(604)-5196; CRZA, AFCRL.

Work includes the photographing of meteor trails with a Baker Super-Schmidt meteor camera and the analysis of such trails to determine luminosity, velocity, etc.

20.31

Hawaii U., Honolulu.
STUDY OF THE DETECTION OF SOLAR FLARES, W. Steiger. Project 8635(804A), Contract AF 19(604)-2292; CRZH, AFCRL.

Photograph the disk of the sun in the light of the $H\alpha$ line of hydrogen at intervals of 3 minutes or less during all clear daylight hours. The films are reduced daily and all flares and other significant activity reported by wire to the World Data Center at Boulder, Colorado.

20.32

Illinois U., Urbana.
ASTROPHYSICAL STUDIES ON ATOMIC AND NUCLEAR PROPERTIES AND ORBIT PERTURBATIONS, F. Seitz, H. Frauenfelder, S. Wyatt. Project 9774(804A), Contract AF 49(638)-896; SRPP, AFOSR.

The experimental portion of this research will involve use of the Mossbauer effect for precise studies of natural line shapes and other atomic and nuclear properties of astrophysical interest. Refined theoretical models will be constructed from the findings above. Additionally a theoretical study will be conducted on orbit perturbations resulting from weak interactions; atomic impact, radiation and related factors. This research is expected to increase the accuracy of interpretation of high altitude phenomena both radiative and particulate, also the secular effects of non-linear phenomena on rotational motion.

20.33

Instituto Geofisico de Huancayo (Peru).
COLLECTION AND ANALYSIS OF RIOMETER DATA, A. Giesecke. Project 5631(803A), Grant AF-AFOSR-61-83; CRRK, AFCRL.

This project is for the measurement of ionospheric absorption by utilizing cosmic noise as the signal source and a riometer as the receiver. Depressions in the normal amplitude characteristic are indicative of upper atmosphere absorption and this is to be correlated with geophysical and solar phenomena for a better understanding of the upper atmosphere, that is, the various propagation parameters.

20.34

Instituto Geofisico de Huancayo (Peru).
SPECTROPHOTOMETRIC STUDIES OF CHROMOSPHERIC FLARES, A. Giesecke. Project 9774(804A), Contract AF 49 (638)-637; SRPN, AFOSR.

Solar flares, which are associated with geophysical phenomena, appear in the chromosphere of the sun. Spectrophotometric observations are being made of the chromosphere with rapid handling equipment. This equipment makes it possible to record the unpredictable flares in separated spectral regions. The spectrographs are separated in time by a few minutes and will be analyzed with the intent of furthering our knowledge of the mechanism and time course of flares.

20.35

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
PARTICLE DIRECTIONS IN INTERPLANETARY SPACE, L. Katz. Project 8600(804A), Internal.

The experiment is designed to determine the average direction and angular distribution of solar proton streams in interplanetary space for proton energies between 100 Kev and 100 Mev. From a knowledge of the angular distribution of solar particles at planetary distances, information on magnetic fields and plasma clouds in the solar system can be derived. The experiment has been conceived to shed more light on the

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magnetic field, its gradient and the existence of scattering plasma clouds between the sun and the earth.

20.36

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass. OSCILLATIONS FROM METEORS, E. Maple. Project 8601 (804A), Internal.

A preliminary investigation of the relationship between geomagnetic oscillations having frequencies of about 1.5 cps and meteor showers has been started. Progress has been negligible, since the present state of the theory is rather inhospitable to the possibility of the required phenomena in the lower ionosphere where the meteors expend almost all of their energy. It is anticipated that further observational evidence relating to the relationship may help to clarify this situation.

20.37

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass. IONOSPHERIC STUDIES USING ROCKET VEHICLES, W. Pfister. Project 8605(804A), Internal.

Conduct a rocket program using probe devices mounted on suitable vehicles for the measurement of ambient electron densities in the ionosphere. Conduct experimental investigations on shock wave phenomena in the auroral region for purposes of improving theories of magnetic and ionospheric storms.

20.38

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass. SOLAR RELATIONSHIPS, D. F. Smart. Project 8600(804A), Internal.

The relation of solar phenomena to the polar cap blackout and aurora phenomena observed on the ground is to be investigated. Emulsions and detectors with electronics are to be exposed to incident particles by means of rockets launched at the time of the phenomena to obtain quantitative data on the intensity-energy spectrum and time history of the particles.

20.39

Ionospheric Physics Lab., CRZ; AFCRL, Bedford, Mass. ASTROPHYSICAL PROCESSES, Project 8635(804A), Internal.

A broad program of both high and medium resolution spectroscopic studies of processes occurring in real and laboratory-simulated hot gas sources is in progress. Some of the topics in progress or being planned are the following: (a) interferometry of extended astrophysical sources: two large-aperture high-order, fast-scanning, photoelectric Fabry-Perot interferometers have been developed for the study of line profiles in the spectra of extended sources such as gaseous nebulae, polar auroras, the twilight and night airglows. Studies of the Doppler profiles of the forbidden atomic oxygen lines in auroras and airglow are in progress; (b) high resolution spectroscopy of astrophysical sources such as stars and nebulae using Czerny-Turner spectrometer and a Fabry-Perot interferometer at the focus of a large telescope; (c) interferometry of the 5200 A (NI) line in the aurora and the nightglow in order (1) to determine the wavelengths of the two members of the doublet with an accuracy of ± 0.01A; (2) to measure the ratio of intensities of the two members; and (3) to determine the temperature of the atmospheric layer emitting this line. Preliminary observations on the nightglow were made during April 1961 in India; (d) spectroscopic studies of certain features of planetary atmospheres such as possible auroras on Venus; (e) shock tube spectroscopy and interferometry of high temperature gases: quantitative determination of fundamental spectroscopic constants such as oscillator strengths (f-values) of high temperature gases of astrophysical interest.

20.40

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass. INTERSTELLAR MATTER, G. W. Wares. Project 8635(804A), Internal.

A program of theoretical studies is under way dealing with interstellar matter, in particular, interplanetary matter associated with the solar corona. The aim is a unified theory which will predict the interaction of material ejected from the sun and the solar magnetic field. With the present theoretical model it may be possible to predict the interplanetary weather conditions as far as the earth's orbit knowing the conditions of the sun's magnetic field. Present work deals with the so-called quiet day conditions on the sun. Future work will try to take account of departures from a dipole magnetic field and the effect of the rotation of the sun. A new experimental program of spectroscopic and interferometric studies of interstellar gaseous nebulae has been initiated. The immediate purpose of this program is to study the internal structure and motions in gaseous nebulae such as the Orion nebula from measurements of the profiles and displacements of emission lines in the spectra of these sources.

20.41

Lowell Observatory, Flagstaff, Ariz. SOLAR ENERGY VARIATIONS, J. Hall. Project 7649(770A), Contract AF 19(604)-8031; CRZR, AFCRL.

To develop and apply necessary techniques to measure variation in the brightness of the sun by both direct and indirect methods. The indirect method utilizes

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the reflected light of the planets Uranus and Neptune as compared with stars having minimum variability and having spectral types similar to the sun. Using this method differential absorption by the earth's atmosphere is accurately removed from the observations. Due to the small chance that solar energy can change the reflectivity of these planets, the work includes direct comparison of the stars with the sun.

20.42

Lowell Observatory, Flagstaff, Ariz.
INFRARED AND VISUAL STUDIES, W. M. Sinton. Project 8602(804A), Contract AF 19(604)-5874; CRZE, AFCRL.

Contractor has been performing systematic visual and photographic observations of Mars and Venus in different wave length regions as well as radiometric and spectrometric studies of the moon and planets.

20.43

Manchester U. (Gt. Brit.).
LUNAR PHYSIOGRAPHIC STUDY, Z. Kopal. Project 8654(804A), Contract AF 61(052)-524; CRZG, AFCRL.

Research leading to the relative height determination of lunar features with an emphasis on the lunar maria areas is being performed. A selenodetic evaluation and measuring program is being conducted, utilizing the original Paris Grand Coude lunar photographic plates. Input observational data will be reduced as part of the CRZGG in-house lunar control study. A classical approach to defining the figure of the moon is being performed utilising heliometer observational data.

20.44

Manchester U. (Gt. Brit.).
PHOTOGRAPHIC STUDIES, Z. Kopal. Project No. 8602(804A), Contract AF 61(052)400; CRZE, AFCRL.

New high resolution photography of the moon and planets will be undertaken at the Pic-du-Midi Observatory in France. The high altitude of the observatory (9300 feet) combined with the outstanding astronomical seeing existing there will permit the acquisition of photographic, photometric and spectrometric data about the planets in detail not heretofore achievable.

20.45

Maryland U., College Park.
DRAG OF CHARGED BODIES IN A PLASMA, S. F. Singer. Project 9781(806A), Grant AF-AFOSR-61-57; SREM, AFOSR.

The contractor set up for machine calculations a model for the interaction of a charged sphere with a moving plasma environment where the distribution of charged species around the sphere was fairly general.

20.46

Massachusetts Inst. of Tech., Cambridge.
MECHANICS FOR OPTIMIZATION OF CELESTIAL TRAJECTORIES; P. E. Sandorff. Project 9783(806A), Contract AF 49 (638)-363; SRE, AFOSR.

The contractor will conduct a theoretical study of the basic principles involved in the mechanics of navigating extra-terrestrial vehicles in space, particularly from the standpoints of achieving, changing and correcting possible trajectories. Variations from these trajectories, due to perturbations and when a vehicle is transferred from one Keplerian trajectory to another, will be investigated to determine the optimization of thrust under the assumed condition.

20.47

Max-Planck-Institut Fuer Asronomie (Germany).
TIME VARIATIONS IN IONIZING RADIATION FROM THE SUN; Ehmert G. Pfetzer. Project 9774(804A), Grant AF-EOAR-62-98; SRPN, AFOSR.

This study will advance our knowledge of the sun-earth relationship by giving us information about the time changes in the flux and composition of the low energy cosmic radiation at times of quiescent and active sun. The energy range covered here is from a few Kev to a few hundred Mev. These studies are being made in Northern Europe; some being made at Kiruna, Sweden which is in the auroral zone. The data is collected at high altitudes by means of balloon flights. The purpose of this is to determine if there are time differences in the onset of solar flare effects at different places on earth. In addition a study is being made of the presence of protons in Sturmer theory forbidden regions in an attempt to determine the nature of the special mechanism which puts particles in these regions.

20.48

Michigan U. Research Inst., Ann Arbor.
ELEMENT ABUNDANCE RESEARCH IN SUN, STARS AND NEBULAE; L. H. Aller. Project 9774(804A), Contract AF 49(638)-807; SRPP, AFOSR.

Studies will be made of relative element abundances in the sun and like stars and in gaseous nebulae. An atmospheric model for the sun will be constructed and tested to permit evaluation of the effects of stratification of the solar atmosphere on observations of the spectral intensity of weak spectrum lines at several points on the solar disc. Computational methods will be developed for the analysis of spectral lines of elements of particular present interest in geochemical and nucleogenic matters, particularly those relating to the different abundance ratios of the composition

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ASRHE- Electronics Technology Lab
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RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
HSD- Electronics Systems Division
ESRR- Operational Applications Lab

of meteorite and the earth's crust. The studies will also include abundance ratios of lead-gold, gallium-germanium, and those important to current theories of heavy-element formation. Similar studies will be made of abundances in gaseous nebulae using the recent spectral data available from the Mt. Wilson and Palomar Observatories.

20.49

National Bureau of Standards, Washington, D. C.
EFFECT OF DRAG AND OBLATENESS ON SATELLITE ORBITS, J. P. Vinti. Project 9783(804A), Contract ISSA 60-2; SRE, AFOSR.

The objectives of this theoretical investigation are: (a) to examine the physical conditions required for the existence of "quasi-elliptic", "quasi-circular" and "ballistic" stages of satellite motion; (b) to analyze the motion of a hypothetical spherical satellite under the action of the inverse-square component of the earth's gravitational field, the oblateness of the earth and an assumed aerodynamic drag force, applying direct perturbation methods that may be feasible; and (c) to apply mathematical methods to obtain numerical solutions of the pertinent equations established by the analysis.

20.50

New Mexico Coll. of A. and M. A., State College.
CLOUDCROFT SEEING STUDY, C. Tombaugh. Project 8602 (804A), Contract AF 19(604)-7443; AFCRL, CRZE.

The contractor has established a field station at the Cloudcroft Observatory site at which he is conducting visual and photographic stellar and planetary observations, as well as photoelectric and microthermal studies, in order to determine the quality of the astronomical "seeing" at the site for a planetary observatory.

20.51

Northwestern U., Evanston, Ill.
MANNED BALLOON FLIGHT, J. A. Hynek. Project 8602 (804A), Grant AF-AFOSR-62-75; CRZE, AFCRL.

Conduct manned balloon astronomical research studies using improved photographic, photometric and stabilization techniques.

20.52

Northwestern U., Evanston, Ill.
STELLAR IMAGE MOTION AND SCINTILLATION, J. A. Hynek. Project 9774(804A), Contract AF 49(638)-941; SRPP, AFOSR.

Studies will be conducted with a servo-stabilized telescope platform at balloon altitudes above 50,000 feet. Photoelectric and photographic studies will be made of star scintillation, stellar image instability parameters, and criteria for manned-balloon-borne telescopic platforms with pilot over-ride of a star tracker to change targets.

20.53

Ohio State U. Research Foundation, Columbus.
SPACE VEHICLE CROSS-SECTION, H. Peters. Project 5633 (803A), Contract AF 19(604)-7270; CRRI, AFCRL.

This work consists of a theoretical study of the echo area of selected artificial satellites and space vehicles in the presence of an ion sheath of both uniform and non-uniform density and of various shapes and dimensions. These results will be compared with available empirical results. The effects of loss and the geomagnetic field will be included.

20.54

Oslo U. (Norway).
OPTICAL RADIO ACTIVITY, S. Rosseland. Project 7649 (770A), Contract AF 61(052)-186; CRZR, AFCRL.

To investigate solar radio phenomena based on observations obtained with the 200 mc radiometer and the 200 mc interferometer in connection with data from other radio receiving equipment. Studies are also to be made of optical solar phenomena based on data obtained with the solar tower telescope and the Zeiss Coude solar telescope.

20.55

Paris Observatory (France).
POLARIMETRIC STUDIES, A. Dollfus. Project 8602(804A), Contract AF 61(052)-508; CRZE, AFCRL.

Contractor will perform polarimetric observations of the moon, near planets and their moons in the visible and near infrared. Contractor will perform analysis of these observations and draw conclusions concerning the probably structure and composition of the surface and atmospheres of these bodies.

20.56

Princeton U., N. J.
NUMERICAL RESEARCH ON STELLAR EVOLUTION, M. Schwarzschild. Project 9774(804A), Contract AF 49(638)-295; SRPP, AFOSR.

Numerical research will be conducted on stellar evolution models emphasizing combined hydrostatic, heat conduction and radiative phenomena. Models and

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solutions will be sought relating luminosity, boundary conditions, internal parameters, and initial star composition. A study will also be made of analytical techniques for handling later evolutionary stages such as helium burning by automatic calculation.

20.57

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
REFRACTION, ABSORPTION, AND SCINTILLATION BY RADIO ASTRONOMY TECHNIQUES, J. Aarons. Project 5631(803A), Internal.

The radio star source research centered around Cygnus A and Cass. A. Considerable information was gained by making simultaneous measurements at 5 different frequencies (108, 218, 400, 1300, and 3000 Mc).

20.58

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
INVESTIGATION OF CHARACTERISTICS OF THE EARTH'S OUTER ATMOSPHERE BY RADAR ASTRONOMY TECHNIQUES, R. Allen. Project 5629(803A), Internal.

Theoretical and experimental research in this area will be emphasized utilizing the unique capabilities of the 1000-foot DOD antenna at Arecibo, Puerto Rico. Measurement of electron density magnetic field, drift and turbulence effects will be made monostatically and bistatically. Results will apply to understanding the physical electromagnetic characteristics of clouds of ionized particles emitted during solar flares. The effect of solar radiation and the solar corpuscular stream on the earth's atmosphere will be studied for solar effects on Faraday rotation of radio signals from space vehicles and satellites, total ionospheric refraction of radio signals, and the patchy ionospheric structure of importance in radio scattering studies.

20.59

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
SOLAR SYSTEM STUDIES, J. Castelli. Project 5629(803A), Internal.

Analysis of the February 15, 1961 data for polarization of sunspots and for intensity of plage region as a function of frequency is being completed. The spectrum analysis of the envelope of solar noise bursts is planned.

20.60

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
HYDROGEN-LINE RADIATION, N. H. Dieter. Project 5629 (803A), Internal.

Observation of the 21-centimeter line radiation from extra-galactic nebulae is being carried out using the 60-foot radio telescope of Harvard Observatory. The galaxies under investigation are close enough to the earth to allow moderately detailed study of the neutral hydrogen distribution and motion. In addition, they have permitted the determination of the mass of two systems and the ratio of hydrogen to total mass in each, a quantity which is probably related to the type and age of the galaxy.

20.61

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
VERY LOW FREQUENCY MEASUREMENTS FROM UPPER ATMOSPHERIC SOURCES, I. J. Etkind. Project 5631(803A), Internal.

Instrumentation has been developed and built which will measure and record noise bursts at five (5) KC per second. This equipment is installed at a field site and operates continuously. This data will be compared with similar data taken at different parts of the world in order to study the noise source distribution in more detail and their relation with solar corona.

20.62

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
UHF MOON REFLECTION STUDIES, J. Klobuchar. Project 5629(803A), Internal.

Studies of amplitude cross-correlation between two closely spaced lunar reflected signals near 915 megacycles are being made using double sideband suppressed carrier transmissions. Changes in the cross-correlation coefficient plotted as a function of frequency separation are being studied for various lunar libration rates. Also lunar libration angle or aspect angle effects are being investigated. Theoretical studies of frequency cross-correlation of lunar reflections as compared to spatial correlation on the lunar surface are continuing. A digital computer program is being written which will give lunar libration rate data along with our normal lunar position ephemeris.

20.63

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
IONOSPHERIC ABSORPTION STUDY, L. J. McCabe. Project 5631(803A), Internal.

A 30 MCPS riometer will be operated at Trinidad to

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measure the ionospheric absorption of cosmic noise. The riometer will be in continuous operation for a period of about a month beginning the week of 8 January 1962. The interest is a determination of the electron density above the F maximum by vertical backscattering. The Trinidad BMEWS radar and a C-4 will be utilized. Their results will be compared with data from the riometer.

20.64

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
JUPITER BURST STUDIES, R. Straka. Project 5629(803A), Internal.

A swept frequency receiver covering the range 19 to 65 Mc will be put into operation in the spring and summer of 1961. Log periodic antennas forming an interferometer have been erected. The phase switching system will study the characteristics of Jupiter bursts as well as the frequency drifts of the sporadic radiation from the planet.

20.65

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
PLANETARY RADIATION, R. Straka. Project 5629(803A), Internal.

Studies will be made of planetary radiation to provide information on the electromagnetic characteristics of the ionosphere of Jupiter and Venus, the magnetic fields of the planets, and in understanding basic processes for production and radiation of radio frequency signals. Measurements will be made using the DODIRF facility in Puerto Rico. The 1000 foot antenna will give a large collecting area so that many of the fine structure components of the HF signals can be studied.

20.66

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
LUNAR SURFACE REFLECTION CHARACTERISTICS BY RADAR TECHNIQUES, H. E. Whitney. Project 5629(803A), Internal.

A study of the electromagnetic characteristics of the lunar surface by radar techniques. The 84-foot and the 150-foot antennas at Sagamore Hill, Massachusetts will be used to transmit or receive signals at 50, 106, 220, and 430 Mc. Emphasis will be placed on detailed pulse and Doppler separation of lunar details and on radio interferometric studies. These radar reflection techniques will be used to determine the feasibility of correlating radio data with optical data to determine detailed surface characteristics of the moon.

20.67

Propagation Sciences Lab., CRR, AFCRL, Bedford, Mass.
SATELLITE AND CIS-LUNAR PROPAGATION STUDIES, H. E. Whitney. Project 5631(803A), Internal.

The program monitors signals from satellites and space vehicles by means of the 84-foot antenna and smaller units. The in-house effort is directed towards the correlation of auroral reflection and auroral scintillations from radio stars with distinctive signals from the satellites. The in-house effort correlates local data with that received from contractors in Europe and Japan.

20.68

Puerto Rico U., Mayaguez.
STUDY OF IONOSPHERIC DRIFTS AND STRUCTURE BY MEANS OF EXTRATERRESTRIAL RADIO NOISE, B. Dueno. Project 8605(804A), Contract AF 19(604)-8500; CRZI, AFCRL.

Study of ionospheric drifts and structure by means of extraterrestrial radio noise sources. Of special interest are the fluctuations of signals from radio stars, the determination of the drift of clouds of ionization in the ionosphere and the measurement of the ionospheric absorption of signals from these sources.

20.69

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
ENVIRONMENTAL STUDIES, J. W. Salisbury. Project 8602(804A), Internal.

Assisted by contractor personnel, in-house scientists will determine spectrometric, radiometric, and other physical characteristics of probable lunar and planetary surface materials in their respective environments.

20.70

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
PHYSICAL CHARACTER STUDY, J. W. Salisbury. Project 7698(770A), Internal.

Probable lunar and planetary surface materials will be placed within an environmental chamber simulating their respective environments. An effort will be made to determine their physical characteristics within this environment, and the environmental factors

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primarily responsible for these characteristics.

20.71

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
THEORETICAL STUDIES, J. W. Salisbury. Project 8602 (804A), Internal.

Using knowledge gained from research conducted under this project and gained from a complete survey of the literature, improve existing theories and develop new theories of the nature of lunar and planetary atmospheres and surfaces.

20.72

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
THEORETICAL STUDIES, J. W. Salisbury. Project 7698 (770A), Internal.

Will maintain a constant survey of the scientific literature regarding lunar and planetary environments. Will continue statistical and theoretical studies of lunar and planetary surface features and interiors.

20.73

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
INSTRUMENTATION, R. A. Van Tassel. Project 7698 (770A), Internal.

Develop new techniques and instrumentation for the accurate determination of lunar and planetary temperatures.

20.74

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
PHOTOCHEMICAL STUDIES, R. A. Van Tassel. Project 8602(804A), Internal.

Research directed toward an understanding of photochemical processes acting within planetary atmospheres. Includes continuous monitoring of the literature.

20.75

Rochester U., N. Y.
COSMIC GAS DYNAMICS, M. P. Savedoff. Project 9774 (804A), Grant AF-AFOSR-62-255; SRPP, AFOSR.

A study will be made of stellar evolution, the dynamics of interstellar gases, thermonuclear reactions in variable stars, and magnetohydrodynamics. In addition, specific investigations are being made of stellar convective-zone resonance phenomena and the radio noise produced in colliding galaxies. This work is expected to increase knowledge of the large-scale processes that convert mechanical energy into electromagnetic energy and also to get a better measure of the physical and dynamic characteristics of interstellar space.

20.76

Smithsonian, Cambridge, Mass.
ATMOSPHERIC ENTRY AND IMPACT OF METEORITES, F. B. Riggs. Project 9751(801A), Contract AF 18(600)-1596; SRPP, AFOSR.

A systematic survey and instrumental measurements of various collections of meteorites is being carried out to provide information on the atmospheric entry of high speed particles and the temperature effects on metal and stony materials versus depth from the surface for meteorites exhibiting stable atmospheric entry and passage. Modeling studies are also conducted in liquids.

20.77

Sacramento Peak Observatory, CRZ, AFCRL, Bedford, Mass.
SOLAR ATMOSPHERE, J. W. Evans. Project 7649(770A), Internal.

Research on the physical processes in the observable solar atmosphere. Spectrographic observations are made with the 16" coronagraph or 12" fixed telescope and the high dispersion spectograph to determine line profiles, intensities, and Zeeman and Doppler shifts in the photosphere, chromosphere, prominences and flares. The analyses of these observations are unravelling the properties of each type of solar feature with respect to density, temperature, mass motion and longitudinal magnetic field strengths. To supplement these purely spectrographic studies, photographs, particularly in the active centers around sunspots, reveal the features analysed in spectra. Research instruments are being developed.

20.78

Sacramento Peak Observatory, CRZ, AFCRL, Bedford, Mass.
SPACE AND EARTH RESPONSES, J. W. Evans. Project 7649 (770A), Internal.

Prediction of time intervals during which space operations are free from the danger of showers of fast solar protons; analysis of observational data for the development of better methods of prediction; observation of solar activity related to emissions of solar

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protons, electrons, X-rays, and extreme ultraviolet radiation.

20.79

Stanford U., Calif.
SOLAR RADIO ASTRONOMY AT MICROWAVE WAVELENGTHS, R. Bracewell. Project 9768(803A), Grant AF-AFOSR-62-342; SRPP, AFOSR.

The 400 ft. radio telescope is now tuned to a wavelength of 9 cm but incoming radiation at other frequencies will also be investigated, including radiation from the moon, planets, nebulae, star clusters and distant galaxies. By scanning the sun's disk and chromosphere with the pencil beam of the Bracewell antenna, "maps" of solar radiation at 9 cm are being prepared which show the growth and movement of sunspots and solar flares. These prominently affect terrestrial phenomena.

20.80

Stanford U., Calif.
RADAR REFLECTION STUDIES OF MOON, SUN, PLANETS AND INTERPLANETARY SPACE, R. Von Eshleman. Project 5629 (803A), Contract AF 19(604)-7436; CRRK, AFCRL.

The 150 foot antenna and the log periodic array will be combined with the 300 kw 20-65 Mc transmitter to obtain radar reflections from the sun, the moon, the planets, and interplanetary space. The first radar reflections from the sun have been obtained at Stanford University by a high powered transmitter in the H-F band. The aim of the study will be to determine radio wave dispersion in cis-lunar space by moon reflection techniques, to ascertain reflection characteristic of the planets by planetary radar experiments, and to determine electron density variations of the sun's corona by solar radar astronomy.

20.81

Stanford U., Calif.
ELECTRODYNAMIC PROBLEMS OF ASTROPHYSICS, P. A. Sturrock. Project 9768(803A), Grant AF-AFOSR-62-326; SRPP, AFOSR.

Theoretical studies on the electrodynamic problems of astrophysics particularly radio noise generation mechanisms, particle acceleration to cosmic ray velocities, magnetic field interactions, and plasma behavior are being conducted under this contract. Initial efforts in these general areas include more limited problems dealing with the generation of type II and III bursts of solar radio noise; the earth's rotating magnetic field interaction with ionized upper atmospheric gas through nonlinear mechanisms; and ordering factors of collision phenomena permitting acceleration of charged particles in an inhomogeneous magnetic field.

20.82

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
LUNAR CONTROL, M. S. Hunt. Project 8654(804A), Internal.

A theoretical approach to the establishment of a system of lunar control has been accomplished. This mathematical approach utilized the theory of a maximum likelihood. The paper is presently being rewritten in tensor form and the reduction technique is being programmed for the IBM 7090 computer.

20.83

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
SPACE REFERENCING SYSTEMS, M. S. Hunt. Project 8654 (804A), Internal.

A space referencing study is being performed which will provide geocentric, selenocentric, planetocentric, and heliocentric systems as well as transformation and rotation equations between systems. A preliminary report of the research under this task is being prepared.

20.84

West Berlin U. (Germany).
CLUSTERING OF GALAXIES AND GRAVITATIONAL THEORY, E. Just. Project 9774(804A), Contract AF 61(052)-335; SRPP, AFOSR.

This research has embarked on a program for studying the clusters and super clusters of galaxies in search of correlations between clustering and the age of the universe. If such correlations can be quantitatively stated, it is possible that new information on the nature of the gravitational field may be obtained.

20.85

Westinghouse Electric Corp., Baltimore, Md.
ANALYTICAL SOLUTIONS TO PROBLEMS IN ORBITAL MECHANICS, G. Shapiro. Project 9783(806A), Contract AF 49(638)-1002; SRE, AFOSR.

Major emphasis will be placed on the problems of: (1) determining relative motion of two satellites of the earth or of an earth satellite and another heavenly body; (2) capture, collision and stability of orbits in earth-moon space; (3) general theory of orbital motion. In all of these problems, the approach will be to begin with a simplified mathematical model of the system and progressively increase the complexity and realism of the model. The emphasis will be on

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analytic techniques including particularly the Krylov-Bogoliuboff method.

20.86

Yale U., New Haven, Conn.
ESTABLISHMENT AND OPERATION OF A RESEARCH CENTER FOR CELESTIAL MECHANICS, D. Brouwer. Project 9783(806A), Grant AF-AFOSR-62-311; SRMA, AFOSR.

The most competent scientists available will be brought together and work toward the solution of problems that cover the entire spectrum of celestial mechanics, with special emphasis on advanced mathematical subjects. New approaches will be sought for problems involving earth-circling satellites, lunar and interplanetary probes, and the two-point boundary value problem encountered in the predetermination of orbits for interplanetary vehicles.

20.87

Yerkes Observatory, Williams Bay, Wis.
GALACTIC FIELDS, W. A. Hiltner. Project 8635(804A), Contract AF 19(604)-4955, CRZI, AFCRL.

In 1949 Dr. Hiltner discovered the optical polarization of the light of individual stars caused by the intervening interstellar dust or grains. He is now refining his technique to achieve close to the theoretical limit of $\pm$ 0.01% or $\pm$ 0.0001 stellar magnitude accuracy in order to be able to measure polarization over shorter path lengths than have heretofore been required, thus enabling magnetic fields to be deduced in regions closer to the solar system. Dr. Hiltner proposes to construct a single, modest-sized telescope of entirely unique construction to provide axial rotation of the entire telescope tube. Standard stars of zero or small known polarization near the celestial equator would be determined.

See also: 3.136, 7.11, 7.19-20, 7.53, 7.62, 7.76, 7.83, 7.93, 7.96, 8.43, 8.88, 12.83, 19.33, 23.23, 23.45, 23.49, 23.94, 23.105, 23.123

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RAEW- Intelligence & Electronic Warfare Div.
RAGR- Advanced Studies Office
RAS- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronic Systems Division
ESRH- Operational Applications Lab

AFOSR- Air Force Office of Scientific Research
- SRA- Directorate of Research Analysis
- SRC- Directorate of Chemical Sciences
- SRE- Directorate of Engineering Sciences
- SRI- Directorate of Information Sciences
- SRL- Directorate of Life Sciences
- SRM- Directorate of Mathematical Sciences
- SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories

CRR- Electronic Research Directorate
- CRRB- Computer & Mathematical Sciences Lab
- CRRC- Electronic Material Sciences Lab
- CRRD- Electromagnetic Radiation Lab
- CRRI- Astrosurveillance Sciences Lab
- CRRK- Propagation Sciences Lab
- CRRS- Communications Sciences Lab
- CRRZ- Control Sciences Lab

CRZ- Geophysics Research Directorate
- CRZA- Photochemistry Lab
- CRZC- Thermal Radiation Lab
- CRZE- Research Instrumentation Lab
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21. BEHAVIOR SCIENCES

Behavior Patterns: Communication; Decision Making; Group Performance; Human Engineering; Human Information Processing; Learning · Mathematical Techniques for Behavior Sciences; Perception and Cognition; Societology; Vision Theory.

21.1

American Inst. for Research, Pittsburgh, Pa.
OPTIMAL CUEING METHODS APPLICABLE TO RESPONSE PROMPTING FOR AUTOMATED INSTRUCTION, A. A. Lumsdaine. Project 9778(805A), Contract AF 49(638)-681; SRL, AFOSR.

The problem proposed for study is that of investigating response-cueing factors that should determine the optimal use of prompts for the elicitation of to-be-learned responses. These factors are applicable in the design of automated teaching methods and teaching-machine programs, and also have general significance in increasing our understanding of fundamental factors that govern human learning. In particular, it is proposed: (1) to analyze the theoretically predictable effects of features that govern the proportion of correct responses vs. errors occurring in practice, and (2) to investigate experimentally some specific techniques for implementing conditions expected to be theoretically of optimal efficiency for effecting transition from prompted response to independent, learned production of desired response patterns.

21.2

Antioch Coll., Yellow Springs, Ohio.
COMPARATIVE STUDIES OF THE JUDGMENT AND PERFORMANCE UNDER STRESS WITH SPECIFIC REFERENCE TO EFFECTS OF ACOUSTIC NOISE, H. J. Jerison. Project 9778(805A), Contract AF 49(638)-536; SRL, AFOSR.

This research will be directed toward the further analysis of relationships between acoustic noise and psychological time. The underlying assumption for this work is that psychological time is malleable relative to physical time. The major difficulty encountered thus far has been noted that it is possible to suggest a role for stress opposed to that of acoustic stimulation. The situation is difficult to examine carefully with human subjects because of the generally complex human response to stress and because human time judgments are probably under control of many factors independent of the experimental situation. The research will involve training animals to make time judgments by using temporal conditioning techniques. Possible distortion of the judgments in noise field of various intensities will then be studied. In order to consider the problem of effect of noise as a source of stress upon time judgments the stressfulness of higher noise levels will be explored with escape conditioning techniques, and the results used in an effort to scale stress in terms of performance.

21.3

Arizona State Coll., Tempe.
SPECTRAL ESTIMATION, I. Miller. Project 7183(805A), Contract AF 33(616)-6857; MRS, AMRL.

Develop methods and techniques for analyzing and describing the relationships among a set of stochastic processes such as Gaussian random processes as might be obtained in human-factors experiments involving control dynamics and control design. Develop mathematical and/or statistical tests to identify data which violate critical assumptions (i.e., stationarity, normality, and linearity).

21.4

Batelle Memorial Inst., Columbus, Ohio.
INFRARED EMISSION FROM MAMMALIAN NERVOUS SYSTEM, R. Roppel. Project 7232(805A), Contract AF 33(657)-8056; MEMA, AMRL.

Researchers at the Battelle Memorial Institute have performed preliminary investigations on this problem. This procurement is for investigation of the infrared emissivity from the cerebral cortex or small mammals in terms of intensity and frequency spectrum. Some recent pilot investigations conducted at Battelle have demonstrated recordable radiations in infrared region emanating from exposed surface or cortex. This contract would further this study to make quantitative measurement and spectral analysis of radiation to determine if sufficient energy is emitted to permit acquisition of useful information concerning cortical function.

21.5

Battelle Memorial Inst., Columbus, Ohio.

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEGR- Research Division
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SWR- Research Directorate
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PGNR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

ANALYSIS OF HUMAN CONTROLLER DYNAMICS, R. Thomas. Project 7183(805A), Contract AF 33(616)-7969; MRP, AMRL.

Examine recent developments in mathematics applicable to analysis of system control with human components. Dynamic programming techniques now being examined appear to offer a general technique for analyzing both discrete and continuous control situations.

21.6

Battelle Memorial Inst., Columbus, Ohio. EFFECTS OF VARIOUS LEVELS OF AUTOMATION ON HUMAN OPERATORS' PERFORMANCE IN MAN-MACHINE SYSTEMS, R. E. Thomas. Project 7183(805A), Contract AF 33(616)-6395; MRSR, AMRL.

This program is an investigation of influence of various levels of machine assistance and automation on human performance. Investigations are concerned principally with these effects on the tasks of human vigilance, computational tasks, and on the tasks of prediction and extrapolation. Also to be investigated are the influences of the machine reliability on human performance. In general, these investigations will deal with small groups of operators (e.g., 3-5 men).

21.7

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. EFFECTS OF STRESS ON PERCEPTION OF VISUAL ILLUSIONS, D. J. Baer. Project 7183(805A), Internal.

This research will examine four hypotheses with respect to the usability of visual illusions as indices of stress: (1) the greater the stress (none, moderate, and severe electric shocks) the greater the illusory effect; (2) a set to perceive illusions will enhance the illusory effect; (3) intra-individual consistency over illusions will be high; (4) mental set is a stronger determinant of the extent of illusory effects than stress except at extreme degrees of stress.

21.8

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. PERCEPTUAL LATENCY, C. A. Baker. Project 7183(805A), Internal.

This investigation studies perceptual latency in the visual system for stimuli which vary in retinal locus, area and intensity. These data are required in order to determine how well an observer can estimate the simultaneity of occurrence of two flashes when the latter are presented in different parts of a display.

21.9

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. HYPNOTIC TECHNIQUES IN LEARNING AND LEARNING RESEARCH, T. E. Cotterman. Project 7183(805A), Internal.

The objective of this exploratory research is to determine the potential use of hypnotic techniques as a means of enhancing learning and as a methodological tool in learning research. Current emphasis is upon the analytic study of selected researches drawn from an extensive bibliography which was assembled in preliminary work. Consultation with selected experts will be sought. A precise statement concerning the probably advantages and limitations of hypnotic techniques used for this purpose will be prepared.

21.10

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. TRANSFER THEORY AND MEASUREMENT, T. E. Cotterman. Project 7183(805A), Internal.

The objectives of this work are (a) to develop improved general theory for the prediction of the kind and amount of transfer of human knowledges and skills under various conditions and (b) to develop and validate effective techniques for the measurement of transfer. These goals will be sought through analytic studies of current practice and theory and through the creation and test of novel approaches.

21.11

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. PSYCHOLOGICAL STUDIES OF THE HUMAN CONTROLLER, J. P. Hornseth. Project 7183(805A), Internal.

This investigation attempts to define the human "describing function" for continuous tasks. Two major regions will be examined: (1) methodology and methodological assumptions and (2) the effects of controlled element dynamics and input characteristics on the function.

21.12

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. ABSTRACT MAN-MACHINE SYSTEM SIMULATOR, W. J. Huebner, J. P. Hornseth, W. H. Pearson. Project 7183(805A), Internal.

This program is an investigation of influence of various levels of machine assistance and automation on human performance. Investigations are concerned principally with these effects on the tasks of human vigilance, computational tasks, and on the tasks of prediction and extrapolation. Also to be investigated

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are the influences of the machine reliability on human performance. In general, these investigations will deal with small groups of operators (e.g., 3-5 men).

21.13

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. INFORMATION TRANSFORMATIONS ON THE PERFORMANCE OF DECISION MAKING TASKS, D. P. Hunt. Project 7183 (805A), Internal.

Underlying this effort is the notion that the design problems related to the presentation of information to man as a component in a man-machine system can be conceptualized as consisting of three steps: (1) the selection of the system parameters concerning which the operator must be informed; (2) the transformation of this selected information into scales that permit the operator to optimally utilize it, and (3) the encoding of this transformed information to permit rapid and accurate discriminations and detections of the state and changes in the state of the system parameters. The purpose of this in-house research is to determine the optimal transformations of information, and the effects of departures from these optima, on the human performance of intellectual tasks. The current effort is being devoted to the development of suitable tasks and methods.

21.14

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. CRITICAL FUSION FREQUENCIES FOR INTERRUPTED LIGHT AS A FUNCTION OF HUE AND LUMINANCE LEVEL, A. Hyman. Project 7183(805A), Internal.

Previous work by the investigator indicates that the critical fusion frequency (CFF) for the higher photopic luminance levels may be dependent on the spectral energy distribution in the stimulus. To further explore this hypothesis the current investigation attempts to obtain, for both normal and color deficient observers, the differences in function contour for the relation between CFF and luminance level when stimulus hue is varied.

21.15

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. INTERMITTENT PRESENTATION IN VISUAL DISPLAYS, A. Hyman. Project 7183(805A), Internal.

The purpose of the present study is to determine the merits, limitations and disadvantages for intermittent presentation when used in generating visual displays. Stimulus complexes to be considered will include those in which there are steady luminance components, backgrounds contiguous to the target, hue differences between target and background, and luminance gradients in the display.

21.16

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. MATHEMATICAL MODELS FOR NEURAL BEHAVIORAL AT THE RETINAL LEVEL, A. Hyman. Project 7183(805A), Internal.

It is the purpose of the present effort to develop mathematical models which will describe this behavior of the visual system. Existing psychophysical data on vision will be used. Also, new critical experiments required for testing and developing the mathematical hypotheses will be conducted. The findings may provide a basis for formulating some of the design requirements for: (1) informational displays which are to be interpreted by a human observer, and (2) devices which attempt to automate detection and recognition of targets.

21.17

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. CUE PROBABILITY AND VALIDITY IN THE LEARNING OF MULTIPLE CUE DECISION TASKS, J. A. Modrick. Project 7183(805A), Internal.

The objective of the study is the determination of the manner in which people learn to use cues in the prediction or anticipation of events and the effect of cue-event parameters on the optimization of accuracy. The parameters under investigation are relative frequencies of cues and events and validity of cues in a two-cue/two-event prediction task. Currently the data from the first experiment are being studied and analyzed and a second experiment is being planned.

21.18

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. HUMAN PERFORMANCE UNDER CONDITIONS OF UNCERTAINTY, J. O. Morrissette, W. J. Haubner, W. Pearson. Project 7183(805A), Internal.

This investigation is concerned with two problems: (1) the study of the relative capability of individuals to predict the future state of an airborne craft from its past history; (2) the determination of the (logical) psychological process by which this is done. A major objective of this research program is the development of a mathematics which will permit the solution of a basic problem - prediction of future states of aircraft - by computers.

21.19

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio.

RECOVERY OF INTELLECTUAL FUNCTIONING UPON AWAKENING, D. W. Ormiston. Project 7183(805A), Internal.

Several experiments are planned which will have as their goal the determination of the length of time that is necessary for subjects to reach their normal intellectual efficiency as measured by their response to test items similar to those found in conventional intelligence tests. Level of sleep and its duration (which will be varied from experiment to experiment) will be monitored via psychophysiological instrumentation.

21.20

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. SELECTIVE SURVEY OF METHODS IN MAN-MACHINE RESEARCH, W. H. Pearson. Project 7183(805A), Internal.

Two avenues for development of statistical techniques appropriate to analysis of man-machine systems and a source of models for conceptualization of man-machine systems are being investigated: (1) an extension of the utility of the t-test by evaluating probability of difference in means for arbitrary p values; and (2) factor analysis involving non-parametric techniques. The literature in bionics, the science of systems which function analogously to living systems, is being systematized and categorized to provide ready reference to pertinent systems.

21.21

Behavioral Sciences Lab., MRS, AMRL, Dayton, Ohio. APPLICATION OF GAME THEORY MODEL TO HUMAN DECISION MAKING, D. L. Zink. Project 7183(805A), Internal.

Research is being conducted to describe man's decision processes in a game theory model. The aim is to provide experimental data relevant to the application of game theory models to decision situations involving competition with others. The variables to be investigated initially will include the number of decision alternatives, the number of persons in the decision situation, and the consequences of the various decisions.

21.22

Biomedical Lab., MRM, AMRL, Dayton, Ohio. NEURAL NETWORKS, H. L. Oestreicher. Project 7232 (805A), Internal.

This effort is directed toward a mathematical theory of neural networks with a large number of components, the behavior of which is not complete specified. If the exact structure, function, and connection of the components are unknown but statistical information on them is available, then statements on the statistical behavior of the network can be derived.

21.23

Biomedical Lab., MRM, AMRL, Dayton, Ohio. FUNCTIONAL CLASSIFICATION OF NEURONS IN AUDITORY CORTEX, E. A. Rice. Project 7232(805A), Internal.

This is a study of the nervous system from an information processing viewpoint. The goal is to classify the neurons of the auditory cortex upon the basis of their function as information processing elements. The method employed is to use microelectrodes to sample single neural units. The pulse-interval coded output of these units is to be analyzed.

21.24

Biomedical Lab., MRM, AMRL, Dayton, Ohio. PHYSICAL BASIS OF MENTAL PROCESSES, J. E. Steele. Project 7232(805A), Internal.

Attempts to relate the function of the nervous system to its structure, particularly in regard to higher mental function. This includes such areas as problem solving, motivation, emotion, development of psychotic symptomatology, and the rationale for various types of therapy.

21.25

Biomedical Lab., MRM, AMRL, Dayton, Ohio. FUNCTIONAL PARAMETERS CONTROLLING AUDITORY REFLEX, H. S. Weiss. Project 7232(805A), Internal.

The human auditory reflex is being studied as a servomechanism. This investigation will define the parameters of auditory stimulation upon which the input arm of the loop operates. Information derived will also be utilized in defining the role of the tympanic muscle reflex as a protective mechanism. Subjects are presented with various acoustic stimuli while response of reflex is observed. This work is presently under way.

21.26

Bolt, Beranek and Newman, Cambridge, Mass. ORGANIZATIONAL CHARACTERISTICS OF MAN-MACHINE SYSTEMS, J. C. R. Licklider. Project 9778(805A), Contract AF 49(638)-355; SRL, AFOSR.

Research to define the domain and parameters of systems theory - particularly with regard to the human factor aspects of the design of complex

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man-man and man-machine systems. Existing hypotheses, principles, miniature theories, rules-of-thumb will be sought out. These will be analyzed, synthesized where possible, and formulations of a generalizable nature postulated. Present understandings of complex systems are very empirical. One of the aims of this work will be to initiate the building of a comprehensive theory of man-machine systems beginning with a synthesis of the limited principles that have been derived from experiments and experience in the man-machine field.

21.27

Bolt, Beranek and Newman, Inc., Cambridge, Mass.
TRANSMISSION AND CODING OF INFORMATION IN AUDITORY NERVOUS SYSTEMS, W. D. Neff. Project 9778(805A), Contract AF 49(638)-1142; SRLB, AFOSR.

The objective of this research is to refine the procedure of controlling and anlyzing psychophysiological data as they are collected. A series of experiments are conducted to produce electrode arrays which will permit adequate sampling of both unit and slow wave activity at several levels of the auditory nervous system. Techniques will be developed to acquire and analyze samples of unit and slow wave activity toward a better understanding of how these function.

21.28

Bryn Mawr Coll., Pa.
PSYCHOLOGICAL ADJUSTMENT FACTORS IN SELF-ESTIMATE OF BODY SPACE, R. S. Davidon. Project 9778(805A), Grant AF-AFOSR-62-1; SRLB, AFOSR.

The proposed studies will attempt to obtain a unified geometry of perceived space; i.e., relative distances within and around one's body, using quantitative measure. Such a metric system will make it possible to study interrelations of tactile, kinesthetic, vestibular and visual stimuli as perceived by an individual. The initial studies will be divided into five stages as follows: (1) develop methods for efficiently determining and systematically describing perceived space as it varies around the body, with tactile-kinesthetic stimuli and without vision; (2) provide norms; (3) relate typical data to the distribution of sensory nerve endings and to cortical representation, and so to make explicit those characteristics of the schema which apparently cannot be explained by known body structures; (4) compare, within the same system of coordinates, distance relationships with visual stimuli alone, and with simultaneous visual and tactile-kinesthetic stimuli; and (5) compare tactile-kinesthetic and visual judgments at different maturational levels.

21.29

Bucknell U., Lewisburg, Pa.
COMPARATIVE STUDY OF REINFORCEMENT OF LEARNING OF VERBAL INFORMATION, J. W. Moore. Project 9778 (805A), Grant AF-AFOSR-62-323; SRLB, AFOSR.

This investigator is testing various types of reinforcement which can be utilized in the area of verbal learning using a commercially available self-tutoring device in conjunction with college level instructional material. He is making the following comparisons: reinforcement is varied in the following ways to determine comparative effects on efficiency in learning: (a) non-reinforcement, (b) immediate knowledge when a correct answer response is given, (c) immediate knowledge of what the correct answer should be, and (d) reinforce by offering a reward having pecuniary value. Each of these conditions is tested in a situation requiring the subject to give constructed responses, and will be tested under conditions where the student responds to multiple-choice alternatives. The investigator is also comparing the relative efficiency of learning under conditions where constructed responses and multiple-choice responses are learned.

21.30

Budd Electronics, Long Island City, N. Y.
PICTORIAL DATA ANALYSIS CONCEPTS AND TECHNIQUES, A. Rosenfeld. Project 9769(803A), Contract AF 49(638)-1143; SRI, AFOSR.

Formulation is expected of objective rules for systematically "organizing" a complex picture into a hierarchy of "description components" in imitation of human performance in assimilating pictorial information. The direction is to optimize goals of (1) minimizing the number of components (texture classes, curves, intersections, etc.), (2) maximizing the internal uniformity and mutual differences of the components, and (3) maximizing the conspicuousness of the components as figures. The study should concurrently lead to the generation of a class of relatively simple mathematical functions which can provide an irredundant description of a given picture at any preselected "level of scrutiny."

21.31

Bureau of Social Science Research, Inc., Washington, D. C.
SELF-MANAGEMENT TECHNIQUES FOR STRESSFUL CONDITIONS, A. D. Biderman. Project 9779(805A), Contract AF 49(638)-992; SRL, AFOSR.

AEL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARS- Applied Mathematics Research Lab
ART- Thermomechanics Research Lab
ARY- Hypersonics Research Lab
ARZ- Solid State Physics Research Lab
AZR- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMH- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
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This is an investigation of the various types of self-management theories and techniques which have been advocated in popular literature and practices (with or without the use of drugs) such as self-control, auto-suggestion, self-hypnotism, etc. The objective is to identify the extent to which prevalent techniques have been subject to experimental testing and/or theoretical evaluation. This will be followed by a theoretical scheme for directing empirical and experimental research on those techniques shown to be most likely to be helpful for improving performance under stressful conditions.

21.32

California U., Santa Barbara, Goleta.
MEASUREMENT OF DECISION REACTION TIME, M. Gottsdanker. Project 9778(805A), Contract AF 49-(638)-730; SRL, AFOSR.

Experimental determinations of commitment time will be made. Commitment time is the interval between the instant that a person receives an external signal for action and the instant he is commited to start the motion. First, techniques will be perfected for the measurement of this interval; and its consistency will be tested. Second, the generality of its relation to the rate of information processing will be investigated. Third, attempts will be made to use commitment time as a kind of universal yardstick of psychological uncertainty, with the eventual goal of expressing probability of occurrence, difficulty of discrimination, degree of learning, etc., in common and additive terms.

21.33

California U., Santa Barbara, Goleta.
PERFORMANCE OF LEADERS UNDER CONDITIONS OF GROUP SUPPORT AND NON-SUPPORT, C. McClintock. Project 9778(805A), Contract AF 49(638)-794; SRLB, AFOSR.

The purpose of this study is to measure the differences in the behavior of leaders and non-leaders, under conditions of group support and group opposition.

21.34

Cambridge U. (Gt. Brit.).
CORRELATION OF ANATOMICAL STRUCTURE WITH PHYSIOLOGICAL FUNCTIONS OF THE HYPOTHALAMUS, B. A. Cross. Project 9777(805A), Contract AF 61(052)-301; SRL, AFOSR.

This study proposed to establish the neural elements involved in arousal and suppression during the various physiological states. Attempts are being made to establish more precisely the conditions in which particular cells are excited or depressed. Towards this end the effects of low oxygen, high carbon dioxide, and blood sugar will be explored.

21.35

Cambridge U. (Gt. Brit.).
MECHANISMS OF VISUAL MOVEMENT PERCEPTION, R. L. Gregory. Project 9778(805A), Grant AF-EOAR-61-13; SRLB, AFOSR.

The objective of this research is to increase our understanding of the mechanisms concerned in the visual perception of motion and the ability of the human organism to orient itself in space. Experiments are designed to throw light on the following aspects of this problem: (1) the properties and limitations of the mechanisms which serve to indicate position and movement of the eyes; (2) the origin of certain illusions of movement, in particular, the autokinetic effect; (3) the relations between depth judgment and the visual perception of velocity; and (4) the study of certain problems of perceptual stability and spatial orientation, using an after-image technique.

21.36

Cambridge U. (Gt. Bt.).
EFFECTS OF CEREBRAL LESIONS ON RESPIRATION AND TIMING, L. Weiskrantz. Project 9778(805A), Grant AF-EOAR 62-20; SRLB, AFOSR.

This contract will conduct exploratory work to determine: (1) the effects of frontal lesions and nitrous oxide on the timing behavior of monkeys; and (2) the effects of limited lesions of the striate cortex on the visual behavior of monkeys.

21.37

Centre d'Etudes de Physiologie Nerveuse et d'Electrophysiologie, Paris (France).
NERVOUS PROCESSES UNDERLYING LEARNING BEHAVIOR, A. Fessard. Project 9777(805A), Contract AF 61(052)-475; SRL, AFOSR.

Permanent electrodes will be implanted into different parts of the brain of cats and monkeys. Recordings can then be made during different stages of the learning processes to elucidate the role of the various brain areas. Attempts will be made to learn the mechanisms of the interactions produced between messages converging on simple neurons.

21.38

Chicago U., Illinois.
ATTENTION AND MAINTENANCE OF ALERTNESS. W. D. Neff. Project 9778(805A), Contract AF 49(638)-925;

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SRL, AFOSR.

Behavioral, neuroanatomical and neurophysiological methods will be used to study the brain mechanisms underlying attention and alertness. Experimental animals will be trained to respond to complex sensory stimuli. Test apparatus to measure the neural responses and techniques for behavioral measurements will be devised. Effects of lesions of the cortex or of sub-cortical centers on ability to maintain attention and alertness will be studied.

21.39

Chicago U., Ill.
PSYCHOPHYSIOLOGY OF INFORMATION PROCESSING, W. D. Neff. Project 9780(805A), Contract AF 19(604)-5526; ASRH. ESD.

Data are being obtained incidentally concerning the cortical areas involved in frequency discrimination and concerning the periodicity principles of such discrimination. Neff has already shown that direct electrical stimulation of subcortical centers of the auditory and visual pathways may be used as behaviorally meaningful signals. He is now conditioning cats to simple patterns of electric stimulation of the auditory pathways to determine what patterns of sound are equivalent in eliciting a learned response. The reverse procedure - conditioning to sound and testing response to direct electrical stimulation - will also be used.

21.40

Chicago U., Ill.
FOUNDATIONS AND APPLICATIONS OF STATISTICS, L. J. Savage. Project 9783(806A), Contract AF 49(638)-391; SRM, AFOSR.

This work, especially that in the behavioral sciences, has tended to emphasize the existence in the practical context, of vagueness and indecision on the part of the idealized deciding person during the process of experimentation. Professor Savage wishes to discover reasonable and practical rules for improving the application of statistical theory to practical difficulties.

21.41

Chile U., Santiago.
ROLE OF CEREBRAL CORTEX IN CLASSICAL AND INSTRUMENTAL CONDITIONED REFLEXES, S. Middleton. Project 9777(805A), Grant AF-AFOSR-61-84; SRL, AFOSR.

Using surgical, electrophysiological and pharmacological techniques, Dr. Middleton will produce functional blackout of different structures of the of the central nervous system at the cortical and subcortical level. He will then analyse the mechanisms underlying the acquisition and retention of the visual avoidance conditioned reflex. Using the same techniques, he also plans to study the role of the various brain centers and pathways involved in the water-acid conditioned salivary reflex.

21.42

Colorado U., Boulder.
METHODS FOR VALIDATION OF JUDGMENTS IN DECISION MAKING, E. Rose. Project 9778(805A), Grant AF-AFOSR-62-278; SRLB, AFOSR.

This task is concerned with the refinement of primitive judgments or common sense in the process of arriving at individual and group decisions. It will examine the basic assumptions that people accept as true and accurate, without test or validation. The task will also deal with unstated assumptions which can be inferred from the more formal or explicit steps in logic used in arriving at decisions. The investigator will study the content and process involved in the refinement of common sense. He will also study the process by which linguistic and semantic factors facilitate or deter individuals or groups in arriving at decisions.

21.43

Columbia U., New York.
SCALING OF SUBJECT ESTIMATES OF MAGNITUDE, W. J. McGill. Project 7183(805A), Contract AF 33(616)-6100; MRSE, AMRL.

The parameters affecting an individual's judgment of magnitude are under study. One aim is to uncover, if possible, a simple correlate for magnitude estimation. Another is to determine the "personal equation" for individuals making judgments of magnitude. The psychophysical data collected will deal mostly with judgments of loudness, but some data will also be concerned with judgments of brightness.

21.44

Columbia U., New York.
COMPARATIVE IMPACT OF ACTUAL VS. ANTICIPATED EVENTS, J. Mahnevajsa. Project 9779(805A), Contract AF 49 (638)-743; SRL, AFOSR.

This study will conduct and evaluate the results of a series of controlled interviews with representative samples of foreign graduate students and potential decision makers. Their judgments will be recorded as to the desirability and estimated likelihood of a set of possible outcomes in the present international situation. The impact of air-space

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developments and achievements of the East-West blocs will be stressed. The comparison of judgments early in the time scale regarding the desirability of anticipating events will be compared with later judgments about actually transpired events.

21.45

Communications Research Inst., Virgin Islands.
COMMUNICATIONS STUDIES ON TURSIOPS TRUNCATUS AND OTHER DELPHINIDS, J. C. Lilly. Project 9777(805A), Grant AF-AFOSR-61-62; SRL, AFOSR.

This research is a segment of a continuing program on the vocalization and vocalization-capabilities of the bottle-nosed dolphin, Tursiops truncatus. Currently a study of the physical properties of their emissions is in progress. There are three general classes of noise productions being studied for their resemblance to the exchanges of human speaking. Initially and tentatively it appears that they use a "whistling language" in their transactions; however, they may also use their sonar pulsing technique for such exchanges in a way that is not yet understood. At present it is suspected that their squawks, quacks, and bark-like noises are their means of emotional expression. It is the intention of this study to explore the formal structure of vocal exchanges between two animals connected only by an acoustic path. These exchanges will be recorded on separate channels of high speed magnetic tape which will then be fed into computers for auto-and-cross correlational analyses.

21.46

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
INTERACTIONS BETWEEN PSYCHOLOGICAL FACTORS AND SPEECH, W. R. Smith. Project 5632(803A), Internal.

Determine relationships between characteristics of the individual which are measurable by psychological techniques and the speech signal the individual produced or perceives. In particular, deeply rooted behavioral patterns may be discernible in speech production and perception and in characteristics of the signal. Similar patterns may be produced in normal individuals under conditions of temporary stress.

21.47

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
PSYCHO-ACOUSTIC TECHNIQUES FOR EVALUATION, W. R. Smith. Project 5632(803A), Internal.

Develop psycho-acoustic testing techniques for evaluating voice communication systems, not only for their ability to transmit words intelligibly, but also for their effectiveness in transmitting more subtle kinds of information such as talker identity and various quality factors. Furthermore, in order that any measures so developed may be meaningful, they must be in such form and must be worked out in such detail that evaluations performed by different groups at different times and places are directly comparable.

21.48

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
PSYCHOLOGICAL ASPECTS OF SPEECH PRODUCTION AND PERCEPTION, W. Wathen-Dunn. Project 5628(803A), Internal.

Conduct research on the basic psycho-acoustics of the aural perception of speech, e.g., perception of such attributes of the speech signal as pitch, etc. Expand and improve psycho-acoustic techniques for evaluating articulation, talker identification and quality factors in voice communications. Provide listening crews and other assistance in psycho-acoustic testing.

21.49

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
MATHEMATICAL INVESTIGATIONS OF NEURAL PROCESSES, T. A. Kalin. Project 5632(803A), Internal.

Mathematical investigation of visual cortex in mammals, specifically with respect to pattern recognition behavior. Specific topics to be treated include neuron organization in visual cortex as an interpolational field, elementary pattern perception on the basis of fundamentally ordered data from the visual field, and geometrical study of the structure of the lateral geniculate body. Processing of neuroelectric data by special purpose devices (average response and correlation computers) as well as by a general-purpose computer program now under development also is planned.

21.50

Computer and Mathematical Sciences Lab., CRR, AFCRL, Bedford, Mass.
NEUROPHYSIOLOGY, C. E. Molnar. Project 5632(803A), Internal.

Electroneurophysiological research will be conducted in the visual and auditory systems of mammals such as the hooded rat. Topics to be investigated include visual pattern recognition from a neuroelectric viewpoint, study of modes of organization of the visual and auditory cortex, and examination of activity in the medial and lateral geniculate bodies in response to simple and patterned stimulation.

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CRII- Ionospheric Physics Lab
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21.51

Cornell U., Ithaca, N. Y.
DIMENSIONS OF BEHAVIORAL RATINGS, E. F. Borgatta. Project 9778(805A), Grant AF-AFOSR-61-30; SRL, AFOSR.

The purpose of this research is to examine the stability of the findings of recent studies of the variables involved in small group performance. The research will compare findings of Robert F. Bales, Launor Carter, Edgar F. Borgatta and others in an effort to provide empirical reconfirmation and measure of compatability of variables discovered by different investigators. A second objective is the development of a short battery of paper and pencil items which are capable of assessing small group variables. A third goal is to examine the relationships between self-reports, external observations and paper and pencil tests as measures of small group behavior. The fourth objective is to test on a large subject sample the correlation of behavior descriptions, self-reports and attitudinal measures. This will be accomplished on the basis of the Word Association Test.

21.52

Delaware U., Newark.
EFFECT OF AMOUNT OF INFORMATION ON DECISION MAKING AND PROBLEM SOLVING BEHAVIOR, J. T. Lanzetta. Project 7183(805A), Contract AF 33(616)-7621; MRSE, AMRL.

The contractor is presently working on four topics: (a) the relationship of "initial uncertainty," "uncertainty reduction," and information seeking behavior, (b) the relation of the concept of reinforcement to "uncertainty reduction" and "probability of success," (c) the state of knowledge concerning "subjective probability," and (d) the development of new tasks and methods for studying informational variables related to the performance of decision making and problem solving tasks.

21.53

Delaware U., Newark.
EFFECTS OF CHANGES IN GROUP PERSONNEL UPON GROUP PERFORMANCES, R. C. Ziller. Project 9778(805A), Grant AF-AFOSR-62-95; SRLB, AFOSR.

One of the characteristics of military units is the unstability of group composition. The objective of this research is to determine the difference upon group performance and structure between groups whose personnel remain relatively constant and those whose personnel are constantly changing. Through experimental tests upon groups of both kinds, it is hoped to indicate the degree and direction of effects. An attempt will also be made to determine how negative effects of membership change upon group productivity can be maintained.

21.54

Directorate of Engineering, RAS, RADC, Rome, N.Y.
DETECTION-IDENTIFICATION THRESHOLD GAP FOR FORMS, P. J. Bersh. Project 8501(805A), Internal.

Experiments will be performed to determine the size of the difference between form detection and identification thresholds (expressed in terms of minimum contrast), with such variables as area, exposure time, edge sharpness and retinal location stimulated as parameters. Several form populations will be used, including geometric shapes, real object silhouettes and possibly nonsense forms.

21.55

Directorate of Engineering, RAS, RADC, Rome, N.Y.
GENERALIZATION GRADIENTS FOR FORM OVERLAP, P. J. Bersh. Project 8501(805A), Internal.

Experiments will be performed to specify how generalization gradients for forms are determined by their overlap values. Several form populations will be used, including nonsense forms, geometric shapes and possibly real object silhouettes. In addition, several types of overlap measures will be investigated.

21.56

Directorate of Engineering, RAS, RADC, Rome, N.Y.
SPEED OF FORM IDENTIFICATION, P. J. Bersh. Project 8501(805A), Internal.

The speed with which forms can be identified will be related to the area, contrast and edge sharpness of the forms. As a special part of the research, experiments will be performed to determine the applicability to a form identification response of the Bunsen-Rosco Law (IT = constant for durations below a critical value, I = constant for durations above this value), and Ricco's Law (AI - constant for foveal areas up to 10').

21.57

Directorate of Engineering, RAS, RADC, Rome, N.Y.
SHIFTS IN APPARENT PITCH, R. J. Christman. Project 8501(805A), Internal.

An interesting phenomenon in the realm of auditory perception is the existence of a change in the apparent pitch of a pure tone when it has been preceded by a prolonged tone of differing frequency. This subtask will examine the influence on the effect of various values of signal level, time

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relations, and such other parameters as may be considered significant. The work will consist largely of a series of relatively short, definitive experiments, each aimed at determining the influence of a specific variable.

21.58

Directorate of Engineering, RAS, RADC, Rome, N.Y.
TACTUAL DISCRIMINATION, R. Newman. Project 8501 (805A), Internal.

This research will be directed at identifying and quantifying the characteristics of physical stimuli which can be discriminated by the human tactual sense. Such factors as stimulus magnitude, duration, frequency, and locus of stimulations, will be investigated.

21.59

Directorate of Engineering, RAS, RADC, Rome, N.Y.
HUMAN DISCRIMINATION FUNCTIONS, J. B. Nickels. Project 8501(805A), Internal.

Studies will be performed to determine the effect of added information in one sense modality on the discriminative capacity of another sense modality under redundant and non-redundant conditions. In addition, study will be made of techniques aimed to increase information processing ability by providing information to several senses simultaneously and by coding along several dimensions within a single sense modality. Investigations will be made on the effects of intersensory stimulation on theshold sensitivity, memory span, and reaction time.

21.60

Directorate of Engineering, RAS, RADC, Rome, N.Y.
INTERSENSORY DISCRIMINATION, R. C. Sturtevant. Project 8501(805A), Internal.

A human engineering investigation of stimulus factors influencing human discrimination functions will be carried out. The objective of this effort is to determine the conditions under which dual intersensory stimulation enhances, inhibits, or does not affect selected aspects of human behavior. Study will be made of the effects of added stimulation in a second sense modality on reaction time to complex stimuli. Redundant and non-redundant stimulation will be used. The results of these first studies will be compared with the results obtained by stimulation across two dimensions of a single sensory modality. These dimensions will probably be intensity and frequency.

21.61

Directorate of Engineering, RAS, RADC, Rome, N.Y.
TACTILE COMMUNICATION, R. C. Sturtevant. Project 8501(805A), Internal.

Studies will be continued investigating the use of the skin as a sensor for communications purposes, with processed speech as the stimulus. Such studies will endeavor to determine the capability of the skin to sense words, phrases and sentences, and will include investigating the effects of high frequency speech chopping, and selective frequency band amplification and filtering. Attempts will be made to determine the physical factors which control the skin responses. Studies will also consider the effects of frequency, intensity and harmonics as well as such physiological and psychological factors as fatigue and adaptation.

21.62

Florida State U., Tallahassee.
EFFECTS OF SIMILARITY AND TIME OF TEST ON TRANSFER, J. Greenspoon. Project 7183(805A), Contract AF 33 (616)-6408; MRST, AMRL.

This work is to determine how variations in both task similarity and time elapsing between training and skill utilization affect the transfer of skill. In order to accomplish satisfactory and generalizable experimental studies of the effects methods of scaling task elements in similarity are to be developed and validated.

21.63

Florida U., Gainesville.
SLEEP AND AROUSAL OF HUMAN SUBJECTS, W. B. Webb. Project 9778(805A), Grant AF-AFOSR-62-13; SRLB, AFOSR.

This investigator is studying the influence of three variables (drive, deprivation, and habituation), as they affect the speed of the onset of the sleep response. He will examine the wakefulness-sleep continuum as it interacts with human ability to perform. The investigator will also study the arousal process, as influenced by the variables of task complexity and habituation. Human subjects will be involved in monitoring a monotonous signal in an environment that is maximally sleep inducing.

21.64

Georgia U., Athens.
CONFUSION MATRIX ANALYSIS FOR DISPLAYS VARYING ALONG A SINGLE PHYSICAL DIMENSION, L. Peacock. Project 9670(802A), Contract AF 19(604)-7299; ESRH, ESD.

The objective of this research task is to determine the stimulus-response confusion analysis among stimuli from well-defined sensory ensembles. It is

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a test, using psychophysical techniques, of a theoretical model of sensory (neuro-physiological) organization, the constant-ratio-rule. The rule states that the ratio between any two entries in a sub-matrix containing the stimuli and responses under examination is identical to the ratio between the corresponding entries in the master matrix. The task is an attempt to define the generality of the constant-ratio-rule, and to examine stimulus variables which may influence the predictions of the rule, even to the point of breakdown.

21.65

Georgia U., Athens.
COMPUTER ANALYSIS OF BIO-ELECTRIC RESPONSE PATTERNS, H. Zimmer. Project 9779(805A), Contract AF 49(638)-1012; SRL, AFOSR.

The contract will attempt to identify and isolate trustworthy indicators of reaction to stimuli out of the range of awareness of the human organism. If this effort is successful, it will furnish the means and apparatus for computer analyses of bio-electronic data necessary to obtain an inventory of the information possessed by an individual, while this person remains unaware that he has thus revealed himself. The effectiveness of a number of different stimulus conditions and motivational states will be studied to ascertain their success in eliciting involuntary reactions to stimuli ranging from subliminal to supraliminal.

Georgia U. see 21.148

21.66

Gothenburg U. (Sweden).
INTRANEURONAL MECHANISMS FOR INFORMATION STORAGE, H. Hyden. Project 9777(805A), Grant AF-EOAR-62-29; SRLA, AFOSR.

This represents a bold attempt to suggest a chemical basis for learning and memory. Mental processes arenot easily amenable to experimental attack and any chemical approach is even more difficult. By ultramicro techniques, it has been shown that nucleoprotein production is linked with neuronal function. It is proposed here to study the incorporation of radioactively labelled precursors into the nerve cells of the second vestibular neuron during the course of the learning process. Another series of analyses will be made in rats subjected to vestibular stimulation to increase the neuronal function.

21.67

Gustavus Adolphus Coll., St. Peter, Minn.
COGNITIVE DISSONANCE AND THE EFFECTIVENESS OF PERSUASIVE COMMUNICATION, J. O. Whittaker. Project 9779(805A), Grant AF-AFOSR-62-188; SRLB, AFOSR.

The problem of this study concerns a factor which may be decisive in determining reactions to persuasive communications. Previous work in the area of judgment and discrimination suggests that different reactions may partially reflect the extent to which the introduced point of view agrees or clashes with the subject's frame of reference. The first series of experiments in this project will undertake to investigate consonant and dissonant effects under controlled laboratory conditions involving less complex judgmental situations and with persuasive communications. The second series of experiments will be concerned with the exploration of ways of improving the effectiveness of persuasive communications based on the findings in the preceding work.

21.68

Harvard U., Cambridge, Mass.
PROBLEMS IN TRANSLATION OF SURVEY RESEARCH QUESTIONS USED CROSS-NATIONALLY, A. Inkeles. Project 9779 (805A), Grant AF-AFOSR-62-58; SRLB, AFOSR.

The objective of this research is to work out experimentally the techniques for reducing discrepancies of meaning involved in the translation of cross-cultural survey questions into foreign languages. It is hypothesized that such discrepancies can be reduced: (1) when the original question is accompanied by detailed specifications of the intent of the question and the scientific objectives of the individual who originally prepared it; (2) when the translator is guided by a standard list of dimensions which serve as a check to alert him to those elements of a question which are most subject to translation "draft"; (3) when certain panel techniques are used in preparing the questions. These hypotheses will be tested out during the contract period.

21.69

Hawaii U., Honolulu.
PREDICTIVE MODEL FOR INTRA-GROUP NEGOTIATION, O. J. Bartos. Project 9779(805A), Grant AF-AFOSR-62-314; SRLB, AFOSR.

The objective of this research is to produce and test experimentally, a model which will predict the progress of negotiation simulation sessions and indicate the optimal negotiation strategy. Experiments with five-man groups will be conducted in which each member of the group represents competing interests attempting to reach agreement on a crucial issue. The theoretical model, based on "game theory," assumes that each subject of the test group will favor that compromise which, at a given time, maximizes the "expected utility" of the interests

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he represents, resulting from the product of payoff and his estimate of the probability of getting it. If this tests out favorably, the resulting parameters will be used in simulating negotiation sessions on a computer to produce optimal strategies.

21.70

Hebrew U. (Israel).
ROLE BEHAVIOR AND SOCIAL STRUCTURE, S. N. Eisenstadt. Project 9778(805A), Contract AF 61(052)-480; SRL, AFOSR.

Using social groups and organizations of a rapidly changing Israeli society as a basis, this research project proposed to study the components of specific roles that individuals assume in a number of groups such as the parental role in the family, leadership role in a military organization, etc. Some of these components are: general goals of each role, position in the social structure, ethical codes in professional roles, varying continuities of roles. In order to understand variations in behavior it is proposed to study and analyze: (a) the extent to which any components of a role are predominant in a given situation; (b) the social forces which influence the different ways and rates in which these components of roles are dealt with by individuals; (c) the ways in which different role components influence the development of new roles within a given social setting.

21.71

Human Sciences Research, Inc., Arlington, Va.
CONCEPTUAL MODEL OF PERFORMANCE OF MILITARY UNITS AND SMALL GROUPS, J. E. McGrath. Project 9778 (805A), Contract AF 49(638)-256; SRL, AFOSR.

A theoretical integration of research on group performance that has the potential of providing improved methods of predicting leadership, skill and training requirements for Air Force "team" tasks. A framework for integrating studies of military task and work groups will be formulated and the information from all available studies will be systematized therein. Task dimensions and classification and scaling of tasks in terms of these dimensions will be accomplished and predictive models will be developed. The predictive models and generalizations will be tested to evaluate their validity.

21.72

Human Sciences Research, Inc., Arlington, V.
ANALYTICAL MODEL FOR INTEGRATING PHYSICAL AND SOCIAL EFFECTS OF AIR ATTACK, P. Nordlie. Project 9779 (805A), Contract AF 49(638)-549; SRL, AFOSR.

This contract will attempt to integrate social and political data into the mathematical models of foreign societies and economies. It will seek to establish new methods for enumerating and measuring tangible and intangible factors of a society with a view toward more accurately predicting the total effects of various applications of air power.

21.73

Illinois U., Urbana.
PRINCIPLES UNDERLYING BEHAVIOR IN COMPLEX TASKS, J. A. Adams. Project 9778(805A), Contract AF 49 (638)-371; SRL, AFOSR.

The purpose of the proposed research is a preliminary examination of the implications arising from hypotheses based on an analytic approach to complex tasks having multiple stimulus-multiple response demands. The research will emphasize the character of component and total response learning under representative complex task configurations, and an evaluation of certain part-whole transfer of training hypotheses as they relate to task organization variables. Related studies will aim to delineate the conditions under which component responses are independent or dependent, the conditions under which the multiplicative rule for independent component responses can be expected to apply and the general implications of dependent and independent component responses for part-whole transfer of training.

21.74

Illinois U., Urbana.
QUANTITATIVE THEORY OF FORM PERCEPTION, H. Hake. Project 7183(805A), Contract AF 33(616)-6524; MRSE, ARML.

Fundamental concepts found in communication engineering are being investigated in an attempt to formulate a mathematical model of form perception analogous to and using principles of those models used in communication engineering. Laboratory research is being conducted to test the models formulated.

21.75

Indiana Foundation, Bloomington.
LOGICAL PROCESSES IN PHYSICAL THEORY, N. R. Hanson. Project 9769(803A), Grant AF-AFOSR-61-99; SRI, AFOSR.

Phenomenological discoveries in the physical world are believed to result from the application of patterns of thought. This study seeks to evaluate and coordinate implications from analyses of patterns

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of thought involved in explanation, prediction, picturing, interpretation, and establishment of equivalences as they are reflected in the development of theories, observations, and experimentation which have produced increased knowledge in the physical world.

21.76

Israel Inst. of Applied Social Research.
FACET DESIGN AND ANALYSIS OF DATA ON PERSONALITY AND ATTITUDES RELATED TO HUMAN ORGANIZATION, L. Guttman. Project 9778(805A), Contract AF 49(638)-121; SRL, AFOSR.

The objective of this work is to achieve a design and test methods for the analysis of non-parametric structures applicable to several fields in the behavioral sciences. In order to accomplish this, the investigator will: (a) assemble published studies which have been sufficiently systematic as to work out intercorrelations among the variables of their concern in the fields of personality and attitude, and as much as possible with reference to the problems of human organizations; (b) work out the psychological facets for each example to provide a theory from which to predict the statistical structure; and (c) perform the indicated calculations of inverse matrices, communalities and sometimes latent roots and vectors to check the adequacy of the facet theory.

21.77

Johns Hopkins U., Baltimore, Md.
OCCIPITAL CONNECTIONS IN THE CORTEX, R. E. Myers. Project 9777(805A), Grant AF-AFOSR-62-30; SRLA, AFOSR.

An interesting facet of the learning process is the mechanism by which information can be transferred from one hemisphere of the brain to the other. Thus, if a monkey is trained through one eye to recognize a certain pattern, he can make equally satisfactory discriminations with the untrained eye. This indicates a well-ordered system of intercommunication between the brain halves. If the corpus callosum is removed, this transfer of information across the midline is prevented. The animals must undergo similar training with each eye. Different portions of the corpus callosum appear to account for the transfer of visual and touch learning respectively. The knowledge of anatomy of the fiber interconnections between the involved brain centers is markedly deficient. This study has been designed to remedy this deficiency by exploring the finer details of the patterns of interconnections between and within various lobes of the monkey brain. Finally, it is hoped that the total pattern of interconnections between the hemispheres can be elucidated.

21.78

Kansas State U., Manhattan.
PREDICTABILITY OF TASKS AND LONG-TERM RETENTION OF LEARNED SKILLS, M. E. Noble. Project 9778(805A), Grant AF-AFOSR-62-17; SRLB, AFOSR.

The specific objective of this research is to study the learning and long-term retention of motor skills involved in infrequently occurring tasks, with various degrees of predictability of their occurrence. Variables to be investigated include length of the retention interval, type of task, and whether or not time-sharing is required. A number of analytic measures of performance will be obtained through graphic plots (from a direct-writing oscillograph) of the position of the subject's limb (or control) against time.

21.79

Lyon U. (France).
NEUROPHYSIOLOGICAL MECHANISMS IN CONDITIONING AND LEARNING, M. Jouvet. Project 9778(805A), Grant AF-EOAR-62-67; SRLB, AFOSR.

Neurophysiological studies of the brain mechanisms underlying conditioning, learning, and sleep states in animals, in order to provide a basis for exploration into and an understanding of the same phenomena in man. Animals with implanted electrodes will be employed to study the relationship between blockage of sensory stimuli and the capacity for attention during fatigue. Animals with brain lesions will be used to learn the role of the reticular formation and of the diffuse thalamic system in sleep and simple, as well as in more complex, learning processes.

21.80

Massachusetts Mental Health Center, Boston.
HYPNOSIS AS A CONTROL TECHNIQUE, M. T. Orne. Project 9779(805A), Contract AF 49(638)-728; SRL, AFOSR.

The contractor proposes to investigate the nature of hypnosis and its relationship to other phenomena. He will investigate: (1) the differences between "good" and "poor" hypnotic subjects in terms of: (a) their previous history of spontaneously occurring trance-like states; (b) the differences in reactions to situations reported to: induce hallucinations, such as monotonous tasks with rhythmic visual and auditory stimulations; (2) the extinction of autonomic conditioned responses; extinction will be compared between subjects where the response is conditioned in hypnosis and where it is conditioned in the wake state.

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ESRR- Operational Applications Lab

21.81

Massachusetts Inst. of Tech., Cambridge.
NEUROLOGICAL CORRELATES OF INFORMATION RECEPTION AND DECISION MAKING, W. A. Rosenblith. Project 9670(805A), Contract AF 19(604)-4112; ESRH, ESD.

This effort is devoted to the study of the electrical activity of the nervous system to the sensory performance of organisms. Most attention is presently focused upon the auditory system. Computer programs (for the AEC-1 and TX-0 computers) have been developed which make possible the isolation of the electrical response to a simple auditory stimulus, a click, from the totality of potentials recorded from the human scalp.

21.82

Matrix Corp., Arlington, Va.
REDUCING STRESS IN MILITARY GROUPS, E. E. Smith. Project 9779(805A), Contract AF 49(638)-1000; SRL, AFOSR.

The purpose of this research is to study, under field and laboratory conditions, the importance for small group morale and efficiency of the "wit" (funny guy) when the group or crew is in a stressful situation. Based upon previous studies conducted under observation of survival training situations, the investigator will test under field conditions, the hypotheses that (1) "wits" have higher stress tolerance, i.e., will maintain their performance efficiency longer under stress than will "non-wits"; (2) sarcastic wits will increase the stress tolerance of their groups. In the laboratory phase of the research, the results will be validated and discriminative measures for selecting and determining the relative importance of various kinds of "wits" will be further investigated.

21.83

Miami U., Oxford, Ohio.
ORGANIZATIONAL RESEARCH, J. Davis. Project 7183 (805A), AF 33(657)-8035; MRP, AMRL.

Develop a theoretical framework for examining the effects of organizational structure upon systems performance. Develop an appropriate experimental task and conduct experimental studies in which organizational structure is the independent variable.

21.84

Michigan U., Ann Arbor.
DECISION PROCESSES, W. Edwards. Project 9778 (805A), Grant AF-AFOSR-62-182; SRLB, AFOSR.

This research is exploring three scientific problem areas in decision making: (1) given a decision-making task to perform, how do men seek, acquire, edit, and organize information relevant to the task? (2) given a coherent body of information relevant to a decision-making task, how do men use that information to formulate available courses of action? (3) given a set of available courses of action with information about the costs, payoffs, and likeliness of success or failure of each, how do men combine these kinds of information in order to select one of the available courses of action for execution?

21.85

Michigan U., Ann Arbor.
INFORMATION-HANDLING AND DECISION-MAKING BY INDIVIDUALS AND SMALL TEAMS, P. M. Fitts. Project 9778(805A), Contract AF 49(638)-449; SRL, AFOSR.

The development and refinement of apparatus and method which will enable the study of individual and group information-processing and decision-making in tasks characterized by (1) continually changing external events, (2) operation of both exact and probabilistic laws, and (3) control over the amount and nature of input and feedback information available regarding external event sequences. The determination of individual and team performance levels as a function (1) selected task variables, the nature of these task conditions to be specified whenever possible in precise information-theory terms, and (2) procedures employed by individuals and teams, including load-balancing, strategies employed in certain problem solutions, and decision processes employed in the face of uncertainties and partially unreliable information.

21.86

Michigan U. Research Inst., Ann Arbor.
COMMUNICATIONS AND DECISION PROCESSES AS DETERMINANTS OF ORGANIZATIONAL EFFECTIVENESS; S. E. Seashore. Project 9778(805A), Contract AF 49 (638)-1032; SRL, AFOSR.

This study involves the planned experimental modification of important aspects of an organizational structure and process, such as the distribution of influence, supervisory techniques, and communication flow. It also involves the measurement at three points in time of these and other aspects of the organization such as performance goals, motivations, attitudes and performance. The proposed analysis will have four aspects: (1) determinants of employee work-goals; (2) the effect of supervisory practices; (3) comparison of alternative methods for measurement of

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SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
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CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRE- Control Sciences Lab

CRE- Geophysics Research Directorate
CREA- Photochemistry Lab
CREC- Thermal Radiation Lab
CREE- Research Instrumentation Lab
CREG- Terrestrial Sciences Lab
CREM- Meteorological Research Lab
CREI- Ionospheric Physics Lab
CREK- Sacramento Peak Observatory

organizational characteristics; and (4) evaluation of the impact of field experiment on organizational performance.

21.87

Michigan U., Ann Arbor.
HUMAN CAPABILITIES IN INFORMATION DETECTION, W. P. Tanner. Project 9778(805A), Contract AF 49(638)-369; SRL, AFOSR.

The general objective of this contract is the application of new mathematical and electronic models, and high speed computer techniques to research on psychophysical phenomena in order to gain knowledge that will enable precise descriptions of how man can utilize his environment. Specifically, the following work will be undertaken: conduct theoretical and experimental investigations of the efficiency of human observers in utilizing the information of the environment in (a) tasks involving the detection of weak signals; (b) the recognition of signals; (c) redundancy of communication tasks.

21.88

Michigan U., Ann Arbor.
SELECTIVE FACTORS IN COGNITION, R. B. Zajonc. Project 9778(805A), Contract AF 49(638)-367; SRL, AFOSR.

An individual confronted with an amount of information greater than a certain optimum has the tendency to select some items and to ignore others. The aim of the proposed research is to isolate the critical factors in this phenomenon, which will be referred to as informational input selectivity. The nature and organization of the cognitive structure which the individual uses in making this selection will be investigated. A series of studies will be undertaken which will be designed to: (a) isolate the kinds of cognitive structures likely to result in input selectivity, (b) to examine the properties of those cognitive structures which are likely to result in input selectivity and of those which are not, and (c) to study the conditions under which such structures are activated. The proposed empirical work derives from a theoretical model of cognitive processes and employs methods of measurement of cognitive structures previously developed. Thus, the second area of this work is to extend this theoretical model, to improve the measurement methods which are based on this model, and to develop new methods and techniques for the systematic study of cognitive processes.

21.89

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
2D/3D DISPLAYS, J. B. Nickels. Project 8501(805A), Contract AF 30(602)-2379; RAS, RADC.

Studies will be performed to determine the effect of the basic variables in the visual task (e.g., size, separation, direction of travel, and speed) on the ability to estimate absolute and relative position, velocity, and acceleration of targets moving in two and three dimensions.

21.90

Mississippi Southern Coll., Hattiesburg.
AUDITORY PERCEPTION IN HUMANS, R. W. Peters. Project 7232(805A), Contract AF 33(616)-7703; MRMA, AMRL.

Contract will provide research on the psychological auditory parameters with main emphasis on the time varying properties of sounds.

21.91

Montana State U., Missoula.
FACTORS OF URGENCY, MASTERY AND SET IN SERIAL REPRODUCTION OF INFORMATION, F. L. Brissey. Project 9769(803A), Grant AF-AFOSR-62-214; SRI, AFOSR.

The process of communication may be defined briefly as one in which the symbols representing information are transmitted from one individual or group to another. A main objective of the present effort is investigation of the process referred to as serial reproduction, a particular approach to the study of communication relating to the transmission and retransmission of a message through a sequence of individuals, a plausible analog of the communicative process as it may occur in a variety of organizational environments. Three conditions were selected for special study: urgency, mastery, and set. A further question to be investigated concerns the decision making and action taking behavior of the receiver in virtue of the message received.

21.92

Montevideo U. (Uruguay).
FLICKER-FUSION-FREQUENCY MEASUREMENTS AND THEIR APPLICATION TO RESEARCH IN VISION, C. Berger. Project 9778(805A), Grant AF-AFOSR-60-8; SRL, AFOSR.

Dr. Berger will make use of a special instrument designed to generate light flashes with independent control of frequency, dark-light ratios, and intensities in a preselected program. Recent studies have shown that these variables are important in the sensation of flicker-fusion, and indicate the need for a detailed preparation of standards for use of flicker-fusion as a measure in psychophysiological

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studies of vision. The new instruments give promise of being useful in experiments designed to learn more about the functional organization of the retinal units.

21.93

New Mexico U., Albuquerque.
THEORY OF COMMUNICATIVE BEHAVIOR, H. Maclay. Project 9778(805A), Contract AF 49(638)-610; SRL, AFOSR.

Many interpersonal communication situations in the Air Force and other military applications involve operators who are not in a face to face situation. They frequently do not have extensive knowledge of the special qualifications or characteristics of the other person involved in the diadic communication net. Information appears to flow in a highly impersonal channel. This task will attempt to develop a general situation in which the number of variables is restricted to intentions and expectations of the source and the destination of the message. Intentions and expectations are further described in terms of the communicative situation, the message, and referent. It is believed that these variables provide the essential elements for the elaboration of a theory of communicative behavior. The investigator will within this framework: (a) develop formulae which will serve to translate a verbal statement of communicative behavior into an axiomatic system; (b) specify with greater precision the variables involved in communicative behavior; and (d) extend the basic theory of communicative behavior to a wider range of situations to test the validity of the system.

21.94

New York U., N. Y.
MEASUREMENT OF ATTITUDE AND ATTITUDE CHANGE, S. W. Cook. Project 9778(805A), Grant AF-AFOSR-62-176; SRLB, AFOSR.

Research on attitudes has been handicapped by the disorganized state of attitude measurement. There is as yet no systematic, standard methodology for reliably measuring attitudes or attitude changes. The goal of this research is the construction and testing of a set of standardized measuring "instruments" for these important ingredients of human persuasion and motivation. The focus of the work is on the measurement of attitudes toward social groups -- people of other countries, or sub-groups within a country. Particular attention will be given to interviewing techniques and on techniques in which inferences are drawn from performance on objective tasks.

21.95

North Carolina U., Chapel Hill.
RESEARCH TO DEVELOP A MATHEMATICAL MODEL OF HUMAN DECISION PROCESSES THROUGH MEASUREMENT OF SUBJECTIVE PROBABILITY, L. V. Jones. Project 9778(805A), Grant AF-AFOSR-62-5; SLRB, AFOSR.

This research is seeking, through empirical testing, to provide information about two basic psychological aspects of decision theory: (1) subjective probability, personal expectations with respect to the outcome of an event, as contrasted with the actual statistical probability of its outcome; (2) utility, the value or desirability to the individual of an object or event.

21.96

Northwestern U., Evanston, Ill.
SIMULATION OF COMMUNICATION AND INTERACTION, H. Guetzkow. Project 9779(805A), Grant AF-AFOSR-62-63; SRLB, AFOSR.

The contractor is exploring the use of simulation techniques in the study of interactions between nations. "Decision makers" representing nations are selected from different cultural and organizational backgrounds and carry out simulation procedures with a number of programmed input variables such as air power, economic capability, new technical developments, etc. The simulation is so arranged that the "nations" may interact with each other, concluding treaties, giving military or economic aid, etc. Each simulation is developed for long enough periods to insure "historical" background within the interaction.

21.97

Ohio State U. Research Foundation, Columbus.
SPECIFICATION OF NON-UNIFORM CONTRAST, H. R. Blackwell. Project 8501(805A), Contract AF 30(602)-1974; RASH, RADC.

Studies will be performed to determine the applicability of measure to increasingly complex cases of non-uniform contrast. Ultimately an attempt will be made to apply the measure to continuous tone displays (e.g., photographs) and to target recognition rather than target detection.

21.98

Ohio State U. Research Foundation, Columbus.
LEARNING AND TRANSFER OF PSYCHOMOTOR SKILLS, G. E. Briggs. Project 7183(805A), Contract AF 33(616)-6964; MRST, AMRL.

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The contractor will continue investigation of the effect of variations in pursuit and compensatory display components and augmented feedback on the acquisition and transfer of psychomotor skills. During this phase the basic research apparatus will be modified so as to permit both one and two dimensional tracking. Experimentation will include variations in pursuit-compensatory partitioning, display noise, augmented feedback, and control-display directional relationships.

21.99

Ohio State U., Columbus.
SITUATIONAL VARIABLES IN THE PERFORMANCE OF MILITARY UNITS, J. E. Haas. Project 9778(805A), Contract AF 49(638)-447;SRLB, AFOSR.

The objectives of this research are: (1) to develop concepts and methods suitable for the study of human organizational behavior; and (2) utilizing these, to study value acts and situational variables related to organizational behavior.

21.100

Ohio State U. Research Foundation, Columbus.
PRODUCTIVITY IN THE RESEARCH TEAM, D. Howland. Project 9778(805A), Contract AF 49(638)-373; SRLB, AFOSR.

This research aims to discover those factors that affect positively or negatively the performance of research teams. The study includes consideration of the productive and non-productive activities of research teams, and factors affecting creativity in the context of the research organization.

21.101

Ohio State U. Research Foundation, Columbus.
EXTERNAL VS. INTERNAL CONTROL OF BEHAVIOR - A STUDY OF PERSONALITY FACTORS IN MOTIVATION, J. B. Rotter. Project 9778(805A), Contract AF 49(638)-741; SRL, AFOSR.

The investigators will develop: (1) an experimental instrument which will discriminate the degree to which an individual's behavior is responsive to internal or external sources of control in different areas of experience; (2) an analysis of the effects of the source of behavior control on overt social actions; (3) experimental studies of the way in which individuals establish control patterns (learn, adapt, or become conditioned in an experimental situation); and (4) attempt to discover the basic personality factors or character of the individual that determines his predilection for internal or external controls.

21.102

Ohio State U. Research Foundation, Columbus.
FORMAL AND BEHAVIORAL APPROACHES IN DECISION PROCESSES, A. Scodel. Project 9778(805A), Contract AF 49 (638)-317; SRL, AFOSR.

Research to provide a methodological basis for integrating the mathematical and behavioral research approaches and findings related to decision-making processes. The development of the methodological base will be attempted through the combined application of mathematical and behavioral techniques in studies of individual differences and situational effects in risk-taking situations, motivation underlying actions in risk-taking, and of the generality of risk-taking behavior.

21.103

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
COMPUTER SIMULATION OF PSYCHOLOGICAL PROCESSES, C. R. Brown. Project 9670(805A), Internal.

The development contract for a universal controller for psychological experimentation will provide us with the capability for work in computer simulation of psychological and physiological processes. The more obvious immediate applications are in the areas of recognition, memory, and decision making.

21.104

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
PROCESSES INVOLVED IN RECOGNITION, C. R. Brown. Project 9670(805A), Internal.

Although recognition is a complex process which, according to various theorists, involves perceptual tuning, information processing, decision making, and responding, the methodologies used in recognition studies are quite simple. This results in explanations with more degrees of freedom than the data under examination. Thus, our "theories" do not generate interesting predictions or suggest techniques for such things as computer simulation. An in-house effort has been to devise more adequate methodologies.

21.105

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
TEMPORAL MECHANISMS OF THE VISUAL SYSTEM, C. R. Brown. Project 9670(805A), Internal.

The psychophysical data of vision are very diversified and tend to lack a comprehensive theoretical

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framework. This has been especially true of the data concerned with temporal mechanisms. An in-house effort has been to determine if much of these data can be subsumed under filter theory. Preliminary results are quite encouraging. It appears that data dealing with temporal resolving power, brightness discrimination, and acuity may be considered within this framework.

21.106

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
FORM CONSTANCY OF REGULAR AND IRREGULAR SHAPES UNDER VISUAL NOISE, J. Coules. Project 9675(805A), Internal.

Experiments with irregular shapes are being performed to determine which psychophysical method provides the most reliable data. In addition, the results will be used to derive stimulus-stimulus mathematical relationships. These relationships specify how a measurable attribute of one physical stimulus as a function of another, when the observer's responses are held constant.

21.107

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
HUMAN PERFORMANCE VARIABILITY UNDER HIGH INFORMATION DENSITY AND NOISE CONDITIONS, J. Coules. Project 9675(805A), Internal.

Conduct experimental investigations to determine the degree of system performance variability and human performance variability under system stress conditions. The system will be stressed by increasing the information rate and density in a communication network under visual and auditory noises. Individual performance measures may be correlated with system output and physiological responses. Physiological responses will be restricted to measurement of muscle potentials. Physiological measures may indicate when human performance decrement reaches a critical point prior to system breakdown.

21.108

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
PRODUCTION OF TWO-COMPONENT COLOR PICTURES, D. R. Davee. Project 9675(805A), Internal.

Quantitative studies are planned to determine the materials required to produce a scale of discriminable hues suitable for color coding.

21.109

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
SURVEY OF [illegible]
Davee.

The literature [illegible] and terminology has been conducted and terminal elements have been investigated for potential methods of producing [illegible]

21.110

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
PERCEPTION OF [illegible]
(805A), Internal

Experiments were performed in which subjects viewed a spot moving horizontally across a CRT at several different speeds and rated the speeds on an ordinal scale. Preliminary analysis of the data suggests that under the conditions of the experiment, five different ranges of velocity can be discriminated accurately. Extension of this research into three-dimensional motion is contemplated.

21.111

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
AUTOMATED LABORATORY FOR PSYCHOLOGICAL RESEARCH, J. R. Hayes. Project 9670(805A), Internal.

The objectives of this effort are to explore problems in, and to develop techniques for, exploitation of the capabilities of digital computers in controlling ensembles of laboratory apparatus and carrying out research procedures. The ultimate aim is to make the computer operate the laboratory, carrying out such procedures as calibrating and interconnecting electronic equipment, controlling experimental conditions, presenting stimuli, and scoring responses - with flexibility and dispatch comparable to that with which we are familiar in computer processing of numerical data.

21.112

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
DECISION MODEL FOR WORD RECOGNITION, J. R. Hayes. Project 9670(805A), Internal.

Work is proceeding on a decision model for word recognition by human listeners. The purpose of the model is to predict human performance in various word recognition and related tasks as a function of the background noise in which the words are presented, the *a priori* probabilities of the words, and the payoffs resulting from correct and incorrect identifications. Future work will be devoted to testing the model thoroughly with

ailable data and to designing experiments specifically to test the model.

.113

Operational Applications Lab., ESRH, ESD, Bedford, Mass.
COMPUTER SIMULATION OF PSYCHOLOGICAL PROCESSES, R. Nickerson. Project 9670(805A), Internal.

development contract for a universal controller psychological experimentation will provide us n the capability for work in computer simulation psychological and physiological processes. Since chological and physiological theories have a dency to become complex, even qualitative deriions from theory may become unwieldy. Thus, ulating theoretical processes is an important nique for determining the consequences of conring data from one viewpoint or another.

14

erational Applications Lab., ESRH, ESD, Bedford, ss.
RMATION PROCESSING OF DYNAMIC VISUAL SPLAYS, . Sumby. Project 9670(805A), Interna

ability to recognize dynamic visual displays, lays passing the line of vision at extremely l speeds, is a function of the speed, the comlty and, to some extent, the amount of practat viewing such displays. This task is an pt to determine the nature of changes in perual processes as a function of display speed mplexity. It is concerned both with the ological events as the image of a stimulus es the retina, and the means whereby any ological and anatomical inadequacies may be ome. Furthermore, it is concerned with the nsating factors in the processing of such ays which permits the transmission of informadespite low detail resolution. Extremely time stroboscopic sampling has been carried is have studies in simple perceptual deterin of a moving stimulus.

ational Applications Lab., ESRH, ESD, Bedford, .

ATION PROCESSING OF VIBROTACTILE STIMULI, W. by. Project 9670(805A), Internal.

tion processing by the human operator typis concerned with information transmitted er the visual or auditory sensory modalities. is an examination of the possibility of incorporating vibrotactile information into the ongoing informational complex. It is an attempt to define the information processing capacities when vibrotactile stimuli are presented either in sensory isolation or simultaneous with information being processed by other sensory modalities.

21.110

Oxford U. (Gt. Brit.)
BRAIN STEM STIMULATION AND ETHOLOGICAL STUDIES IN BIRDS, N. Tinbergen, D. Vowles. Project 9777 (805A), Grant AF-AFOSR-62-22; SRLA, AFOSR.

Following microelectrode implantation it is planned to use brain stem stimulation as a tool for producing a specific behavior pattern in the test animals. The ability to produce such behavior under precisely controlled conditions is of prime importance in studying the following problems: (a) how do internal states and external stimuli interact in those cases where they are jointly responsible for the elecitation or the cessation of a behavior pattern? (b) how do internal states and external stimuli participate in the switch from one movement to another in the case of action chains or sequences? (c) do sequences of movements reflect an intensity scale of some common underlying factor? (d) are some movements the result of a simultaneous arousal of two or more, wholly or partly incompatible behavior patterns?

21.11

Personnel Lab., MRP, AMRL, Dayton, Ohio.
APPLICATION OF PERCEPTION OF RELATIVE FREQUENCY TO HUMAN DECISION MAKING, Project 7183(805A), Internal.

Research is being conducted to determine man's capability to perceive information when presented at very fast rates. Measures are being made of man's ability to estimate, quantitatively, the relative frequency of occurrence of events as a function of rate, number of different events, and duration of observation. Future work will involve the perception of the relative density functions of events occurring over time.

21.118

Personnel Lab., MRP, AMRL, Dayton, Ohio.
GROUP STRUCTURE AND HUMAN PERFORMANCE, J. O. Morissette, J. P. Hornseth. Project 7183(805A), Internal.

Research on group structure and group performance which has been conducted over the years clearly demonstrated, under both field and laboratory conditions, that group structure is an important factor

Research Laboratories
Research Lab
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e Physics Research Lab
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in group performance. Structure has been shown to be significant with respect to affecting individual and group morale as well as productivity. The major difficulties with these studies is that group structures have been defined and described in qualitative terms. Consequently, the derivation of basic principles relating structure to performance has been lacking. Through the use of the mathematics of directed graph theory, or simple di-graph theory, a program of research is being evolved which will permit a rigorous description of group structure, sub-structures, and properties of points in the structure.

21.119

Personnel Lab., MRP, AMRL, Dayton, Ohio.
PERFORMANCE AND EGO STRENGTH, Project 7183(805A), Internal.

The present program is aimed at determining the performance of subjects varying in ego strength under conditions of physical and psychological threat. The study is also attempting to determine what conditions will lead to high performance in situations where human failure is to be expected.

21.120

Personnel Lab., MRP, AMRL, Dayton, Ohio.
PERFORMANCE AND RELIABILITY OF PERFORMANCES OF INDIVIDUALS AND GROUPS UNDER VARIOUS CONDITIONS OF WORKLOAD, J. O. Morrissette. Project 7183(805A), Internal.

Conflicting evidence exists with respect to the relative productive capacity of individuals and groups. Theoretical considerations suggest that the conflicting evidence results from poor experimental controls on workload. Preliminary investigations offer strong support for this contention. Data obtained in this study suggested also that, under all workload conditions, the performance of groups was more consistent than that of individuals. Both of the questions are being investigated intensively in the present effort.

21.121

Personnel Lab., MRP, AMRL, Dayton, Ohio.
TASK MONOTONY AND PERFORMANCE, J. O. Morrissette. Project 7183(805A), Internal.

Subjects will perform a vigilance-discrimination task for a period of four hours under conditions of minimal environmental stimulation. Attempts to activate the reticular formation, which is absolutely essential to alert behavior, will be accomplished by introducing random visual, auditory and tactile stimulation at subliminal, liminal, and supra-liminal levels. The condition of minimal environmental stimulation is being used for three reasons: (1) this condition, along with task monotony, will maximize work decrements; (2) it is known to reduce reticular activity; and (3) it permits rigorous control of stimulation conditions.

21.122

Personnel Lab, MRP, AMRL, Dayton, Ohio.
INTERACTION OF STRESS AND MOTIVATION IN HUMAN PERFORMANCE, R. I. Thackray. Project 7183(805A), Internal.

The goal of this effort is to establish the relationships between certain psychophysiological measures and operator performance levels. The information obtained will permit control for varying levels of motivation in experimentation in this area and thus increase the precision with which the performance capabilities and limitations of the human operator can be established for advanced aerospace systems. The testing of 30 subjects has been completed on a verbal learning task with recordings of various psychophysiological measures being made. Data analysis is in progress.

21.123

Personnel Lab., MRP, AMRL, Dayton, Ohio.
APPLICATION OF GAME THEORY MODEL TO HUMAN DECISION MAKING, D. L. Zink. Project 7183(805A), Internal.

Research is being conducted to describe man's decision processes in a decision situation involving competition with others. The aim is to provide experimental data relevant to the applicability of game theoretic models to complex decision making. Measures are taken of how well subjects are able to detect deviations from an optimal strategy by their opponent, and to change their own responses to capitalize on these deviations. To date, apparatus has been developed, and several pilot experiments conducted. This research has implications for the structuring of the informational environment in man machine systems.

21.124

Pittsburgh U., Pa.
COMPARATIVE IMPACT OF ACTUAL VERSUS ANTICIPATED EVENTS (OUTCOMES), J. Nehnevajsa. Project 9779 (805A), Contract AF 49(638)-1116; SRIB, AFOSR.

This study is conducting and evaluating the results of a series of controlled interviews with representative samples of foreign students and potential decision makers. Their judgments are recorded as to the

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CRRS- Communications Sciences Lab
CRRT- Control Sciences Lab
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CRER- Sacramento Peak Observatory

present desirability and estimated likelihood of a set of possible outcomes in the present international situation. The impact of air-space developments and achievements of the East-West blocks is stressed. The comparison of judgments early in the time scale regarding the desirability of anticipated events are compared with later judgments about actually transpired events.

21.125

Princeton U., N. J.
FACTORS IN LEARNING EFFICIENCY, R. M. Gagne. Project 9778(805A), Grant AF-AFOSR-62-197; SRLB, AFOSR.

The purpose of the research is to determine principles of learning efficiency leading to the arrangement of schedules of material to be learned and applicable to devices for programmed learning. Tasks requiring identification and problem solving, typical of many Air Force jobs, will be employed to provide performance standards following periods of learning. Following an analysis of these tasks to determine the required responses, studies will be conducted to find principles of learning efficiency.

21.126

Princeton U., N. J.
PERCEPTION OF TIME-VARYING STIMULUS MAGNITUDES, J. M. Notterman. Project 9778(805A), Contract AF 49 (638)-381; SRLB, AFOSR.

The results of the proposed investigation will be applicable to a wide variety of situations in which the operator is called upon to respond in some fashion to the velocity and acceleration of visual stimuli. Research is being undertaken on the human ability to detect velocity and acceleration differences, and on the relation of perceived to actual velocity as it influences response capability. This exploratory work on the correlation between the human's visual error-detection characteristics and error-correction behavior has as its objectives the addition of new knowledge relating to visual and auditory discriminatory processes, and theoretical implications, with respect to sensory and perceptual mechanisms.

21.127

Purdue Research Foundation, Lafayette, Ind.
ADAPTIVE AUTOMATIC CONTROL AND LEARNING SYSTEMS, J. E. Gibson. Project 9783(806A), Grant AF-AFOSR-62-351; SRDM, AFOSR.

This program of research will study adaptive control systems theory and will tie adaptive systems to systems using "learning" techniques. The "learning" techniques here involve the use of past experience accumulatively to achieve a more efficient adjustment sequence rather than repeating old sequences when faced with previously encountered environments. Information theory will also be studied and used in the "learning" technique approach. Analysis and synthesis of such systems will also be made.

21.128

Purdue Research Foundation, Lafayette, Ind.
MEASUREMENT OF MOTIVATION, K. M. Michaels. Project 7183(805A), Contract AF 33(616)-7962; MRP, AMRL.

This work is for the development of a test instrument which will determine the propensity of subjects in psychological experiments on environmental stress to be motivated to perform experimental tasks. The test instrument will draw on existing item pools which will be validated against performance and conditioning criteria. Such a device will aid greatly in improving the efficiency of stress experiments.

21.129

Rochester U., N. Y.
FORM DISCRIMINABILITY AS A FUNCTION OF DEGREE OF OVERLAP AND AREA, R. M. Boynton. Project 8501 (805A), Contract AF 30(602)-1973; RAKW, RADC.

Similarity of form pairs is specified in terms of the degree to which they overlap, objectively measured. Psychophysical experiments have been performed which show that the discriminability of members of nonsense form pairs under impoverished viewing conditions is inversely related to degree of overlap. This relationship exists whether area of the forms is held constant or permitted to vary. Extension of the research to good viewing conditions, as well as to other form populations (e.g., pairs of ellipses), indicates that measures of overlap still remain good predictors of form discriminability.

21.130

Stanford Research Inst., Menlo Park, Calif.
INDIVIDUAL INFORMATION HANDLING PROBLEMS, D. C. Engelbart. Project 9769(803A), Contract AF 49 (638)-1024; SRI, AFOSR.

The progressive increase in the complexity and urgency of problems needing solution by human decision makers and the comparative static status of the human capability in problem solution emphasize the significance of research into means of improving human intellectual effectiveness. Research in progress is directed toward establishing

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AEU- Hypersonics Research Lab
AEX- Solid State Physics Research Lab
AEZ- Metallurgy & Ceramics Research Lab
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a conceptual framework for study. The individual and his "augmentation means" (language, artifacts, and methodology at his disposal) will be examined in the light of this framework. Information-handling techniques are expected to result which will make the individual more effective in handling his creative tasks.

21.131

Stanford Research Inst., Menlo Park, Calif.
INCENTIVES FOR SCIENTISTS IN VARIOUS ORGANIZATIONAL CONTEXTS, H. Vollmer. Project 9778(805A), Contract AF 49(638)-1028; SRLB, AFOSR.

The objective of this research is to study the relationship between scientific specialists and employing organizations, and the factors affecting this relationship. The findings of this study should be applicable to problems of organization and management of scientific personnel that are common to the Air Force and other large-scale organizations. These problems include: recruitment, placement, motivation, and career development.

21.132

Stanford U., Calif.
LEARNING THEORY FOR RESPONSE CONTINUA, P. C. Suppes. Project 9769(803A), Contract AF 49(638)-1037; SRI, AFOSR.

The aim of the research proposed is to develop and experimentally test a quantitative learning theory for spatial and temporal response continua. This research should contribute to our understanding of fundamental learning processes when the organism is confronted with a continuum of possible responses. The theoretical approach will be to apply the kind of stochastic models for response continua already studied by the principal investigator. These are generalizations of linear response and stimulus sampling models for a finite number of responses. The important conceptual generalization is to represent the conditioning of a stimulus by a continuous probability distribution on the response continuum rather than by a determinate connection with a single response.

21.133

Stockholm U. (Sweden).
PSYCHOPHYSICAL RELATIONS IN PERCEPTION OF SPACE, TIME AND VELOCITY, G. Ekman. Project 9778(805A), Grant AF-EOAR-62-76; SRLB, AFOSR.

The subjective variables of (perceived) space, time, and velocity have been separately investigated and have been found to be related to corresponding physical (stimulus) variable by power functions. This research will determine the interrelations among perceptual continua, e.g., determination of what function subjective velocity is of subjective space and subjective time. The method and rationale of the study lend themselves to extrapolation to other fields such as interpersonal perception, group dynamics, attitude research, experimental linguistics, learning and training.

21.134

Sylvania Electronic Systems, Waltham, Mass.
APPLICATION OF COLOR VISION THEORY TO TWO-COLOR MIXTURES, H. Yilmaz. Project 8501(805A), Contract AF 30(602)-2635; RASH, RADC.

The contractor will collect systematic data on Land color phenomena and on simultaneous contrast. A quantitative test will then be made of the agreement between theory and data. This research program will provide data with direct application to color displays. Thus, it may lead to the development of color display systems based upon the use of two, rather than three, primaries, and, therefore to a substantial reduction in the cost and complexity of such systems.

21.135

System Research Ltd. (Gt. Brit.).
DESIGN OF ADAPTIVE TEACHING SYSTEMS, G. Pask. Project 7183(805A), Contract AF 61(052)-402; MRP, AMRL.

The contractor will continue research on the design of adaptive teaching systems with emphasis on further theoretical development and on the preparation of specifications, functional designs and prototypes for such systems. These efforts will deal specifically with a practical group instruction device, requirements of the "automated" classroom, measures of misinformation tolerance as skill indicants, an economical device for use with individuals, and theoretic studies of conceptual and creative thinking as involved in teaching automata.

21.136

Texas U., Austin.
AROUSAL, MANAGEMENT AND REDUCTION OF HOSTILITY, P. Worchel. Project 9778(805A), Contract AF 49(638)-460; SRL, AFOSR.

Research as to the casual conditions of agressive behavior to determine (a) some of the personality factors in the susceptibility to the arousal of hostility, (b) the direction and quantity of the overt expression of hostility, and (c) the efficiency

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CRRT- Control Sciences Lab
CRP- Geophysics Research Directorate
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CRPC- Thermal Radiation Lab
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of various techniques for the reduction of hostility. The examination of presently formulated personality theories to obtain practical predictive measures of hostility and to validate the personality (aggressive) theory held by the investigator.

21.137

Tufts U., Medford, Mass.
INNOVATION IN TASK ORIENTED COMMUNICATION, T. B. Roby. Project 9778(805A), Grant AF-AFOSR-61-66; SRL, AFOSR.

The objective of this research is to identify specific factors that will make it easier to develop new task communication signals (language idioms) permitting precise and rapid exchange of necessary information in entirely new task situations. It is concerned with the ways in which individuals and groups, faced with distinctly new environments, modify their communication behavior to adapt actions speedily and efficiently to the new environment and with each other. The research will be based on task situations that make it impossible to transfer established habits of language and signals to the new environment. Independent variables to be manipulated will be prior experience of the participants with similar tasks and with each other, and signal facilities (amount and types of information that could be exchanged). The dependent variables will be the efficiency of the task language that is developed, measured by content and/or by task performance.

21.138

Universitaet des Saarlandes, Saarbruecken (Germany).
EFFECTS OF FEAR AND ANXIETY ON PERFORMANCE, O. Spreen. Project 9778(805A), Contract AF 61(052)-483; SRL, AFOSR.

The objective of this research is to measure the degree to which a number of psychophysiological, simple and complex behavioral responses will change under induced fear and anxiety stresses in a laboratory situation. These responses have heretofore been studied individually by different investigators under various conditions and in varying populations. The aim here is to study them in a common experimental setting. Specifically, the aim is to determine: (1) the relationship of these responses to chronic anxiety; i.e., whether there significant differences in these functions between high, middle and low anxious groups; (2) the relationship of these responses to immediate, induced stress conditions; (3) whether there are differences between high, middle and low anxious groups in their reactions to induced stress. Autonomic response as well as psychomotor response measures will be utilized and results factor analysed.

21.139

University Coll., London (Gt. Brit.).
ANATOMICAL LOCALIZATION OF TARGET LEARNING AND MEMORY, J. Z. Young. Project 9777(805A), Grant AF-EOAR-61-39; SRLA, AFOSR.

This project will be a continuation and development of the work that has demonstrated the role of the vertical lobe of the octopus brain in the learning and retention of attack behavior patterns. The effect of lesions in the brain on attack behavior will be studied. The method of transfer of information stores from one part of the brain to another (i.e., the opposite side) will be investigated. This provides a means of discovering the nature of the store. After certain operations the store is no longer effective but can then be made partially so by retraining. This also provides clues to its nature. Further information will be obtained from study of which shapes can and cannot be discriminated and of the capacity to carry multiple stores. All of these capacities are to be interpreted in the light of the results of investigations of the connection patterns within the lobes concerned. The project will therefore be undertaken partly at Naples, where octopuses are available, partly at University College in London where there are facilities for investigation of connectivity, including electron microscopy. In London there are also engineers investigating the performance of machines designed on the principles operating in octopus.

21.140

Veterans Administration Hospital, Boston, Mass.
NEUROPHYSIOLOGICAL PRINCIPLES OF LEARNING MECHANISMS, J. R. Segal. Project 9777(805A), Contract ISSA 62-1; SRLA, AFOSR.

This project is formulated to provide information concerning the nature of the neurophysiological changes accompanying the development of an inhibition of the prey capture and feeding movements in the salamander. The first portion of the investigation will be an electrophysiological search for the anatomical location of the centers responsible for the establishment and retention of the acquired habit. Secondly, a correlation (in time) of the changes in such centers with the overt behavioral pattern will be made.

21.141

Vienna U. (Austria).
FACTOR ANALYSIS OF SPATIAL ORIENTATION, G. Schubert. Project 7220(805A), Contract AF 61(052)473; NRDA, AMRL.

AEL- Aeronautical Research Laboratories
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ARX- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARZ- Solid State Physics Research Lab
ARE- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMEE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEM- Intelligence & Electronic Warfare Div.
RAGR- Advanced Studies Office
RAG- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AMRC- Arnold Engineering Development Center
AMR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESMR- Operational Applications Lab

Evaluation of three receptor systems (visual, vestibular and derma-kinesthetic) normally used for subject space orientation to determine which is most susceptible to gravitational cues and which is prepotent.

21.142

Washington School of Psychiatry, D. C.
GROWTH OF LOGICAL THINKING, J. J. Goodnow. Project 9778(805A), Contract AF 49(638)-682; SRL, AFOSR.

This research will test certain hypotheses concerning the growth of logical thinking proposed by Piaget and Inhelder. The changes in thought from late childhood to adolescence are regarded by Piaget and Inhelder as forming the major bases for adult thinking and problem-solving. The specific hypotheses in their work concern the relation of growth of age, the interrelation of several aspects of logical thought, the course of development and the effect of the cultural and educational milieu. These hypotheses will be tested: (a) by standardizing the procedure for three of Piaget's test situations and developing techniques to allow quantitative scoring and statistical analyses; (b) on a sample of 300 to 400 British and Chinese subjects ranging in age from 9 to 15 years have British, Chinese and no educational backgrounds.

21.143

Washington State U., Pullman.
SHORT TERM MEMORY IN A SEQUENTIAL TASK, K. E. Lloyd. Project 9778(805A), Grant AF-AFOSR-62-41; SRLB, AFOSR.

The purpose of the proposed work is to determine how short term memory of sequential tasks operates and can be improved. Research will be done to determine the interrelationship of the material being "stored," including the relationship and importance of "key" words ("recall points"). The effect on recall of different variables that can be imposed on a sequential task such as: (1) kinds of material; (2) amount of material; (3) meaningfulness of material to subject; 94) method of obtaining recall; (5) subject's overall knowledge of the task; (6) noise; and (7) the role of competing responses will be studied.

21.144

Washington U., St. Louis, Mo.
PARTIAL REDUCTION OF METHODS IN FACTOR ANALYSIS, P. H. DuBois. Project 9778(805A), Grant AF-AFOSR-62-181; SRLB, AFOSR.

Multiple factor analysis has become an increasingly valuable analytical tool for discovering and correlating basic variables in behavioral sciences research. The objective of this research contract is to produce a new generalized approach to multivariate correlation analysis.

21.145

Wisconsin U., Madison.
CUMULATIVE SCALING AND ERROR ESTIMATION, E. F. Borgatta. Project 9778(805A), Grant AF-AFOSR-62-16; SRLB, AFOSR.

Cumulative scale construction has become an important social science method of data ordering and analysis. One of the problems of such scale construction is that they usually involve a certain amount of error in the distribution of items. The objective of this research is to explore the possibility of estimating item error and class parameters corresponding to latent structure models for cumulative scales.

21.146

Wisconsin U., Madison.
ALTERATIONS OF BRAIN BIOCHEMISTRY AND DEVELOPMENT OF BEHAVIOR, F. E. Shideman. Project 9777(805A), Grant AF-AFOSR-61-56; SRL, AFOSR.

This research is an attempt to understand the effects of alterations in fetal brain biochemistry on both physiological and morphologic development, and the development of behavior and behavior status during adult life. The investigation combines the experimental and theoretical resources of psychological and pharmacological laboratories. It is proposed to explore not only specific behavioral phenomena of development, including reflex, learning, perceptual capacity and stress tolerance, but also correlated biochemical and physiological aspects of activity. The primary pharmacologic variables of interest are biochemical alterations, particularly depletion of known biochemical components, e.g., serotonin and catecholamines, of the central nervous system. This will be accomplished by use of chemical agents, such as reserpine and more recently studied compounds, which are capable of producing known changes in concentration of certain normally occurring substances in the brain.

21.147

Zootomiska Inst. (Sweden).
NEURAL MECHANISMS INVOLVED IN INSTINCTIVE BEHAVIOR, E. Fabricius. Project 9777(805A), Grant AF-EOAR-62-15; SRLA, AFOSR.

Studies will be made of the alterations in instinctive behavior of birds and mammals, such as the beaver, which are caused by localized lesions

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produced in various parts of the brain by a microbeam of 185 Mev protons from a synchrocyclotron. The techniques for producing these lesions are being developed at Uppsala by Dr. Larsson. Under this contract Dr. Fabricius will concentrate on ethological studies of animals that have had selected areas of the brain destroyed by proton beams.

21.148

Georgia U., Athens.
INFLUENCE OF TECHNOLOGICAL CHANGE ON PROFESSIONAL CAREERS IN INDUSTRIAL AND MILITARY ORGANIZATIONS, V. Bowers. Project 9778(805A), Contract AF 49(638)-804; SRLB, AFOSR.

This research will investigate the way in which career professionals in industry and in the military adjust to technological changes that occur in their respective fields that alter the technical, administrative, or organizational aspects of their employment.

See also: 7.91, 10.3, 17.140, 20.13, 22.24, 22.32, 22.47, 22.62, 22.69, 22.83, 22.86, 22.89, 22.102-103, 22.107-109, 22.115, 24.10

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22. BIOLOGICAL AND MEDICAL SCIENCES

Thermal Stress (physiol); Bionics; Biosynthesis; Blood; Drug Effects; Electrophysiology; Hormones; Muscles; Neurophysiology; Photosynthesis; Physiology; Microbiology; Retina; Physiological Effects of Sensory Deprivation.

22.1

Agricultural Research Council, London (Gt. Brit.). EFFECT OF DRUGS ON AMINES AND METABOLITES IN NERVOUS TISSUE, M. Vogt. Project 9777(805A), Grant AF-EOAR-62-19; SRLA, AFOSR.

It has been postulated by various workers that the action of drugs on the central nervous system may depend upon changes of the content of noradrenaline or other nerve hormones. Drugs which stimulate sympathetic centers cause a fall in brain noradrenaline. Only reserpine, thus far, has been shown to deplete peripheral sympathetic neurones of noradrenaline. This study proposes to test the effect of other drugs, including amphetamine, nicotine-like compounds, tremorine, and others on the noradrenaline content of brain and sympathetic ganglia. Other transmitter substances will also be studied.

22.2

Agricultural U., Wageningen (Netherlands). PHYSICAL AND CHEMICAL STUDIES OF CHLOROPHYLL SYSTEMS, K. C. Wassink. Project 9777(805A), Grant AF-EOAR-62-30; SRLA, AFOSR.

This investigation seeks to procure data on green plant chlorophyll and on bacteriochlorophyll. Fluorescence yield, energy transfer, changes in absorption spectra, and other properties will be determined on dissolved chlorophyll and on various pigment-protein complexes.

22.3

American Medical Research Foundation, Dayton, Ohio. EFFECT OF CIGARETTE SMOKING ON BLOOD LIPID CLEARANCE AND COAGULABILITY AFTER A FAT TEST MEAL, G. Talbott. Project 6300(805A), Contract AF 33(616)-8095; MRM, AMRL.

The contractor suggests that the association between smoking and coronary disease depends upon the metabolic response to smoking, and is mediated by the effect smoking has on specific lipid fractions during fat clearances. This hypothesis is to be tested by a two-stage experiment utilizing male prison inmates maintained in a regimented environment and subjected to continuous dietary and experimental control. First a comparison will be made of the individual fat clearance curves of a group of 20 healthy men who are habitual smokers with 20 age-matched habitual non-smokers. Next the smokers will be required to smoke intensively or drastically curtail their smoking habit for a period of time before again determining their individual fat clearance curves. In addition, the effect of nicotine on the lipid clearance of smokers and non-smokers may be undertaken. Biostatistical analyses between groups and individuals will be made. The statistical significance of the fractional lipid variation noted may indicate the desirability of restricting excessive cigarette smoking as a means of mitigating coronary heart disease.

22.4

Armed Forces Inst. of Pathology, Washington, D. C. DETERMINATION OF CARBOXY-HEMOGLOBIN IN DECOMPOSED BODIES, H. E Christensen. Project 7163(805A), Contract MIPR 33-657-2-RD-175; MRMP, AMRL.

This work is designed to aid in the clarification and etiology of death in certain aircraft or other accidents. The common current practice of CO determinations in biological fluids and tissues has resulted in interpretation of doubtful validity due to possible post-mortem formation of CO or interfering gases produced by putrefaction. This aspect of the problem will be thoroughly investigated using gas chromatography, electrophoresis and spectrophotometric techniques. Tissue extracts of various organs and blood will be putrefied under a number of different conditions such as incubation at several temperatures and under aerobic and anaerobic conditions. Samples will be fractionated to isolate the CO producing systems. The results of in-vitro putrefaction of blood and tissue samples will be applied to and correlated with actual analysis of those

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tissues submitted to AFIP as a part of the routine medical investigation of aircraft accident fatalities.

22.5

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
SPINAL REFLEX MECHANISMS, L. O. Hoeft. Project 7232 (805A), Internal.

The spinal reflex mechanism is being investigated as a simple biological servo-loop. This biological servomechanism is being studied for principles applicable to the design of mechanical control devices. A machine has been developed and modified. This machine is capable of giving a muscle a prescribed mechanical stimulus and at the same time varying the mechanical load on the muscle and recording displacement and tension at muscle insertion. Muscle mechanical output is related to mechanical input and a transfer function derived from this relation.

22.6

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
BIOCHEMICAL PROPERTIES OF FLUIDS OF THE INNER EAR, M. T. Johnson. Project 7232(805A), Internal.

This study is to link cochlear biological potentials to specific biochemistry. It will provide information about generation of DC electrical current by oxidative metabolism - a "living fuel cell" - as well as biochemical changes produced by exposure to loud sound. The work is a joint in-house and contractual effort. Development of microanalysis techniques is being done by contractor. Development of microanalysis techniques is being done by contractor. Development of a technique for the collection of the fluid is being done in-house. Glass micropipettes are fabricated which can withdraw fluid while simultaneously monitoring the biological potential at the point of withdrawal.

22.7

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
BIOMECHANISMS IN THERMAL STRESS, A. T. Kissen. Project 7220(805A), Internal.

Biomechanisms involved and physiologic responses of human and animal subjects exposed to a variety of transient and steady states of thermal stress are under study with skin, rectal, body heat storage, physiologic strain index, sweat, evaporative, metabolic and circulatory changes measured, recorded and correlated with environmental or physical variables. The effects of various levels of hyperthermia on a visual function (dark adaptation); hypnosis on temperature response and regulation of the cold and hot exposed subject; the role of humidity on evaporative temperature regulation in the temperature range 100°-160°F are being investigated to describe the interrelationships between various possible indices of overall thermal strain, body heat storage, cardiovascular function, and environmental heat stress. Limits of human thermal tolerance and the nature of physiologic response to severe thermal transients and combined stress states involving hypo- and hyperthermia are being studied.

22.8

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
PHYSIOLOGY OF WATER IMMERSION, M. McCally. Project 7220(805A), Internal.

To define the physiologic mechanisms responsible for the effects of water immersion on cardiovascular function, body fluid distribution and mobilization and metabolism. It is generally agreed that weightlessness poses one of the most serious obstacles to man's hope of conquering space. Water immersion is, at present, the best available simulator of certain physiologic effects of prolonged weightlessness, particularly those relating to the loss of the hydrostatic column due to gravity.

22.9

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
MECHANICAL EFFECTS OF THE TYMPANIC MUSCLES, J. R. Mundie. Project 7232(805A), Internal.

The purpose of this research is to test the theory of the action of these muscles and resolve the specific action of them. Previous studies done on the mechanical characteristics of the guinea pig ear indicated that the tympanic muscles can alter the acoustical properties of the ear rather remarkably. As a result of these studies a theory of the action of these muscles was evolved. Use will be made of the techniques of impedance measurement and tympanic muscle reflex measurement previously developed.

22.10

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
ELECTROPHYSIOLOGY TECHNIQUES, D. G. Pitts. Project 7163(805A), Internal.

The objective of this effort is to conduct a literature survey of electrophysiological techniques and instrumentation used in vision research. This includes domestic and foreign publications pertaining to the ERG, EOG, and EMG with different types of electrodes to pick up the various signals.

22.11

Biomedical Lab., MRM, AMRL, Dayton, Ohio.

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BREATHING IN ENCLOSED SPACES, D. A. Rosenbaum. Project 7163(805A), Internal.

Breathe down studies are being conducted using subjects completely enclosed in a 14.4 cubic foot capsule. Studies of pO_2, pCO_2, respiratory rate, relative humidity, and alveolar pO_2 and pCO_2 will be conducted. Eight subjects have been enclosed in this capsule and most have terminated about 1-1/2 hours after beginning the experiment. The inspired pCO_2 was up to 7% and the inspired pO_2 was down to 13% upon termination. The subjects will again be studied under similar conditions with an alveolar air sampler enclosed in the system. This data will give us further insight into the body CO_2 stores and the mechanisms of adapting to altered environments.

22.12

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
STRESS ON GASTROINTESTINAL PHYSIOLOGY, E. G. Sander. Project 7163(805A), Internal.

The objective of this research is to determine the effect of stress on the functions of the gastrointestinal tract. The functions to be studied are digestion, absorption, blood flow, and food passage.

22.13

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
COMPACT SYSTEM FOR RECORDING MUSCLE POTENTIALS, E. W. Shinabarger. Project 7232(805A), Internal.

The use of muscle potentials as control signals for mechanical devices is being investigated under the bionics effort. Necessary for a workable system is an easy to use, small, convenient system for picking up muscle potentials and amplifying them to a usable level. Several transistorized amplifiers have been designed and fabricated and a unique electrode attachment system developed.

22.14

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
NEW TECHNIQUES OF ANALYSIS OF ELECTROPHYSIOLOGICAL DATA, E. W. Shinabarger. Project 7232(805A), Internal.

The purpose of this study is to determine new methods of data analysis to either obtain additional information from the data, or increase the speed of data reduction. This is accomplished as follows: (1) a technique has been developed to use the analogue electronic correlator to analyze the bioelectric output from the guinea pig's auditory cortex. This technique is being used to separate the spontaneous discharges and slow evoked potential from the pattern of unit pulses associated with a specific audio signal; the technique is developed and in use daily; (2) a pulse height analyzer has been designed and is being constructed; this analyzer is designed to identify the response from a single nerve channel from a group of responses based upon amplitude discrimination; (3) plans are being formed to devise systems which will decipher the pulse interval code of the nervous system. The on-line digital computer is expected to be the key to this problem.

22.15

Biomedical Lab., MRM, AMRL, Dayton, Ohio.
SMALL AMPLIFIER AND TRANSMITTER FOR BIOLOGICAL POTENTIALS TO BE IMPLANTED BENEATH THE SKIN OF SMALL ANIMALS, E. W. Shinabarger. Project 7232(805A), Internal.

The purpose of this study is to permit some electrophysiological studies to be performed without the necessity of restraining the experimental animal. A small transistorized amplifier and FM transmitter is designed and constructed. This unit, together with power source, will be implanted beneath the skin of experimental animals freeing them from any external connections. Power source will be rechargeable without further surgery. Technical specifications for the system extend frequency response and increase input impedance from presently available commercial items.

22.16

Wake Forest Coll., Winston-Salem, N. C.
CONCENTRATION, PURIFICATION AND STUDY OF THE RENAL EFFECTS OF THE URINARY DIURETIC FACTOR, J. M. Little. Project 7220(805A), Contract AF 33(616)-7691; MRM, AMRL.

Through the use of fractions of urinary total nondialyzable solids, attempts will be made to concentrate and purify the diuretic factor in human urine and determine the effects of this factor on renal blood flow, glomerular filtration rate, and tubular reabsorption processes so that the mechanisms of diuretic action may be found.

22.17

Brazil U., Rio de Janeiro.
ELECTROPHYSIOLOGY OF EXCITABLE TISSUES, C. Chagas. Project 9777(805A), Grant AF-AFOSR-61-61; SRL, AFOSR.

Many animals have specialized tissues which perform either unique functions or more common functions with amazing sensitivity. Among the most intriguing

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

of these are the electric fish which apparently can use the electric discharge as an orientational aid. Some, such as the electric eel, can generate truly remarkable voltages which it uses in stunning its prey. The mechanism by which this current is generated is poorly known and the mechanism by which it is utilized for orientation purposes almost completely unknown. In this investigation, attempts will be made to gather more information on both problems, but especially on the latter. This will be done by observing and modifying the actions of the fish both in the laboratory and in the field.

22.18

Brooks Hospital, Inc., Brookline, Mass.
FUNCTION OF ACCESSORY PLANT PIGMENTS IN PHOTOSYNTHESIS, G. C. McLeod. Project 6694(750F), Contract AF 19(604)-8443; CRZA, AFCRL.

The validity of the basic concept that photosynthesis is due to two separate photochemical reactions, each driven by a specific pigment, is being investigated by means of spectrophotometric analysis of algal cells when the ratio of accessory to chlorophyll pigments is altered by a variation in culture conditions. The measurement of photosynthetic rates, action spectra and cell population in the presence of chemical inhibitors is also under study.

22.19

Buenos Aires U. (Argentina).
ULTRA STRUCTURE AND FUNCTION OF THE RETINA, E. De Robertis. Project 9777(805A), Grant AF-AFOSR-61-40; SRL, AFOSR.

This is a combined neurophysiological and morphological analysis of the retina during its development and under stressful conditions. Coordinated studies using the electron microscope, microelectrode recordings, histochemical techniques, and pharmacological analyses will be undertaken to elucidate the structure and function of the different layers of the retina, with particular emphasis on the synaptic strata. Animals having genetic defects of the photoreceptors will also be used.

22.20

California Academy of Sciences, San Francisco.
ASTRONAVIGATION IN MIGRATORY BIRDS, W. J. Hamilton. Project 9777(805A), Grant AF-AFOSR-62-281; SRLA, AFOSR.

Dr. Hamilton intends to carry out observations on the bobolink in the Morrison Planetarium. The bobolink promises to be an interesting species to study because it has a breeding range across the whole North American continent from British Columbia to Nova Scotia yet it assembles in the southeastern part of the U. S. before it proceeds in a single migration front to Argentina. Young individuals from various parts of the breeding range will be exposed to simulated patterns of stars in a planetarium and their responses observed.

22.21

California U., Berkeley.
BIOLOGICAL EFFECTS OF AIR IONS, A. P. Krueger. Project 9777(805A), Contract AF 49(638)-669; SRL, AFOSR.

Air exposed to ultraviolet light, electrical discharges, cosmic rays, or radioactive materials is converted in part to clumps of gaseous molecules bearing an electrical charge. These air ions seem to exert both beneficial and harmful biological effects depending upon the charge and other factors. The nature of these effects and the mechanisms producing them are being investigated.

22.22

California U., Berkeley.
MICROBIOLOGICAL WASTE CONVERSION IN CONTROL OF ISOLATED ENVIRONMENTS, W. Oswald. Project 6694 (750F), Contract AF 19(604)-6637; CRZA, AFCRL.

Perform research on microbiological waste conversion within a balanced biological system. The areas of investigation include: (1) determination of optimum conditions for algal growth; (2) improved design and operation of specialized units to obtain maximum waste treatment; (3) advanced development and operation of a unit, microterella, in which a small animal may be isolated from the external environment with respect to gas exchange, waste disposal and water reclamation.

22.23

Cambridge U. (Gt. Brit.).
NEUROPHYSIOLOGICAL STUDIES OF INSTINCTUAL BEHAVIOR AND LEARNING, W. H. Thorpe. Project 9777(805A), Grant AF-EOAR-62-44; SRLA, AFOSR.

Studies will be made on the behavior of birds under a variety of stimuli. Basically, birds have the same behavioral patterns as mammals despite rather marked differences in the respective anatomical structure of their brains. This investigation will explore the different ways in which similar basic elements in the brains of birds and mammals can combine to produce comparable behaviors.

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22.24

Carnegie Inst. of Tech., Pittsburgh, Pa.
VARIATIONS IN PERCEPTUAL RESPONSES AS A FUNCTION OF ACQUIRED CUES, H. Karn. Project 9778(805A), Contract AF 49(638)-770; SRL, AFOSR.

The specific objective of the proposed research is to determine precisely the manner in which the acquired relevant or meaningful information is established and to relate this to certain states of the organism such as sets, attitudes, motivational factors, prior habits, etc. Visual experiments will be done to determine (1) what conditions tend to minimize variability of perceptual responses, (2) what conditions lead to the greatest efficiency of perceptual responses, and (3) what training procedures or instructions provide optimum conditions for perceptual tasks.

22.25

Centre de la Recherche Scientifique, Gif-sur-Yvette (France).
NUCLEIC ACIDS AND PROTEIN SYNTHESIS IN MICROORGANISMS, B. Nisman. Project 9777(805A), Grant AF-EOAR-62-50; SRLA, AFOSR.

Nucleic acids are directly involved in protein synthesis. Isolated enzyme systems are capable of synthesis, but show no effects from amino acid composition. This is puzzling and the reasons for this failure are the subject of this research. The attack will be based on following the synthesis carried out by isolated bacterial fragments, i.e., subcellular soluble systems from Escherichia coli. After the fragments are isolated, synthesis will be carried out using nucleotides and amino acids, labeled compounds, and gas chromatography.

22.26

Centre National de la Recherche Scientifique, Paris (France).
ELECTROPHYSIOLOGY OF THE APLYSIA GANGLION, A. Arvanitaki-Chalasonitis. Project 9777(805A), Grant AF-EOAR-61-30; SRLA, AFOSR.

In this study Dr. Arvanitaki will employ biochemical, electrophysiological, and cytological techniques in the investigation of the relatively simple somata and the ganglion of the gastropod, Aplysia. These cells are of interest because topological and cytological differentiations permit the recognition of at least 6 giant (up to 1 mm in diameter) cell bodies. Intracelluler recordings have shown that each of these identifiable cells exhibits its own pattern of spontaneous activity. Such patterns resemble those known to occur in central nerve cells of higher animals.

22.27

Chance Vought, Inc., Dallas, Tex.
EFFECTS OF ZERO G ON CELLULAR PHYSIOLOGY, R. McKinney. Project 7220(805A), Contract AF 33(616)-7803; MRM, AMRL.

This research on protoplasmic streaming is designed to determine the effects of zero gravity on cellular physiology and evaluate the postulate that since cells have evolved in an environment of 1 g, absence of this force may alter their physio-chemical equilibrium so that normal metabolic processes are not possible.

22.28

Chicago U., Ill.
APPLICATION OF INFORMATION THEORY TO THE NERVOUS SYSTEM, H. D. Landahl. Project 9777(805A), Grant AF-AFOSR-62-117; SRLA, AFOSR.

This is a biomathematical study of the mechanism by which the retina serves as a transmitter of signals to the central nervous system. The known structures and functions of the retina are being investigated to determine possible information transmitting mechanisms. One aspect is to understand the so-called "bottleneck effect" in which more information can be transmitted to the brain than can be accounted for by the neural channels apparently available.

22.29

Chicago U., Ill.
RELATIONAL APPROACH TO BIOLOGY, R. Rosen. Project 9777(805A), Contract AF 49(638)-917; SRLA, AFOSR.

This represents a mathematical approach to certain qualitative relationships between biology and physics. Until recently, virtually all efforts of mathematical biologists centered about the construction of mathematical models which would give quantitative explanations of biological phenomena. The qualitative relations of biological phenomena were largely ignored. With the introduction of the use of topology in biology, some of these relations become amenable to mathematical attack. This has led to the development of experimentally verifiable conclusions. In this study, the principal investigator plans to continue the topological approach and in addition to use more general and powerful mathematical methods he has developed.

22.30

Chile U., Santiago.
ANATOMICAL BASIS OF PATTERN RECOGNITION, H. R. Maturana. Project 9777(805A), Grant AF-AFOSR-61-44;

AEL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermochemistry Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRMM- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAE- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
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SRLA, AFOSR.

The specific objective of this study is to discover the anatomical reasons in the retina for the electric coding observed in the optic nerve of the frog. Previous work of Dr. Maturana and Dr. Lettvin at MIT has indicated the types of abstractions and coding performed by the retina and show that optic nerves identified with a particular coding operation go to separate areas in the brain. The present study will continue the work on the retina by both anatomical and neurophysiological means.

22.31

Colorado State U., Fort Collins.
EFFECT OF ENVIRONMENTAL STRESS ON ADRENAL-THYROID RELATIONSHIPS, R. M. Johnson. Project 7163(805A), Contract AF 33(616)-7258; MRMP, AMRL.

This is a three-year study to investigate the effect of stress on thyroid-adrenal relationship with accent on mode of interaction. Current work on determining dose levels, and experimental surgery to being done. This work should provide additional data on the mode of interaction between the adrenal and thyroid glands and the specific response of each and their combined responses to environmental stress. Thyroid secretion rates have been determined over a 9-12 month period for 15 experimental animals in a controlled environment. With the removal of one adrenal, the animals are able to maintain relatively normal adrenal function. Upon removal of the second adrenal, the study of effects of adrenal steroids on thyroid function will begin.

22.32

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
PHYSIOLOGY AND NEUROLOGY OF SPEECH PRODUCTION AND PERCEPTION, P. Lieberman. Project 5628(803A), Internal.

Investigate pertinent aspects of the physiology and neurology of the human speaking mechanism and the hearing mechanism. Increase understanding of the role these aspects play and thus gain insights relevant to the analysis and synthesis of speech. Relate data derived from this effort with acoustical and psychological aspects of the total speech production and perception problem.

22.33

Communications Sciences Lab., CRR, AFCRL, Bedford, Mass.
BIOLOGICAL ANALOGUES, E. Prange. Project 5628(803A), Internal.

The aim of this work is to extend the mathematical theory of the nets of formal neurons (threshold devices) of McCulloch. Questions include problems in minimal realizability, reliability, stability, flexibility, adaptivity. For example, with respect to the stability problem it has been shown constructively that for $1 > \epsilon > 0$ and n about ϵ^{-2}, two level nets exist yielding any specified output function of n binary input variables, and such that each neuron of the net is allowed to respond at random on all except a relative frequency ϵ of the 2^n values in its domain. During the past year work has been done on the theory of general amphecks which are defined as single m - ary operations on a finite set S in terms of which every operation on S can be defined, the use of constants not being allowed in the definitions. Two necessary conditions on amphecks have been found that are conjectured to be sufficient.

22.34

Copenhagen U. (Denmark).
PHYSIOLOGICAL MECHANISMS FOR THE RECOGNITION OF THE QUALITY OF SENSORY STIMULI, M. A. Lennox. Project 9777(805A), Contract AF 61(052)-189; SRL, AFOSR.

This work represents an attempt to unravel the mechanism whereby the quality of sensory stimuli is recognized. Single units in the optic tract of various animals will be studied to determine the organization of the visual system required to distinguish colors. The possible role of subcortical mechanisms in this recognition of color or of other sensory stimuli will be explored as well as the site of action of drugs modifying these responses. An understanding of sensory discrimination may allow the development of more effective signals or cues for communication. Knowledge of the central as well as the peripheral mechanisms, may allow understanding of drug or environmental action.

22.35

Cornell U., Ithaca.
METABOLISM OF CARBON DURING PHOTOSYNTHESIS, M. Gibbs. Project 9777(805A), Contract AF 49(638)-798; SRL, AFOSR.

The classical research of Calvin and Benson into the path of carbon in photosynthesis was climaxed with a proposed scheme for the photosynthetic carbon cycle. Such a scheme must be put to all tests before it can be accepted without reservations. Dr. Gibbs' previous work with Kandler has produced data that does not fit this scheme, in that the hexose formed during photosynthesis from $C^{14}O_2$ is asymmetrically labeled. The cause of the asymmetry is unknown. The present work will pursue the problem further, using carbon labeled 3-phosphoglyceric acid.

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22.36

Duke U., Durham, N. C.
MAMMALIAN RESPIRATORY FUNCTION, F. G. Hall. Project 7163(805A), Contract AF 33(616)-6803; MRM, AMRL.

These studies will include effects of direct gas infusion of carbon dioxide into various blood vessels for the purpose of determining if CO_2 neuro-receptors exist in the circulation system. Toxicity and thresholds of narcosis will also be studied together with the mechanisms of elimination CO_2 from the body. Further studies of cardiac output will be made and the effects of various CO_2 concentrations upon the physiological function of animals enclosed in capsules will be explored. The influence of CO_2 on nitrogen elimination in relation to seroembolism will also be investigated.

22.37

Duke U. School of Medicine, Durham, N. C.
PSYCHOPHYSIOLOGICAL MECHANISMS OF STRESS, S. I. Cohen, A. J. Silverman. Project 9778(805A), Contract AF 49(638)-354; SRL, AFOSR.

This research covers the development of multiple-focused techniques for the investigation of the neurophysiological, neurohormonal, and psychophysiologic mechanisms underlying the stress response capability of human beings. It will involve the identification of and focusing on specific physiologic and psychologic factors in order to evaluate the interaction of specific emotional, neurohormonal, and neurophysiologic factors. The ultimate aims are to establish techniques applicable to the evaluation of human tolerance to stressors of any type, and to formulate methods for altering human response to stressful situations.

22.38

Duke U., Durham, N. C.
ELECTROPHYSIOLOGICAL STUDIES OF GLANDULAR SECRETION, S. Thesleff. Project 9777(805A), Grant AF-AFOSR-61-16; SRL, AFOSR.

This investigation is an attempt to study, by complicated electrophysiological techniques, the intra- and extracellular potentials of the nasal gland of certain marine birds. This gland acts as an extra-renal mechanism for electrolyte elimination by excreting a highly hypertonic solution of NaCl following stimulation of its cholinergic nerve, or when given an osmotic load.

22.39

Edinburgh U. (Gt. Brit.).
SMOOTH MUSCLE RESPONSES AS ALTERED BY HUMORAL BACKGROUND, M. Pickford. Project 9777(805A), Grant AF-EOAR-62-79; SRLA, AFOSR.

The existence of the highly potent posterior pituitary hormone, vasopressin, has been known for years. No unequivocal function for this material has yet been established. It is, as its name implies, a potent vascular constructing agent under certain conditions. Under other conditions, especially endocrine ones, vasopressin either has little constrictive effect or may actually dilate blood vessels. Just how this is possible and the mechanisms involved will be studied in a variety of animal species with various endocrine backgrounds. Especial attention will be directed towards the effects of vasopressin in males and toward effects in females under oophorectomy, estrogen therapy and other controlled conditions.

22.40

Edinburgh U. (Gt. Brit.).
VASCULAR SYSTEM RESPONSES IN RELATION TO THE HORMONAL BACKGROUND, M. Pickford. Project 7220(805A), Contract AF 61(052)-272; MRMA, AMRL.

This contract calls for the investigation of the cardiovascular system responses in relation to variations in hormonal background. The work will attempt to determine the site of action on the vascular system of estrogens, progestrone, oxytocin, and the vascular response to testosterone and vasopressin under varying conditions. Present work considers the effects of posterior pituitary hormones and estrogens on the vascular system in male and female animals of several species (rat, cat, dog and fowl). Modifications of the effects of nervous destruction and nervous blocking agents have continued. Direct observation of the peripheral blood flow in the anesthetized dog are underway using both the naturally supplied and cross-circulated hind limb and intra-arterial and intravenous injections of the hormones mentioned above. Differences relating to both the species and the sex of the animals have been observed, as well as differences in injections of the same hormones.

22.41

Florida State U., Tallahassee.
PHOTOBIOLOGY AND PHOTOCHEMISTRY, H. Gaffron. Project 9777(805A), Grant AF-AFOSR-62-190; SRLA, AFOSR.

The implications of photosynthesis in a variety of areas are now well recognized. The unique ability of plants to convert solar energy to chemical energy offers hope that this process may ultimately be reproduced synthetically to the benefit of

agriculture, medicine, and the military. More immediate applications of military significance lie in the utilization of CO_2 and the concomitant evolution of O_2. Before such steps are practicable, it will be necessary to amass considerably more data on the basic mechanisms involved; particularly on the initial photochemical steps.

22.42

Genoa U. (Italy).
RELATION BETWEEN THE BRAIN STEM AND ELECTROCORTICAL ACTIVITY, G. F. Rossi. Project 9777(805A), Contract AF 61(052)-461; SRLA, AFOSR.

It is known that the electrical activity of the cortex can be controlled, in part at least, by more primitive, sub-cortical areas. A large, poorly defined area known as the reticular formation appears to control the state of consciousness of the animal, causing an "arousal" or increased attentiveness upon its stimulation. There is some evidence that lower brain stem structures compete with the reticular activating system to modify its influence on the brain. The present studies are aimed at exploring this portion of the brain stem to localize such modifying structures. The electrical events of the brain will be followed when various subcortical areas are stimulated in the same animal in very different conditions, ranging from full alertness to the sleeping state. If sites causing changes can be found, parallel studies on the animal's behavior during stimulation will be initiated.

22.43

Georgia U., Athens.
CHEMICAL AND ENZYMATIC STUDIES ON THE CONVERSION OF CHEMICAL ENERGY TO LIGHT, J. R. Totter. Project 9777(805A), Grant AF-AFOSR-62-73; SRLA, AFOSR.

This work is concerned with the changes, which occur in certain chemicals under the actions of enzymes, which lead to emission of light. Since this is an exceedingly sensitive technique, it may allow more precise determination of enzymatic actions and hence biological conservation of energy. In some ways, these reactions may represent reversal of usual enzymatic effects.

22.44

Georgia U., Athens.
COMPUTER ANALYSIS OF BIO-ELECTRIC RESPONSE PATTERNS, H. Zimmer. Project 9779(805A), Grant AF-AFOSR-62-110; SRLB, AFOSR.

The contract will attempt to identify and isolate trustworthy indicators of reaction to stimuli out of the range of awareness of the human organism. If this effort is successful, it will furnish the means and apparatus for computer analyses of bioelectronic data necessary to obtain an inventory of the information possessed by an individual, while this person remains unaware that he has thus revealed himself. The effectiveness of a number of different stimulus conditions and motivational states will be studied to ascertain their success in eliciting involuntary reactions to stimuli ranging from subliminal to supraliminal.

22.45

Gothenburg U. (Sweden).
SYNTHETIC AND METABOLIC PATHWAYS, A. Carlsson. Project 9777(805A), Grant AF-EOAR-61-44; SRLA, AFOSR.

Adrenaline in the body is synthesized via the pathway: dihydroxyphenylalanine (DOPA) to its decarboxylated produce (DOPAMINE) to noradrenaline to adrenaline. Although the latter compounds have been investigated exhaustively and are recognized to have profound physiological actions, little is known of dopamine. It is generally dismissed as serving merely as a precursor of adrenaline and noradrenaline. Recent work suggests that this is not the case and that dopamine may have important physiological functions of its own. This study is aimed at uncovering such a role. The formation, storage, and transformation of dopamine in brain will be followed, and drugs having a selective action on dopamine levels will be sought.

22.46

Gottingen U. (Germany).
RADIO TRANSMITTED UNIT ACTIVITY IN THE BRAIN STEM, R. Von Baumgarten. Project 9777(805A), Contract AF 61(052)-470; SRLA, AFOSR.

These studies will extend knowledge of the way the central nervous system receives and interprets signals from receptors in the viscera.

22.47

Harvard U., Cambridge, Mass.
ELECTRICAL STUDIES OF CORTICAL BEHAVIOR, D. H. Hubel. Project 9777(805A), Grant AF-AFOSR-62-76; SRLA, AFOSR.

Micro-electrode studies will be made from precise sites in the brain in conscious, unrestrained, unanesthetized animals. The influence of various behavioral states (attention, state of wakefulness, anxiety, pain, etc.) on the unit responses will be determined. The current research is concentrating on the visual cortex.

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SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRE- Electronic Research Directorate
CREB- Computer & Mathematical Sciences Lab
CREC- Electronic Material Sciences Lab
CRED- Electromagnetic Radiation Lab
CREI- Astroscurveillance Sciences Lab
CREL- Propagation Sciences Lab
CRES- Communications Sciences Lab
CRET- Control Sciences Lab
CRI- Geophysics Research Directorate
CRIA- Photochemistry Lab
CRIC- Thermal Radiation Lab
CRIE- Research Instrumentation Lab
CRIG- Terrestrial Sciences Lab
CRIM- Meteorological Research Lab
CRII- Ionospheric Physics Lab
CRIR- Sacramento Peak Observatory

22.48

Harvard U. Medical School, Boston, Mass., Massachusetts Mental Health Center, Boston.
RELATIONSHIPS BETWEEN BEHAVIORAL AND PHYSIOLOGICAL RESPONSES TO SENSORY DEPRIVATION, H. J. Liederman. Project 7220(805A), Contract AF 33(616)-6110; MRM, AMRL.

This contract has as its purpose the study of disruptive mental changes that often occur with a qualitative and quantitative reduction in sensory stimulation. The research includes the effects of sensory deprivation on verbal, motor, autonomic and behavioral responses of individual subjects. The deprivation are primarily caused by subject or situation variables. Since subjects employ various modes of adaptation, present emphasis is placed on exploring the psychological and physiological responses under repeated experiments. This will allow a more precise delineation of responses resultant from reduced stimuli and those from the subject.

22.49

Harvard U., Cambridge, Mass.
HYPOTHALAMIC SECRETORY FACTOR FOR ADRENOCORTICOTROPIC HORMONE, P. L. Munson. Project 9777(805A), Grant AF-AFOSR-62-212; SRLA, AFOSR.

The objective of this research is the elucidation of the mechanisms involved in regulating the rate of secretion of the adrenocorticotropic hormone (ACTH) from the pituitary. This hormone plays an important role in controlling man's response to a variety of stressful conditions. A neural hormone has been postulated to be secreted by the hypothalamus and to stimulate ACTH liberation from the pituitary. Attempts will be made to extract and purify this hormone.

22.50

Hebrew U. (Israel).
LIGHT INTERMITTENCY AND PHOTOSYNTHETIC YIELDS IN THE MASS CULTURE OF ALGAE, A. M. Mayer. Project 6694 (750F), Contract AF 61(052)-546; CRZA, AFCRL.

The improvement of the efficiency of algae production. Research includes the following studies on the mass culture of algae: (1) light intermittency of light and dark which will give maximal yields of algae; (2) physical characteristics of algae such as surface properties, settling and electrical behavior; (3) engineering problem of the economic removal of algae from the growth solution.

22.51

Henri Rousselle Hospital (France).
RELATION OF THE VISCERAL AFFERENTS ON THE ACTIVITY OF THE BRAIN STEM RETICULAR FORMATION, P. C. Dell. Project 9777(805A), Contract AF 61(052)-229; SRL, AFOSR.

The general hypothesis under investigation is that those portions of the reticular formation exercising somatic control are related to portions controlling the autonomic system. The effects of altered activity in cardiac, venous, and pulmonary afferents upon the reticular formation will be studied.

22.52

Illinois U., Urbana.
ANALYZING PRINCIPLES OF THE MAMMALIAN AUDITORY SYSTEM, H. Von Forester. Project 7232(805A), Contract AF 33(616)-6428; MRMA, AMRL.

The contractor will continue his work on the formulation of principles permitting the construction of a working model of the mammalian auditory system. The desired goal of this research is to design an electrical, electro-mechanical, mechanical, or other analyzer utilizing the methods and techniques of man's auditory system, achieving equally good frequency analysis and transient characteristics.

22.53

Illinois U., Urbana.
ELECTRON MICROSCOPY OF ULTRASONICALLY IRRADIATED MUSCLE, W. J. Fry. Project 9777(805A), Grant AF-AFOSR-62-128; SRLA, AFOSR.

It is proposed in this study to irradiate muscles with precisely controlled doses of high intensity ultrasound. The effects of the sound on the mechanical properties and on the electrical characteristics will be correlated with information determined from the electron micrographs. Advantage will be taken of the ability of the sound field to increase the temperature of a predetermined volume of the muscle to a desired value. Comparisons can then be made with similar tissue heated to the same temperature by other means.

22.54

Indiana U., Bloomington.
ACCOMMODATION AND CONVERGENCE RELATIONSHIP, M. J. Allen. Project 7163(805A), Contract AF 33(616)-6146; MRVP, AMRL.

The research will include pre-school children, middle age, and presbyopic age groups in an attempt to investigate the developmental stages of accommodation and convergence. Convergence-accommodation and accommodative-convergence measurements, reaction

time and speed of reaction, and the linearity of the relationship are presently being investigated. The development of an infrared optometer-haploscope resulted in a highly sensitive and reliable instrument.

22.55

Institute of Occupational Health, Helsinki (Finland).
THERMAL EXCHANGES OF THE HUMAN BODY IN EXTREME HEAT, M. J. Karvonan. Project 7220(805A), Grant AF-EOAR-62-31; MRMB, AMRL.

To provide data on thermal exchanges of the resting nude subject at high environmental temperatures using the Finnish Sauna Bath as a physiologic tool to determine the quantity and distribution of the heat load on skin and respiratory surfaces of subjects exposed to severe and rapidly changing environmental heat stresses. Variables of air temperature, humidity, air movement and radiant temperature are correlated with physiological variables including rectal, mediastinal, intracranial, average skin and body temperatures and metabolism.

22.56

Instituto de Investigacion de Ciencias Biologicas (Uruguay).
NEURONE REGENERATION AND NEUROPHYSIOLOGY OF WAKEFULNESS, SLEEP AND HYPNOSIS, C. Estable. Project 9777 (805A), Grant AF-AFOSR-61-64; SRL, AFOSR.

This contract is concerned with two basic aspects of neurophysiology: the mechanisms by which neurones regenerate, and the processes accounting for different behavioral states in the animal. The former problem will be explored by simultaneous physiological, biochemical, and electron microscopic studies on regenerating nerves. Attempts will be made to discover common features of different regenerating neurones, the intrinsic factors influencing regeneration, and the effects of a variety of substances (extracts, hormones) on the regenerating cells. The second portion of the program will attempt to establish mechanisms involved in the maintenance of wakefulness and reactivity. Animals with implanted electrodes will be conditioned to a tone and their behavior and electroencephalographic responses observed during sleep, wakefulness, and hypnosis.

22.57

Instituto de Neurologia (Uruguay).
ATTENTION, HABITUATION AND CONDITIONING AS RELATED TO EVOKED BRAIN WAVES, R. Arana-Iniguez. Project 9777(805A), Grant AF-AFOSR-61-65; SRL, AFOSR.

When a sensory input is made to the body such as a touch or a flash of light, a transient evoked potential occurs on the scalp, but one stimulus evokes such a minute change that it is lost in the much higher amplitude brain wave that is going on continuously. By a special technique in which a series of flashes of light are given, the background brain wave can be averaged out and the single minute evoked potentials added to make a clearly observable reading both as to location and as to time relation to the stimulus. With this technique a valuable tool is available to relate brain phenomena with psychological phenomena, or with the action of drugs. This study will explore the use of evoked potentials in normal subjects during the course of variable attention, habituation and conditioning.

22.58

Instituto Superiore di Sanita (Italy).
CENTRAL ACTION OF ADRENERGIC-BLOCKING DRUGS, F. R. Domer. Project 9777(805A), Contract AF 61(052)-469; SRL, AFOSR.

The correlation of pharmacological activity with chemical structure is not only interesting from a theoretical viewpoint, but also promises the possibility of tailoring drugs for specific purposes. Such correlation requires the study of various compounds with marked pharmacological action. In this study, a group of benzodioxane compounds are being used to produce marked effects in the central nervous system.

22.59

Instituto Superiore di Sanita (Italy).
EFFECT OF DRUGS ON CENTRAL NERVOUS SYSTEM NEURONS, V. G. Longo. Project 9777(805A), Contract AF 61 (052)-399; SRLA, AFOSR.

The effects of a number of drugs on the interneurones of the spinal cord will be studied. Attempts will be made to develop a procedure for testing the effects of these drugs on spontaneous and induced single cell activity. For the most effective use of drugs it is necessary to localise their action with as great a precision as possible. This study aids in such an objective and at the same time should increase our understanding of the pathway of nervous transmission.

22.60

Johns Hopkins U., Baltimore, Md.
EFFECT OF REDUCED PRESSURE OR OXYGEN ON GUT ABSORPTION, B. F. Chow. Project 9777(805A), Grant AF-AFOSR-62-137; SRLA, AFOSR.

This study is a continuation based on data which indicate certain marked changes in absorption from

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRE- Geophysics Research Directorate
CREA- Photochemistry Lab
CREC- Thermal Radiation Lab
CREE- Research Instrumentation Lab
CRES- Terrestrial Sciences Lab
CREW- Meteorological Research Lab
CREI- Ionospheric Physics Lab
CRER- Sacramento Peak Observatory

the gut under conditions of low barometric pressure, low oxygen partial pressure or normal oxygen pressure with low total pressure. Additional information indicates that some but not all of the effects on absorption may be reversed by crude pituitary extracts, but by no known pure extracts.

22.61

Johns Hopkins U., Baltimore, Md.
MOLECULAR BASIS OF MUSCLE MECHANICS STUDIED BY PARAMAGNETIC ELECTRON RESONANCE TECHNIQUES, J. P. Isaacs. Project 9777(805A), Contract AF 49(638)-580; SRL, AFOSR.

This study will support an exploratory effort to detect free radical formation in an active muscle preparation. If this effort is successful a variety of biochemical variables can be altered in the preparation and experiments designed to test some of Dr. Isaacs' ideas about the molecular basis of muscle mechanics.

22.62

Johns Hopkins U., Baltimore, Md.
SINGLE UNIT STUDIES OF CORTICAL AND SUBCORTICAL FUNCTION IN UNRESTRAINED ANIMALS, V. Mountcastle. Project 9777(805A), Grant AF-AFOSR-62-31; SRLA, AFOSR.

Investigations of single unit activity in the brains of unanesthetized and unrestrained chronically prepared animals will be made with the following specific objectives in mind: (1) to examine spontaneous activity of single units in various cortical and subcortical areas and to relate changes in this activity with changes in the states of wakefulness; (2) to ascertain, for each region studied, those types of physiological stimuli which are most effective in influencing the discharges of units, and to study the influence of behavioral states (attention, state of wakefulness, etc.) on these responses; and (3) to correlate the activity of single units with slow waves obtained with large electrodes, in various states of arousal.

22.63

Karolinska Inst. (Sweden).
BIOPHYSICAL AND NEUROPHYSIOLOGICAL STUDIES OF NERVE CELL ACTIVITY, C. G. Bernhard. Project 9777(805A), Grant AF-EOAR-62-13; SRLA, AFOSR.

This investigation is to relate function with structure in the nervous system. Particular emphasis will be given to the relationship of the chemical and ultra-structural organization of certain nerve units such as junctional transmission mechanism and receptors such as olfactory epithelium. Neurophysiological studies will be made to explore, with extra- and intra-cellular microelectrodes, the function of individual brain cells in relation to behavior.

22.64

Kaiser Foundation Research Inst., Richmond, Calif.
PIGMENT SYSTEMS OF PHOTOSYNTHETIC ORGANISMS, M. B. Allen. Project 6694(750F), Contract AF 19(604)-6636; CRZA, AFCRL.

Study the pigment systems of photosynthetic organisms and their mutants; determine the composition of different pigment systems; investigate the function of these pigments within the photosynthetic organism by means of absorption, action and electron paramagnetic resonance spectra.

22.65

Karolinska Inst. (Sweden).
MEASUREMENT OF O_2 SATURATION OF ARTERIAL BLOOD IN THE HUMAN DURING PROLONGED ACCELERATION, H. Bjurstedt. Project 7220(805A), Contract AF 61(052)-153; MRM, AMRL.

This work effort involves the measurement of oxygen and carbon dioxide exchange in subjects exposed to prolonged accelerations (positive and transverse) and specifically, the measurement of oxygen saturation of the arterial blood, as well as concentrations of oxygen and carbon dioxide in the alveolar air. The techniques and experimental data obtained should be applicable to the establishment of objective physiologic indices of human tolerance of accelerations in various vectors.

22.66

Karolinska Inst. (Sweden).
CORRELATION OF ION EXCHANGE COLUMN WITH MOLECULAR STRUCTURE OF BONE, D. Carlstrom. Project 9777(805A), Grant AF-EOAR-62-11; SRLA, AFOSR.

In this study, bone is compared with an ion exchange column in which ions can be rapidly taken up and released. This mechanism may be highly important in regulation of ionic balance. By using micro techniques, largely developed in this laboratory, it is proposed to examine the structure of bone under normal and stressful conditions. The molecular structure of ionic regulating areas in bone will be studied. Bone will be implanted and transplanted in animals for long periods and the ultrastructural organization observed during these periods.

22.67

Karolinska Inst. (Sweden).

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronic Systems Division
ESER- Operational Applications Lab

BRAIN STEM MECHANISMS REGULATING AUTONOMIC ACTIVITIES, U. Soderberg. Project 9777(805A), Contract AF 61 (052)-119; SRL, AFOSR.

The relationship between central nervous and autonomic activities is under study. The brain and certain peripheral nerves are stimulated and the response of various organs measured. Indices of this activity have been developed by measuring hormonal and cardiovascular events as related to the electrical activity of the brain. Hormonal secretion after stimulation or after stress will be determined as well as changes in kidney function, and in blood flow through the cerebrum, skin, and muscle.

22.68

Karolinska Inst. (Sweden).
SYMPATHETIC VASODILATOR OUTFLOW, B. Uvnas. Project 9777(805A), Contract AF 61(052)-502; SRL, AFOSR.

Dr. Uvnas hypothesizes that sympathetic vasodilator impulses to skeletal muscle may open up parascapillary (non-nutritional) channels in the skeletal muscles. The vasodilator outflow might take part in a centrally governed reaction pattern leading to a shift of blood from nutritional to non-nutritional vessels in the muscles at the same time as anaerobic muscular metabolism is stimulated by the discharge of adrenaline from the adrenal medulla. Experiments will be performed on animals and humans with recording of blood flow, oxygen consumption, lactic acid production, etc., under circumstances when the sympathetic vasodilator activation and a reaction pattern as discussed above might be expected to occur; e.g., emergency conditions, flight and flight reactions, emotional reactions, suffocation, fainting, etc.

22.69

Karolinska Inst. (Sweden).
DISTRIBUTION OF BIOLOGICALLY ACTIVE COMPOUNDS IN THE BODY, U. S. Von Euler. Project 9777(805A), Grant AF-EOAR-62-14; SRLA, AFOSR.

Certain compounds in the body produce profound physiological effects in minute concentrations. Among these are the catechol amines, particularly adrenaline and noradrenaline. These substances seem to play a vital role in the regulation of various body processes. Knowledge of their biosynthesis, storage, and release is necessary to understand their action and control. Certain drugs and other factors cause marked behavioral and psychological effects. These alterations are accompanied by corresponding changes in the catechol amine stores in the brain and other organs.

22.70

Kerchoff (W. G.) Inst. (Germany).
CARDIAC PRESSORECEPTORS, O. Gauer. Project 7163 (805A), Contract AF 61(052)-541; MEMP, AMRL.

This study is research to locate coronary pressoreceptors and determine the stimuli and reflex pathway of the receptors.

22.71

Kerchoff (W. G.) Inst. (Germany).
MECHANISM INVOLVED IN VOLUMETRIC CONTROL OF BODY FLUIDS, O. H. Gauer. Project 9777(805A), Contract AF 61(052)-31; SRL, AFOSR.

This investigation is aimed at a better understanding of the control of body fluids under stressful conditions. Stretching of the left atrium has been shown to cause a diuresis. Other studies have emphasized the role of sodium balance in volume regulation. In this study, an attempt will be made to determine the precise conditions under which distention of the intrathoracic receptor areas causes a change in sodium excretion and vice versa.

22.72

Kentucky U., Lexington.
PHYSIOLOGICAL MECHANISMS INVOLVED IN TOLERANCE TO AEROSPACE FLIGHT ENVIRONMENTS, L. D. Carlson. Project 7220(805A), Contract AF 33(616)-8414; MEMB, AMRL.

The contractor will conduct research on the physiological mechanisms influencing human responses to hypodynamic environments and the subsequent return to normal conditions, changes in the respiratory mechanisms during acceleration and their effect on human tolerances and the mechanisms of human body temperature regulation during exposure to thermal extremes peculiar to aerospace flight. At the completion of each work phase the contractor will reduce, analyze and present the data obtained.

22.73

Laval U. (Canada).
NEUROHUMORAL CONTROL OF THYROTROPIC ACTIVITY, C. Fortier. Project 9777(805A), Grant AF-AFOSR-62-6; SRLA, AFOSR.

This is an investigation of the nervous or chemical control of the pituitary, and how it in turn controls the hormonal secretion of the glands. The secretion of thyrotropic (TSH) hormone by the pituitary will be used as a model. The adjustment of

TSH secretion to the varying metabolic requirements or the organism will be explored. Consideration will be given to TSH release and synthesis during stress, drug administration, and thyroidectomy. These experiments will be done in the intact and adrenalectomized animal and in those with hypothalamic lesions.

22.74

Leicester U. (Gt. Brit.).
METABOLISM OF SIMPLE CARBON COMPOUNDS IN MICRO-ORGANISMS, H. L. Kornberg. Project 9777(805A), Grant AF-EOAR-61-12; SRLA, AFOSR.

Using radiochemical techniques, Kornberg proposes to obtain information on the nature of the metabolic routes whereby micro-organisms satisfy their needs both for energy and for the carbon precursors of cellular constituents. He will also study the influence of environmental change (particularly the presence or absence of oxygen, and the composition of the nutrient media) on the functioning of such metabolic routes. He will then apply the information obtained to gain an understanding of the processes which regulate the simultaneous operation of anabolic and catabolic pathways in living cells.

22.75

Liege U. (Belgium).
MECHANISM OF NERVOUS INTEGRATION, J. Schlag. Project 9777(805A), Contract AF 61(052)-22; SRL, AFOSR.

The major problems to be attacked in this contract are the control of cortical activity by subcortical structures, the generation of spontaneous electrical rhythms in the electroencephalogram (EEG), and the role played by spontaneous activity in the central nervous integration . Analysis will be made of the complex excitatory-inhibitory pattern of unit firing seen in the reticular formation during EEG activation. These investigations point to the mechanisms by which brain activity originates and is integrated.

22.76

London U. (Gt. Brit.).
FUNCTION OF THE INNER EAR, F. C. Ormerod. Project 9777(805A), Grant AF-EOAR-62-2; SRLA, AFOSR.

The objective of this research is to elucidate the mechanism by which physical energy is transformed into nerve activity within the inner ear, particularly of the vestibular portion. The composition of the intimate structures of this area will be investigated, as well as the nature of their secretory products. Chemical substances known to alter the function of the inner ear will be applied and their effects on the secretory epithelium explored by isotopic techniques. Physiological and histological changes after degeneration of certain nerve fibers will be followed. These experiments will be done in various normal, injured, and congenitally abnormal animals.

22.77

Louvain U. (Belgium).
RESPONSE TO PAIN, J. Colle. Project 9777(805A), Contract AF 61(514)-1101; SRL, AFOSR.

These studies concern the role of central nervous processes in the response to pain. The response to painful stimuli is studied by measuring simultaneously the objective reactions, psychogalvanic response, electrocardiogram, electroencephalogram, and respiration.

22.78

Librascope, Inc., Glendale, Calif.
ANALOGICAL SIMULATION OF NEURAL BEHAVIOR, R. F. Reiss. Project 9777(805A), Contract AF 49(638)-1021; SRL, AFOSR.

This work will follow four main lines of investigation and study: (1) digital simulation studies of nerve nets -- a flexible digital simulation program will be constructed incorporating all know behavioral and structural characteristics of cardiac neurons of lobsters. This system will be used for formulating and discovering the logical consequences of neural hypothesis which can then be tested by physiological experiments at UCLA; (2) analogical simulation of neural behavior -- an attempt to uncover concepts and techniques which may eventually lead to the development and evaluation of a fundamentally new and powerful class of research tools which can be profitably used to study structure-function relations in neuromuscular type mechanisms; (3) studies of the behavior and possible roles of arrays of mutually inhibiting hypothetical neurons; (4) a study of hypothetical nerve nets for the control of antagonistic pairs of effectors -- a hypothetical nerve net will be coded for execution of a LGP-30 computer. This effort will require the formation of precise but flexible algorithms for the temporal integration of input pulses and fatigue (adaptation) in the hypothetical elements.

22.79

Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
MECHANICS OF VENTILATION AND OF PULMONARY GAS EXCHANGE IN MAN DURING STRESS, J. Muxworthy. Project 9777(805A), Grant AF-AFOSR-61-35; SRL, AFOSR.

AFL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARR- Thermomechanics Research Lab
ARS- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab
ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
ESD- Electronics Systems Division
ESER- Operational Applications Lab

The object of this research is the pulmonary gas exchange under conditions of stress and trauma. The parameters to be evaluated are the rates of gas flow, intrathoracic pressure, total ventilation, alveolar pCO_2 and pO_2 and arterial venous blood gas concentrations. These measurements are to be made under conditions of stress, i.e., during surgery and anesthesia and under controlled conditions in man. The ventilation will be controlled by the use of the Engstrom respirator and anesthesia machine. An attempt will be made to evaluate the effect of stress on various pulmonary lesions, crushing injuries of the chest and head injuries.

22.80

Lund U. (Sweden).
EFFECTS OF ACETYLCHOLINE ON THE MAMMALIAN MOTOR END PLATE, S. Thesleff. Project 9777(805A), Grant AF-EOAR-62-28; SRLA, AFOSR.

This is an investigation of the effects of acetylcholine on the motor end-plates of mammalian muscles, using the electrophoretic micro application technique. The kinetics of the drug end-plate interaction will be studied. Finally, various neuromuscular blocking drugs will be testing in similar fashion to learn their interaction with acetylcholine.

22.81

Marseille U. (France).
AUTOMATIC ANALYSIS OF BRAIN WAVES, H. Gastaut. Project 9777(805A), Contract AF 61(052)-20; SRL, AFOSR.

A critical study of what is effectively a "new language" of the brain wave and exploration of its potential application to studies of human performance. This development offers the promise of a far more sensitive indicator than heretofore available, to the brain wave events correlated with states of consciousness and responses to stress.

22.82

Marseille U. (France).
NEUROPHYSIOLOGICAL MECHANISMS OF SKILLED MOVEMENTS IN MAN, J. Paillard. Project 9777(805A), Contract AF 61(052)-95; SRL, AFOSR.

A newly perfected technic of monosynaptic testing of the lower motoneurone in man will be used to study the regulations taking place at the level of the tension receptors (muscle spindles) via the motor system of gamma fibers. Investigations into the problems of motor control with reference to the activation of the alpha motoneurones will be extended to man. Attempts will be made to explain the manner in which voluntary commands control the motor mechanism of the spinal cord.

22.83

Massachusetts General Hospital, Boston.
BEHAVIOR AND PERFORMANCE, M. A. Brazier. Project 9777(805A), Contract AF 49(638)-98; SRL, AFOSR.

This is a multidisciplinary study in which the biochemical and physiological processes underlying human behavior will be explored. Dr. Ames will continue his studies on the biochemical and electrophysiological characteristics of excised retina. Dr. Anliker will continue his studies of suggestibility and sleep.

22.84

Massachusetts Inst. of Tech., Cambridge, Mass.
NEURAL NETWORKS, W. C. McCulloch. Project 7232 (805A), Contract AF 33(616)-7883; MRMA, AMRL.

This contract will provide an experimental and theoretical investigation of biological neural nets. Particular emphasis will be devoted to the study of the high reliability of biological systems.

22.85

Massachusetts Inst. of Tech., Cambridge, Mass.
COMPARATIVE INVESTIGATIONS OF NEURAL OPERATORS, L. Stark. Project 7232(805A), Contract AF 33(616)-7588; MRMA, AMRL.

The contractor is presently developing new techniques for processing single nerve cell data with automatic digital equipment in order to classify the types of neurons on the basis of their response to different input light functions. Studies are under way to determine the manner in which information is coded and how the code is employed by each of the functional types of single nerve cells. The goal of this research is to derive a model of the neural information channel and to explore the parameters affecting its performance as a general communication channel.

22.86

Massachusetts Inst. of Tech., Cambridge.
SENSORY MECHANISMS, L. Stark. Project 9777(805A), Contract AF 49(638)-1130; SRLA, AFOSR.

Dr. Stark proposes to bombard the nervous systems of various test animals (ranging from crayfish and land-crabs, to cats) with a number of sensory inputs such as light, stretch, rotation, etc. The interaction between these sensory inputs, and especially their mutual facilitation and inhibition, will be studied from both a neurophysiological and communications sciences point of view. He is studying the interactions between proprioceptive stimuli and

light stimuli in the crayfish. Another type of study underway is a quantitative evaluation of noise summating to the response of the pupillo motor system.

22.87

Massachusetts Mental Health Center, Boston.
EFFECTS OF PROLONGED, ATYPICAL, SENSORY DEPRIVATION INPUT ON PERFORMANCE, S. J. Freedman. Project 9778 (805A), Grant AF-AFOSR-62-11; SRLB, AFOSR.

This work is part of a program of research on the effects of human isolation and limited sensory input on performance. It aims to describe and measure, as precisely as possible, the visual, auditory, and visual-motor disturbances produced by prolonged sensory deprivation; and to describe how different aspects of the deprivation situation are related to the measured effects. Subjects are tested for responsivity of their brain waves to intense, rhythmically flashing light. The results will be compared with test information on the same subjects for response to limited sensory deprivation.

22.88

Massachusetts Inst. of Tech., Cambridge.
HIGH ENERGY METABOLITES, S. A. Goldblith. Project 7163(805A), Contract AF 33(616)-6008; MRM, AMRL.

This is the third phase of a continuing effort to develop new sources of metabolic energy which will not promote ketosis. From this study several new compounds have proved to be suitable as possible carbohydrate replacements. These compounds have been shown to be utilized in a similar manner as carbohydrate but have a higher energy density. Palatability of these compounds appears to be a problem which will have to be circumvented. A branched chain of fatty acid has been synthesized which will theoretically act as a fat replacement without producing ketosis. A small animal calorimeter has been constructed which will prove invaluable in determining the metabolizable energy value of new high energy metabolites.

22.89

Massachusetts Inst. of Tech., Cambridge.
BEHAVIORAL ACTIVITIES RELATED TO PERCEPTUAL DEPRIVATION, R. Melzack. Project 9777(805A), Contract AF 49(638)-898; SRL, AFOSR.

Animals raised under environmental conditions restricting their perceptual experiences have shown profound disturbances in their emotional, perceptual, social, and intellectual development. This investigation is to explore the nature of the physiological disturbances that underlie such abnormalities. This will be done by simultaneous studies of the behavioral and the physiological patterns in cats raised under varying types of perceptual restrictions.

22.90

Massachusetts U., Amherst.
EFFECTS OF ENVIRONMENTAL FACTORS ON HUMAN PERFORMANCE, W. H. Teichner. Project 9778(805A), Grant AF-AFOSR-62-202; SRLB, AFOSR.

The goal of this research program is to investigate stresses, particularly noise, glare, monotony, and illumination; develop scales of discomfort, together with ratios of physical intensities of environmental conditions, and from these data develop a theory which can serve as the basis for the design of equipment, and the selection and modification of personnel by various means for these stressful situations.

22.91

Maudsley Hospital (Gt. Brit.).
NEUROENDOCRINOLOGY, G. W. Harris. Project 9777(805A), Contract AF 61(052)-454; SRL, AFOSR.

This investigation is designed to map out some of the forebrain pathways involved in the control of the anterior lobe of the hypophysis. The hypothalamus and parts of the cerebral cortex will be stimulated with permanently implanted electrodes and the release of the adrenocorticotropic (ACTH) and of the thyrotropic (TSH) hormones from the pituitary will be measured.

22.92

Maudsley Hospital (Gt. Brit.).
CHEMICAL FACTORS IN EXCITATION OF CEREBRAL TISSUES, H. McIlwain. Project 9777(805A), Grant AF-EOAR-62-4; SRLA, AFOSR.

Function of the brain must ultimately be explained on the basis of chemical changes within this intricate organ. However, it is difficult to extrapolate findings on the isolated, macerated or sliced tissue to its action in the living animal. The investigator has developed a technique which overcomes some of these difficulties by analysing brain slices which can be artifically stimulated. In this way, too, electrophysiological studies can be made on the isolated slices. This allows a correlation between the chemical processes and such neurophysiological indices as resting potentials, and excitability in isolated tissues.

22.93

Max-Planck-Institut fuer Zellchemie (Germany).
BIOSYNTHETIC MECHANISMS INVOLVED IN THE FORMATION OF TERPENES AND TERPENE DERIVATIVES, F. Lynen. Project

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
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AFWC- Air Force Special Weapons Center
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PGBL- Ballistics Directorate
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9777(805A), Contrac t AF 61(052)-251; SRLA, AFOSR.

Compounds having a terpene-like structure are ubiquitous in nature and are undoubtedly of great biological significance. Examples of these are vitamins D, K, and E, various carotenoids, and coensyme C. Furthermore, the formation of cholesterol in the body -- presumably other steroids as well, occurs by way of mevalonic acid, a vital intermediate in terpene biosynthesis. The studies proposed in this contract should provide a solid basis for understanding the biosynthesis of this of this highly important group of compounds. By learning the ensymatic processes involved, it should be possible to stimulate or inhibit certain specific steps which might have far reaching implications. For example, inhibiting the production of cholesterol could be important in the treatment of atherosclerosis.

22.94

Max-Planck, Institut fuer Biologie (Germany).
INFORMATION PROCESSES IN BIOLOGICAL SYSTEMS, W. Reichardt. Project 9777(805A), Grant AF-EOAR-62-41; SRLA, AFOSR.

Simple biological systems such as the visual tract of insects will be used as biological models for the study of information processing. The methods by which this relatively primitive system can gain information of surprising sophistication will be analyzed.

22.95

Milan U. (Italy).
THORACO ABDOMINAL MECHANICS DURING POSITIVE PRESSURE BREATHING, E. Agostoni. Project 7163(805A), Grant AF-EOAR-12-95; MEMP, AMRL.

These studies will include a literature survey for existing information on thoraco abdominal mechanics. Investigative studies will include thoraco abdominal mechanics during normal and positive pressure breathing studying (a) transdiaphragmatic and transthoracic pressure, (b) development of a diagram plotting transdiaphragmatic pressure versus lung volume, (c) nervous control of the diaphragm, (d) mechanical behavior of the inspiratory muscle and the diaphragm.

22.96

Naples U. (Italy).
NEURAL MECHANISMS OF CEREBELLAR FUNCTION, V. Braitenberg. Project 9777(805A), Grant AF-EOAR-62-8; SRLA, AFOSR.

The objective of this investigation is to show that the cerebellar cortex acts as a timing organ. The available clinical and electrophysiological data will be analyzed from this point of view and if possible, a theory will be formulated to integrate these observations. Mathematical formulations will be attempted to describe input-output relationships in the cerebellar cortex. The timing of the arrival of impulse volleys at different anatomical sites will be correlated with the distances travelled.

22.97

National Bureau of Standards, Washington, D. C.
AUTOMATIC PROCESSING OF PSYCHOPHYSIOLOGICAL DATA, H. L. Mason. Project 9779(805A), Contract ISSA 61-10; SRL, AFOSR.

The contractor will provide knowledge and research required to: (a) modify existing magnetic tape monitoring and conversion equipment so that psychophysiological data (including time records of skin resistance, respiration, heart rate, muscle potential, pulse volume and arterial pressure) recorded on analog type magnetic tape can be automatically converted to digital magnetic tape in a format which will permit statistical analysis on an electronic computer; (b) preparation of digital computer programs and operation of an NBS computer on statistical analyses, utilizing the magnetic tape output of (a) in pilot runs.

22.98

National Institute of Optics (Italy).
RETINAL MECHANISMS AND RESPONSES, R. Ronchi. Project 9777(805A), Grant AF-EOAR-61-34; SRLA, AFOSR.

Basic information will be sought on various aspects of vision. This will include studies on the vision of moving objects when the images of fixed objects are stabilized on the retina; effect of interaction of one eye on the apparent brightness of a field seen by the other eye; and psychophysical investigation into the influence of the shape of the light stimulus upon the critical fusion frequency.

22.99

New York State Psychiatric Inst., N. Y.
AMINE AND AMMONIA METABOLISM OF DAMAGED AND NORMAL BRAIN TISSUE, H. Waelsch. Project 9777(805A), Grant AF-AFOSR-62-221; SRLA, AFOSR.

An enzyme system has recently been demonstrated which allows the incorporation of amines into proteins with the concomitant liberation of ammonia. This provides a mechanism whereby proteins can be modified. These altered proteins may have unique properties having implications in many areas of biology and medicine. The processes involved in

this incorporation as well as the fate of the ammonia liberated are of great theoretical and practical interest. Further, it has been shown that freezing small areas of the brain may produce epileptic-like lesions. Chemically, there is a significant decrease of glutamine, glutamic acid, and glutathione; and presumably a corresponding increase of ammonia. Exploration of this lead should provide basic information on the metabolism of normal and damaged brain tissue.

22.100

Ohio State U. Research Foundation, Columbus.
INFORMATION PROCESSING IN THE FROG'S RETINA, L. Lipetz. Project 7232(805A), Contract AF 33(657)-7578; MEMA, AMRL.

This contract will investigate the operations performed by the retina of the frog and relate them to the structure of the retinal nerve net.

22.101

Ohio State U. Research Foundation, Columbus.
CORONARY RESPONSE TO INCREASED INTRATHORACIC BLOOD VOLUME, E. Ogden. Project 7163(805A), Contract AF 33(616)-6928; MEM, AMRL.

Conduct research to validate the mechanism of the coronary changes due to increased intrathoracic blood volume. The original studies have shown that with shift in fluid spaces, an ischemic heart and a failing circulation result. The coronary haemodynamic response that follows may be caused by increased pulmonary blood volume. This study will attempt to locate and isolate the reflex mechanism responsible for this response.

22.102

Operational Applications Lab., RSRH, ESD, Bedford, Mass.
PERFORMANCE UNDER STRESS, J. Coules. Project 9670 (805A), Internal.

The objective of this effort is to study psychological and physiological correlates of human information processing performance under stress, where stress is a function of information overload, number of response alternatives, or number and varieties of sense modalities involved. Measurement of physiological factors such as GSR, blood pressure, etc., will be studied to evaluate their use as indices of performance variability under stress. Preliminary studies are underway to develop experimental techniques and instrumentation methods.

22.103

Oslo U. (Norway).
FUNCTIONAL SIGNIFICANCE OF TEMPORAL LOBE CENTERS IN THE BRAIN, B. Kaada. Project 9777(805A), Grant AF-EOAR-62-36; SRLA, AFOSR.

An attempt will be made to map out the brain areas involved in various behavioral processes. This will include attentiveness, learning, memory, arousal, social facilitations, and instinctive sex behavior patterns. Lesions will be made in various structures of the temporal lobe and the rat's responses compared with those during the preoperative period.

22.104

Oxford U. (Gt. Brit.).
BIOCHEMISTRY OF BIOGENIC AMINES, H. Blaschko. Project 9777(805A), Contract AF 61(052)-235; SRL, AFOSR.

It is becoming increasing apparent that biologically active amines play a vital role in the automatic and the central nervous systems. The action of many drugs will probably be shown to depend upon alterations in the formation, storage, and destruction of these compounds. This study proposes the exploration of the pathway by which pharmacologically inert precursors are converted to the active compound, how they are activated, and where they are stored in the body.

22.105

Oxford U. (Gt. Brit.).
PROPERTIES OF SMOOTH MUSCLE, E. Bulbring. Project 9777(805A), Grant AF-EOAR-62-5; SRLA, AFOSR.

Smooth muscle is an excellent tissue in which to study the interrelationships among biochemical mechanisms, surface phenomena, electrical activity, and physical events (contraction). In addition, certain smooth muscles manifest the property of autorhythmicity, or pacemaker properties, which has many implications into numerous biological events as well as in clinical medicine. The approach to this complex problem must of necessity be multidisciplinary. Electrophysiological techniques will be used to study the electrical potential across the membrane, the action potential, the excitability, and conduction within the muscle. Radioactive tracers will be used to follow ion movement across the cell membrane. The metabolic activity under varying conditions will be followed by traditional biochemical methods. Finally, the effect of drugs on all these responses will be explored.

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RAOR- Advanced Studies Office
RAE- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare
AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
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22.106

Oxford U. (Gt. Brit.).
ACETATE METABOLISM IN MICROORGANISMS, H. A. Krebs. Project 9777(805A), Grant AF-EOAR-62-45; SRLA, AFOSR.

The objective of this research is to elucidate the mechanism whereby microorganisms can grow and reproduce on a substrate containing one- and two-carbon atoms as the sole source of carbon. Particular emphasis will be placed on the study of new carbon dioxide fixation reactions.

22.107

Oxford U. (Gt. Brit.).
NEURAL MECHANISMS, EVOLUTION, GENETICS AND BEHAVIOR IN CERTAIN DIPTERA, S. A. Pearce. Project 9777(805A), Grant AF-EOAR-62-49; SRLA, AFOSR.

This study will be conducted on several species of the genus Drosophila using ethological, neurophysiological, and specialized microelectrode techniques. The investigator will concentrate on three major problems: (1) the nervous control of complicated chains of behavior as elicited by simple stimuli; (2) the effect of gene changes, which in turn affect behavior either directly (by affecting nervous pathways) or indirectly (by changing the morphology or functioning of a sense organ); and (3) the evolution of nervous mechanisms.

22.108

Oxford U. (Gt. Brit.).
NEURAL MECHANISMS UNDERLYING PERCEPTION, D. M. Vowles. Project 9777(805A), Contract AF 61(052)-420; SRL, AFOSR.

These studies are aimed to gain insight into basic mechanisms of perception by utilizing the relatively primitive nervous systems found in insects. Microelectrodes will be implanted to stimulate various parts of the nervous system. By recording from different loci in the brain, information will be gained on how the patterns of excitation are changed as they pass from the eye through the various centers in the brain.

22.109

Pennsylvania U., Philadelphia.
PHYSIOLOGICAL MECHANISMS INVOLVED IN THERMAL TOLERANCE IN MAN, H. T. Hammel. Project 7220(805A), Contract AF 33(616)-6306; MRM, AMRL.

To understand the physiological mechanisms involved in the thermal tolerance of man, it is first necessary to extend our knowledge of the relative roles of the central and peripheral components in temperature regulation in the lower vertebrates. In this research, techniques have been developed by the investigator for displacing the core or hypothalamic temperature controlled amounts and then measuring the heat conserving or dissipating responses which result. Magnitudes of the measured responses, with concurrent skin and core temperatures required to produce a given motor response in a given thermal environment, are studied. Physiological responses to heat or cold of poikilothermic vertebrates are investigated; behavioral responses noted and relationships between peripheral vascular changes and displacements of hypothalamic temperatures are studied.

22.110

Pennsylvania State U., University Park.
PHOTOMETABOLISM, E. S. Linstrom. Project 9777(805A), Grant AF-AFOSR-62-283; SRLA, AFOSR.

Photosynthesis includes quantum conversion processes leading to energy production and to metabolic control. Dr. Linstrom proposes to extend our present investigations of the mechanism and yield of photophosphorylation and photoreduction of sulfate and nitrogen in order to develop concepts of the structural and biochemical relationships involved. He proposes further, to examine the metabolic effects of red and far-red light. These lead to photoperiodism and a variety of photosensitive reactions in plants. The effects of far-red light upon the relationships between photosynthetic and respiratory metabolism of carbohydrate intermediates will be investigated. It is anticipated that the photocontrol phase of plant photometabolism may provide information essential to understanding photosynthesis.

22.111

Pennsylvania U. School of Medicine, Philadelphia.
NEUROHUMORAL CONTROL OF PITUITARY, S. M. McCann. Project 9777(805A), Grant AF-AFOSR-62-133; SRLA, AFOSR.

When man is exposed to stressful conditions, an intricate hormonal response is initiated. Apparently the hypothalamus stimulates the pituitary to secrete adrenocorticotropic hormone (ACTH) which in turn stimulates the adrenal glands to secrete certain steroid compounds. These have rather profound effects on the body and in turn inhibit the pituitary secretion. This sets up a delicate "feed back" mechanism to control the individual's physiological response. The exact mechanism by which the pituitary is controlled is not known. This study is designed to provide further information on the specific hormones required and their exact site of action.

22.112

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
ENERGY TRANSFER IN BIOLOGICAL SYSTEMS, M. Tavla. Project 6694(750F), Internal.

Reversible photo-reduction which is produced by molecules complexed to photosensitive pigments is being studied. This process is of significance in the primary quantum conversion in biological systems. Three areas of study are being explored: (1) Hydrazine hydrate (an electron donor) is complexed with chlorophyll and the optical and photochemical properties of this complex are studied. In in vivo photosynthesis, there is a possibility that protein acts as an electron donor, leaving a positive hole. (2) The complex between protein and 3',6'-dichlorofluoran shows a photoreversible reaction possibly based on an electron transfer from the protein to the dye. The mechanism of the formation of this complex and the nature of the photochemically produced metastable state are under investigation. In both of these systems, the role of the triplet state is being evaluated. (3) It has been shown that the long wavelength absorption of phycoerythrin responsible for its fluorescence depends upon the interaction of a certain group in protein with the pigment. This group has an electron donor property. Similar interaction has also been observed in visual pigment. The effect of this interaction on energy transfer and photochemical reaction are under study. Specific systems are phycobilin pigments, chlorophyll-protein complex and visual pigment.

22.113

Pierce, John B., Foundation, New Haven, Conn.
THERMAL REGULATION IN THE EXERCISING MAMMAL, H. T. Hammel. Project 7220(805A), Contract AF 33(657)-7603; MRMB, AMRL.

The relative roles of peripheral and central components in the temperature regulation of the unanesthesized exercising mammal (dog) are under study using implanted hypothalamic thermodes for displacing the central (core) or hypothalamic temperature controlled amounts, then measuring the resultant heat conserving or dissipating responses. Magnitudes of the measured responses with concurrent skin, rectal and hypothalamic temperatures required to produce specific motor responses in specific thermal environments are observed. Effects of cold, hot, and neutral environments are studied and hypothalamic, skin, rectal temperatures, oxygen consumption and evaporative heat loss of both resting and exercising animals are compared.

22.114

Pisa U. (Italy).
RELATION OF BRAIN STEM RETICULAR FORMATION TO ANIMAL BEHAVIOR, G. Moruzzi. Project 9777(805A), Grant AF-EOAR-62-9; SRLA, AFOSR.

The objective of these studies is to relate the ascending reticular system of the brain with the instincts and conditioned reflexes in various species. An attempt will be made to localize the midbrain structures whose destruction will precipitate the typical electroencephalographic (EEG) pattern of sleep in pontine preparations. The course and function of this system will be investigated in the cat, rat, pigeon, and monkey.

22.115

Pisa U. (Italy).
NEUROPHYSIOLOGICAL STUDIES OF CONDITIONING, G. Ricci. Project 9777(805A), Grant AF-EOAR-61-36; SRLA, AFOSR.

These experiments have several objectives relating neurophysiological activities to behavioral responses. More precise knowledge will be sought in the function of different areas of the cortex during physiological and psychological situations. Clarification will be attempted of the role of subcortical structures in establishing a "learned" pattern of behavior. The effects of reticular formation activation will be studied on the discharge patterns of cortical neurons in different areas.

22.116

Pittsburgh U., Pa.
EFFECT OF THERMAL STRESS ON CELLULAR STRUCTURES AND FUNCTION, R. Buchsbaum. Project 7220(805A), Contract AF 33(616)-8093; MRMB, AMRL.

In order to extend our knowledge of the fundamental changes which result in thermal injury or death in hypo- or hyper-thermic cells, specific cellular or sub-cellular changes are determined (either morphologically or biochemically), the reversible or irreversible nature of these changes defined, the time-intensity curves required to produce various degrees of cellular functional or structural damage investigated, and thermal tolerance or survival temperature range defined. Changes in several types of living cells (mouse kidney and fibroblast) are presently studied during a programmed temperature change of 10°C (37°-47°C) with cytoplastic alterations recorded by use of phase contrast microphotography.

22.117

Pittsburgh U., Pa.
FLASH SPECTROSCOPY AND FLASH FLUORIMETRY IN PHOTOSYNTHETIC STUDIES, J. L. Rosenberg. Project 9777(805A), Contract AF 49(638)-762; SRL, AFOSR.

AEL- Aeronautical Research Laboratories
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Considerable advances have been made within the past few years on the intermediate biochemical processes in photosynthesis. Very little is know, however, of the primary photochemical reaction by which solar energy is converted to chemical energy. Additional insight is urgently needed into the physical and chemical requirements for this highly efficient process of green plants. It is proposed to study the primary processes in the infrared and ultraviolet regions using intact cells and possibly cell extracts as experimental material. High energy flash equipment will be utilized so that optical transmission and fluorescence intensity measurement may be made with 0.1 millisecond after the onset of the flash. The presence of photochemically modified chlorophyll or other pigments will be sought. Attempts will be made to distinguish primary from secondary photochemical events by studying rapid absorbance changes over a wide spectral region.

22.118

Princeton U., N. J.
PHYSIOLOGICAL STRESS IN RELATION TO INNATE DAILY RHYTHMS, C. S. Pittendrigh. Project 9777(805A), Contract AF 49(638)-587; SRL, AFOSR.

A study will be made of normal phase relationships between constituent physiological systems in the cell and in the whole organism and the tolerance to severe stresses. The innate daily rhythms of animals will be forced into pattern either longer or shorter than the free-running natural period, and the metabolic efficiency and tolerance to stress will be compared to normal animals.

22.119

Princeton U., N. J.
SENSORY DEPRIVATION, J. S. Robinson. Project 9778 (805A), Contract AF 49(638)-744; SRL, AFOSR.

The present experiment will attempt to determine the strength of need as it may be related to the amount and kind of stimulation the subject is "used to" in his pre-experimental environment. The research will also attempt to determine: (1) the reward effects of various light intensities and (2) concomitant aspects of attention, vigilance and fear. It is hoped that studying behavior motivated by sensory deprivation of simpler organisms may provide insights into human behavior under similar conditions.

22.120

Queen Mary Coll., U. of London (Gt. Brit.).
PHOTOSYNTHETIC MECHANISMS UNDER SUB-OPTIMAL CONDITIONS, C. F. Whittingham. Project 9777(805A), Grant AF-EOAR-62-24; SRLA, AFOSR.

A fairly complete picture has been assembled on the fixation of carbon dioxide in photosynthesis. Practically all work, however, has been done under conditions believed to be optimal for photosynthetic activity. These conditions might minimize the part played by subsidiary mechanisms. Thus, a secondary pathway might be completely obscured which actually under certain conditions would be the dominant pathway. It is proposed here to seek such secondary pathways by employing conditions for photosynthesis which are sub-optimal. The resulting intermediates will be isolated and identified with the aid of labelled carbon.

22.121

RIAS, Inc., Baltimore, Md.
PHOTOSYNTHESIS, B. Kok. Project 9777(805A), Contract AF 49(638)-947; SRLA, AFOSR.

Research in photosynthesis extends into physics, chemistry, biology and various subspecialties. The common goal approached through diverse disciplines is to understand the ability of the plant to convert the energy of visible light into chemical energy. In this contract a number of approaches are being made towards this end. These include studies on the structure, the metabolism and the kinetics of the photosynthetic components and reactions.

22.122

San Marcos U., Lima (Peru).
ESTIMATION OF PRE RADIUS AT BOTH SURFACES OF FROG SKIN, G. Whittembury. Project 9777(805A), Grant AF-AFOSR-61-85; SRL, AFOSR.

Dr. Whittembury will study the size of the pores at both surfaces of frog skin, using the method and equations of Goldstein and Solomon. He will also study the differential effect of ADH upon frog skin and try to determine if Ca-ADH antagonism can be shown in the skin.

22.123

Sheffield U. (Gt. Brit.).
FORMATION AND ROLE OF RADICALS IN FLAVO-PROTEIN CATALYSIS, Q. H. Gibson. Project 9777(805A), Grant AF-EOAR-61-2; SRLA, AFOSR.

This biophysical research problem concerns the nature of the changes taking place in enzyme catalysis. The indications so far available suggest that a radical of unusual properties is formed as a catalytic intermediate. Because the evaluation of the rapid reaction results requires treatment of transient state kinetic equations which are non-linear and do not have analytic solutions, an electronic analogue computer will be used.

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRR- Control Sciences Lab
CRE- Geophysics Research Directorate
CREA- Photochemistry Lab
CRES- Thermal Radiation Lab
CREE- Research Instrumentation Lab
CREO- Terrestrial Sciences Lab
CRER- Meteorological Research Lab
CREI- Ionospheric Physics Lab
CRER- Sacramento Peak Observatory

22.124

Siena U. (Italy).
CENTRAL NERVOUS SYSTEM MECHANISMS IN CIRCULATION REGULATION AND FUNCTIONAL DERANGEMENT (HYPERTENSION), C. Bartorelli, A. Zanchetti. Project 7220(805A), Contract AF 61(052)253; MRM; AMRL.

This contract calls for the investigation of the central nervous system mechanisms that regulate circulation and their functional derangement (hypertension). Work continues on the mapping of the brain stem with electrical stimuli and will be extended from the medulla to the pons in order to study the relative importance of afferent systems in maintaining hypothalamic activity. Studies are in progress to determine the multiple interrelationships between posterior hypothalamus and cardiovascular reflexes as the first step in revealing different brainstem contributions to circulation controls.

22.125

Stanford Research Inst., Menlo Park, Calif.
VISUAL INFORMATION PROCESSING IN INSECTS, J. C. Bliss. Project 9777(805A), Contract AF 49(638)-1112; SRLA, AFOSR.

Basic studies of sensory-information processing biological systems. The functional similarities and differences among the ocular systems of various insects and vertebrates indicate the special techniques nature has used to perform specific visual tasks. An understanding of the capabilities and limitations of these sensory systems will also provide insight into the operation of the brain and its associated recognition mechanisms. Standard neurophysiological techniques as well as newer and more novel methods will be used in conjunction with mathematical models and computer simulation studies to accomplish this research.

22.126

Stanford U., Calif.
NEURAMINIC ACID AND CENTRAL NERVOUS SYSTEM FUNCTION, W. Cutting. Project 9777(802A), Contract AF 49(638)-714; SRL, AFOSR.

Neuraminic acid has been found in the central nervous system both in free and combined forms. It is suspected of having a significant role in nervous activity and its deficiency has been reported in schizophrenia. However, supplies of the compound have not permitted any extensive study of its biological activity. Development of procedures allowing the preparation of adequate amounts should stimulate research in this area. Systematic biological testing will then be possible.

22.127

Stanford U., Calif.
PHYSIOLOGY OF CRUSTACEAN INTERNEURONS, D. Kennedy. Project 9777(805A), Grant AF-AFOSR-62-147; SRLA, AFOSR.

On the under side of the tail of certain crustacea there occur nerve cells which are internuncial in function. At the same time, these cells are light sensitive. There are other instances of such dual function in nerve cells. The work in this area is to elucidate the mutual interaction in the nervous system of these two properties of these nerve cells. Especial emphasis will be on: (1) mechanisms involved in synaptic transmission; (2) responses to repetitive activation of both types, light and tactile; (3) the effect of level of light activation on input to the cells.

22.128

St. Bartholomew's Hospital (Gt. Brit.).
DRUG ACTION DEPRESSING THE CENTRAL NERVOUS SYSTEM, J. P. Quilliam. Project 9777(805A), Contract AF 61(052)-25; SRL, AFOSR.

The isolated superior cervical ganglion is being used as a simple model of more complicated nervous structures for testing the action of drugs. The response of the nictitating membrane is recorded to pre- and post-ganglionic nerve stimulation in the cat before and after injection of central acting drugs. Electrical recording are made of impulses in pre- and post-ganglionic fibers and of ganglionic potentials before and after treatment with drugs. This provides a simple preparation which will allow preliminary trials with drugs and stimuli before testing in the animal. A number of drugs are under investigation with this procedure.

22.129

G. D. Talbott and J. R. Hays, Dayton, Ohio.
EFFECTS OF SODIUM CHLORIDE ON BLOOD LIPID CURVES AND COAGULATION TIMES, G. D. Talbott. Project 6300(805A), Contract AF 33(616)-6331; MRM, AMRL.

Studies have been extended to cover research on the effects of ingested blended whiskey and fat test meals on blood lipid curves and coagulation times.

22.130

Technische Hochschule, Munich (Germany).
INTERMEDIATE METABOLITES DURING PHOTOSYNTHESIS, O. Kandler. Project 9777(805A), Grant AF-EOAR-62-42; SRLA, AFOSR.

A large body of information on photosynthetic

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RAE- Directorate of Engineering
RAEA- Advanced Development Lab
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intermediates is available and this has been synthesized into a generally accepted pathway of CO_2 fixation. However, certain discrepancies suggest that this pathway may need modification, or that alternate pathways are possible. This study will attempt to reconcile these discrepancies and to gain a clearer picture of the metabolic processes in the living cell. This will be done by studying the effect of different inhibitors on C^{14} after short time photosynthesis in $C^{14}O_2$; by determining the phosphate turnover during photosynthesis; and especially by estimating the pool size of the most important intermediates by enzymatic analyses.

22.131

Tennessee U., Memphis.
GASTROINTESTINAL PROBLEMS, J. P. Quigley. Project 9777(805A), Grant AF-AFOSR-62-114; SRLA, AFOSR.

This group of investigators has produced many of the recent advances in gastrointestinal motility studies. By the simultaneous use of the X-ray intensifier, inductograph, catheters, and cine recording, it will be possible to monitor most gastrointestinal activity and measure the various components thereof. By use of a computer (from other sources), the data can be effectively analyzed and the interrelationships determined.

22.132

Texas U., Galveston.
POSTGANGLIONIC CHOLINERGIC MEDIATION OF SYMPATHETIC NERVES, J. G. Hilton. Project 9777(805A), Grant AF-AFOSR-62-241; SRLA, AFOSR.

The status of sympathetic activity through acetylcholine (AcCh) release at sympathetic nerve endings is under examination. There is considerable evidence that AcCh is released by such nerve endings. The part played in this process by automatic ganglion effects as compared to strictly peripheral effects is not know. This will be investigated by using atropine and neostigmine as chemical tools in the study. In addition the effects of other drugs will be studied: ganglionic, if the ganglionic effects predominate; otherwise other drugs acting more peripherally will be studied.

22.133

Toulouse U. (France).
EFFECTS OF HEART DISTENSION ON ALDOSTERONE SECRETION, P. Montastruc. Project 9777(805A), Contract AF 61 (052)-411; SRLA, AFOSR.

Distension of the left atrium of the heart has been shown to provoke an increased urinary excretion and also to inhibit the secretion of anti-diuretic hormone by the posterior pituitary. This study is an attempt to understand better the control of the body fluids and minerals under stressful conditions. Under the gravitational changes of flight, such changes in fluid and minerals may occur.

22.134

Turin U. (Italy).
ORIENTATION OF CRUSTACEA, L. Pardi. Project 9777 (805A), Grant AF-EOAR-62-100; SRLA, AFOSR.

Many amphipods, which are shore dwellers, have the ability to return almost perpendicularly to the sea if they are either passively removed (wind) or actively leave it. The evidence points towards using the sun or moon for the navigation aid. The sensing mechanisms are unknown, but appear to be highly effective. This work will attempt to determine how the return path is determined and by what mechanisms.

22.135

Universidad Catolica (Chile).
PEPTIDE NEUROHUMORS IN THE BRAIN, H. Croxatto. Project 9777(805A), Contract AF-AFOSR-61-58; SRL, AFOSR.

This investigation proposes to extract, purify, and identify active peptides in the brain. Their role in the central nervous system will then be explored.

22.136

Universidad Catolica (Chile).
SYNAPTIC MECHANISMS, J. V. Luco. Project 9777(805A), Grant AF-AFOSR-62-387; SRLA, AFOSR.

Habituation, the disappearance of afferent responses to repeated and identical sensory stimuli, is a phenomenon encountered in most, if not all, central nervous systems. The mechanism is unknown. Dr. Luco proposes to study an isolated insect ganglion, suitably mounted for afferent stimulation as well as for extra- and intracellular recording of electrical activity. The recorded potentials and the responses will then be correlated with the repeated afferent stimuli in an attempt to elucidate habituation phenomena. He also proposes to continue and extend his experiments on the reinnervation of denervated adrenoceptive membrane by cholinergic neurons, and especially, the reinnervation of effector organs with either central or peripheral branches of sensory neurons. These experiments will involve detailed electrophysiological, pharmacological, and histological studies -- including observation of submicroscopic structures.

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22.137

Universidade de Sao Paulo (Brazil).
ROLE OF VARIOUS BRAIN STRUCTURES ON PHYSIOLOGICAL FUNCTION, M. Covian. Project 9777(805A), Grant AF-AFOSR-61-60; SRL, AFOSR.

Many investigators have shown the influence of the hypothalamus on the pituitary. Little has been done, however, to relate other brain structures with endocrine control. The general purpose of this study is to fill this gap by observing the changes produced by destruction of large parts of the brain. Preliminary studies seem to support the view that hemidecortication releases the hypothalamus of the rat from some restraining action exerted either by the cerebral cortex or by some subcortical structure. The present study will extend and refine these observations.

22.138

Universite Libre de Bruxelles (Belgium).
ROLE OF SULFHYDRYL AND DISULFIDE GROUPS IN MORPHOGENESIS, J. Brachet. Project 9777(805A), Grant AF-EOAR-6131; SRLA, AFOSR.

Recently, the principal investigator has shown remarkable inhibitory effects on the development of a number of biological specimens by the chemical β-mercaptoethanol. The oxidized form of this compound exerts stimulatory effects. This and other supporting evidence suggest that biochemical systems involving sulfhydryl (-SH) and disulfide (-SS-) groups may play a key role in many different development systems.

22.139

Universite Libre de Bruxelles (Belgium).
NEUROPHYSIOLOGICAL CORRELATES OF SENSORY PERCEPTION, F. Bremer. Project 9777(805A), Contract AF 61(052)-120; SRL, AFOSR.

The mechanism by which levels of consciousness and sensory perception are regulated will be investigated. The regulation of consciousness and behavior by cholinergic mechanisms will be considered.

22.140

Universite Libre de Bruxelles (Belgium).
GENETIC REPLICATION AND MACROMOLECULAR SYNTHESIS IN TEMPERATE BACTERIOPHAGE, R. Thomas. Project 9777(805A), Grant AF-EOAR-62-17; SRLA, AFOSR.

In this proposal in the field of biochemical genetics, Dr. Thomas plans to investigate the control of gene replication in the bacteriophage lambda, and also to study the mechanisms of transfer of information from a DNA molecule to its daughter molecules. He is particularly interested in the three following questions: (1) Can phage chromosomes multiply in the absence of protein synthesis? (2) Does duplication of a DNA molecule involve the obligate transfer of its genetic information to a non-DNA structure? and (3) what are the relations between the synthesis of viral and host cell DNA?

22.141

University Coll., Dublin (Eire).
ACTIVE TRANSPORT OF IONS, E. J. Conway. Project 9777(805A), Contract AF 61(052)-435; SRL, AFOSR.

There are few problems of greater fundamental significance in cellular physiology than the detailed processes by which ions are actively transported across cell membranes. Conway several years ago proposed the so-called Redox Pump Theory to explain such ion transport. This theory has received wide but not universal acceptance. This study proposes further critical experiments to test the theory and to broaden its scope. The precise nature of the stimulus which induces large scale sodium secretion by skeletal muscle will be sought. The effect of various steroids, hormones, and inhibitors in this mechanism will be investigated. Finally, an attempt will be made to isolate the cation carrier in the yeast cell. This cell is more robust than that from animal tissue and has an extremely active ion transport mechanism.

22.142

University Coll., Galway (Eire).
STRUCTURE OF PHYCOBILINS, C. O'hEocha. Project 9777(805A), Grant AF-EOAR-62-38; SRLA, AFOSR.

Phycobilins are pigments found in certain algae: the blue-green algae and the red algae. Although they apparently have no photosynthetic capacity themselves, it has been speculated that they contribute to photosynthesis indirectly. Certain wavelengths of light are apparently absorbed by phycobilin which may transfer this energy to chlorophyll which then participates in the chemosynthesis.

22.143

University Coll., London (Gt. Brit.).
ELECTROPHYSIOLOGICAL STUDIES ON THE OCTOPUS, J. Z. Young. Project 9777(805A), Grant AF-EOAR-62-37; SRLA, AFOSR.

This research is the study of shape discrimination in the eye of the octopus. It includes studies on the electrical activity of the retina, optic nerve fibers, optic lobes and centers or pathways.

Included also are the activities of the efferent fibers from the optic lobes to the retina.

22.144

University Coll. of Wales (Gt. Brit.).
CAROTENOID BIOSYNTHESIS IN PHOTOSYNTHETIC BACTERIA AND HIGHER PLANTS, T. W. Goodwin. Project 9777 (805A), Contract AF 61(052)-355; SRL, AFOSR.

Carotenoids are present in all photosynthetic tissues and play an important ancillary role in passing light energy to chlorophyll. In this way they make available to photosynthetic organisms light energy which would otherwise have been lost had the chlorophylls alone been concerned with the absorption of light. Carotenoids also act to protect certain organisms against a toxic action of light and oxygen. It is proposed to study the pathway of carotenoid biosynthesis in chloroplasts, and to determine the factors controlling this synthesis in seedlings. In addition, attempts will be made to use isolated chromatophores of photosynthetic bacteria to incorporate labelled substrates into the component carotenoids.

22.145

University of North Staffordshire (Gt. Brit.).
NEW METHODS OF ANALYSIS OF ELECTROPHYSIOLOGICAL RESPONSES, D. M. MacKay. Project 9777(805A), Grant AF-EOAR-62-23; SRLA, AFOSR.

This study is part of a broad attack to understand the organization of the brain from the standpoint of information theory. Novel electronic methods have been developed and are being refined, to analyze electrophysiological data, particularly of the visual system. A pattern of radial lines evokes an after-impression in a subject of rotating concentric circular patterns of wavy lines, which appear to be vibrating at rates approximating 10 per second. At least some of this oscillatory activity is not retinal in origin but seems located within the brain networks. A new magnetic recorder has been devised which enables large numbers of synchronized signals to be superimposed on the same closed loop of tape, so that on demodulation, the average of all signals to date is continuously observable. It is planned to improve this device by developing electronic circuitry in which several hundred responses can be averaged without overloading. It is proposed also to explore artificial mechanisms capable of pattern-recognition.

22.146

Uppsala U. (Sweden).
GENESIS OF ACTION POTENTIAL IN EXCITABLE TISSUE, T. Teorell. Project 9777(805A), Contract AF 61 (052)-363; SRL, AFOSR.

The chief investigator has advanced a new hypothesis to explain the genesis of rhythmical electrical events of the type displayed by nerve membrane and other excitable tissues. It is based fundamentally on known electrochemical properties of living membranes and embodies considerations of water transport, an aspect neglected in earlier concepts of nerve action. A unique feature of the hypothesis is a tentative explanation for the conversion of mechanical stimuli by certain sensitive organs into electrical impulses. The hypothesis has been confirmed physically by a real model system termed the "membrane oscillator." The present investigation will examine further the properties of the membrane oscillator; will expand the physicomathematical theory of the membrane oscillator with the aid of analog computer techniques; and will test its applicability on living material.

22.147

Weizmann Inst. of Science (Israel).
PHOTOPHOSPHORYLATION MECHANISM IN CHLOROPLASTS, M. Avron. Project 9777(805A), Grant AF-EOAR-62-50; SRLA, AFOSR.

Isolated chloroplasts are capable of performing complete photosynthesis: carbohydrate synthesis and oxygen evolution. The primary process is thought to involve an initial light-dependent splitting of water molecules into reduced and oxidized moieties. The energy in the reduced part is utilized for the formation of adenosine triphosphate (the energy currency of the cell) and the oxidized portion gives rise to free oxygen. The mechanism and the intermediate steps by which these reactions proceed are largely unknown. By using chloroplasts fragments, specific inhibitors, and isotopically labeled reactants, it is hoped to fill in some of this void.

22.148

Weizmann Inst. of Science (Israel).
BIOLOGICAL SIGNIFICANCE OF HIGH MOLECULAR WEIGHT POLYPEPTIDES, E. Katchalski. Project 9777(805A) Grant AF-EOAR-62-60; SRLA, AFOSR.

The widespread occurrence and versatility of natural polypeptides and proteins make this group of compounds unusually significant. One of the biochemist's major goals is to elucidate the correlation between this biological function and chemical structure. In this contract, model compounds will be synthesized which will permit more ready analysis of the role of amino acid residues, their sequence,

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and steric configurations in determining biological properties. Such synthetic peptides should also prove extremely useful as substrates for enzymatic activity, as enzyme inhibitors, and for bacterial and virus studies.

22.149

Western Reserve, Cleveland, Ohio.
VASOPRESSIN BIOSYNTHESIS, H. Sachs. Project 9777 (805A), Grant AF-AFOSR-62-77; SRLA, AFOSR.

Largely on the basis of histological and histochemical evidence, it is now generally accepted that certain nervous cells can elaborate and secrete substances having profound effects on the endocrine regulation of the body. This investigation is designed to study how and where such substances, particularly vasopressin, are synthesized. It is hoped also to determine the immediate precursor of this hormone; its binding within the cell under various conditions, and the isolation, characterization, and metabolic properties of the "neurosecretory substance."

22.150

Western Reserve School of Medicine, Cleveland, Ohio.
NEURAL PATHS AND INTEGRATION CENTERS FOR PITUITARY HORMONE RELEASE, G. Sayers. Project 9777(805A), Grant AF-AFOSR-62-3; SRLA, AFOSR.

In the higher organisms, complex regulatory systems have been evolved for the maintenance of both the chemical composition and the volume of the body fluids. The central nervous system receives and integrates information from chemoreceptors and from pressure and volume receptors and from pressure and volume receptors. This information is translated into modifications of visceral activities and of rates of secretion of endocrines. The investigator intends to concentrate attention on one aspect of the larger problem. He proposes to delineate and define the neural pathways and integration centers concerned with the release of adrenocorticotropic hormone and of anti-diuretic hormone in response to painful and premonitory stimuli.

22.151

Wisconsin U., Madison.
COMPLEX PRECURSORS OF INDUCED ENZYMES IN YEAST, H. O. Halvorson. Project 9777(805A), Grant AF-AFOSR-62-205; SRLA, AFOSR.

The synthesis of protein by the cell is one of the key processes typifying life. Knowledge of the mechanism would have far-reaching implications in medicine, genetics, and virtually every phase of biology. This project proposes to study this process by examining the mechanism by which a specific enzyme (protein) is produced by yeast cells. The substances and conditions necessary for the synthesis will be studied and attempts will be made to isolate intermediate products.

22.152

Worcester Foundation for Experimental Biology, Shrewsbury, Mass.
INFLUENCE OF HORMONES ON INTIMAL HYPERPLASIA, G. Pincus. Project 9777(805A), Contract AF 49(638)-866; SRL, AFOSR.

This work is designed to determine the effects of sex hormone administration, particularly testosterone, upon the intima of rodents. A recent hypothesis suggests that testosterone may actually decrease intimal thickness. Hormones will periodically be injected into animals. Following sacrifice their arteries will be microscopically examined after fixation by a special pressure technique. The effects of testosterone, and estrogen will be compared with control animals.

22.153

Yale U. School of Medicine, New Haven, Conn.
IMPLANTATION AND USE OF BRAIN ELECTRODES FOR TOXICOLOGICAL APPLICATION, J. Delgado. Project 7163 (805A), Contract AF 33(616)-6899; AMRL.

The contractor permanently implants deep multipolar (6 channel) electrodes in various areas of the brains of 12 experimental monkeys. Baseline EEG, threshold excitation, and discharge levels are measured. After these animals have been exposed to propellants at the Aerospace Medical Laboratory, and the above measurements repeated, the brains of the animals are histologically prepared by the contractor, electrode positions verified, and all tracings and measurements evaluated by the chief investigator. The first six monkeys have been delivered, exposed and brains returned to contractor. The second group of six animals were delivered and are being exposed. No results are yet available. Significant findings will be immediately applied to an active clinical EEG survey program on fuel handlers. The transient or permanent nature of changes will be evaluated.

See also: 7.13, 7.75, 7.91, 13.9, 21.20, 21.22-25, 21.34, 21.36-38, 21.41, 21.49, 21.77, 21.92, 21.116, 21.139, 21.141, 21.146-147, 24.39

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ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

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ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEOR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESNR- Operational Applications Lab

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23. RESEARCH FACILITIES AND EQUIPMENT

Balloons; Balloon-borne Instrumentation; Computation Facilities; Data Reduction; Furnaces; High Vacuum Technology; Interferometers; Magnetometers; Particle Accelerators; Production of High Magnetic Fields; Radiation Detection and Measurement; Rocket-borne Instrumentation; Solar Energy Devices; Spectrometers; Wind Tunnels.

23.1

Alderson Research Labs., Inc., Long Island, N. Y.
DEVELOPMENT AND FABRICATION OF PLASTIC MANIKINS, S. W. Alderson. Project 8803(805A), Contract AF 29 (601)-4160; SWR, AFSWC.

The contractor will fabricate plastic manikins only. The research will be conducted or arranged in-house. Direct measurements of proton depth dose rates in tissue equivalent material will be attempted. This entails exposing plastic manikins made of tissue equivalent material to proton beams in the laboratory and exposure in the region of the Van Allen belts in recoverable space vehicles, if such flights can be arranged. The data obtained will be analyzed to determine radiation dose rates received by the critical organs of the body.

23.2

American Science and Engineering, Inc., Cambridge, Mass.
LUNAR X-RAY STUDIES, R. Giacconi. Project 7698 (770A), Contract AF 19(604)-8026; CRZE, AFCRL.

The contractor has constructed instrumentation to measure the intensity of X-radiation from the moon, and will construct a laboratory model of an X-ray spectrometer to analyse this radiation. Subsequently, the contractor will design and construct X-ray spectrometers to fly aboard Aerobee rockets and lunar and planetary satellites.

23.3

American Science and Engineering, Inc., Cambridge, Mass.
SPACE RADIATION MEASUREMENTS, R. Giacconi. Project 8600(804A), Contract AF 19(604)-7347; CRZI, AFCRL.

Investigation of the experimental problems associated with the measurement of characteristics of high energy corpuscular radiation in space, such as Van Allen radiation, cosmic radiation, and solar corpuscular streams. The design and construction of instrumentation capable of obtaining information in regard to the charge and energy spectra and time and space variations characteristic of these radiations.

23.4

American Science and Engineering, Inc., Cambridge, Mass.
ANALYSIS AND COMPUTATION, Y. M. Treve. Project 8647 (806A), Contract AF 19(604)-8463; CRZC, AFCRL.

Provide support in mathematical analysis and computation for in-house theoretical investigations of shock wave structure in fully ionized gases with and without magnetic fields. Provide mathematical and computational support for in-house theoretical investigations related to the propagation of shocks and other energy transfer mechanisms in plasmas.

23.5

Antioch Coll., Yellow Springs, Ohio.
COLLECTION AND ANALYSIS OF PSYCHOLOGICAL RESEARCH DATA, H. Jerison. Project 7183(805A), Contract AF 33(657)-7362; MRP, AMRL.

This contract provides services to carry out research studies for personnel of the Behavioral Sciences Laboratory. These services include experimental laboratory space, equipment fabrication, research assistants, data reduction, and subjects.

23.6

Army Signal Research and Development Laboratories, Fort Monmouth, N. J., and Kaysam Corp. of America, Paterson, N. J.
BALLOON FILM MATERIALS, M. Sharenow, J. Kantor. Project 6670(770A), Contract MIPR 62-712; CRZW, AFCRL.

An investigation of the basic materials of expansible balloon film, as well as fabricating techniques will be continued in order to determine optimum design as regards weight, size, durability, and cost of the ultimate operational sounding balloon. Investigation will continue into different lattices which might be

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useable in balloon films, as well as various vulcanizing agents, antioxidants and plasticizers which go into the compound. Small quantities of different types of balloons will be fabricated for feasibility testing.

23.7

AURA Inc., Kitt Peak National Observatory, Tucson, Ariz.
CHILEAN TELESCOPE PROJECT, N. U. Mayall. Project 8635(804A), Grant AF-AFOSR-61-102; CRZI, AFCRL.

The grantee will design and fabricate a 60-inch astronomical telescope and install it in Chile in an observatory to be provided by the National Science Foundation at an optimum site on a mountain top at an altitude of about 7,000 to to 10,000 ft. The telescope will be of the new torque-tube mounting design that provides ample working room at the Cassegrain focus (through a central hole in the main mirror) without sacrificing rigidity. This concept will be modified to provide a Coude focus at which spectrographs, image converters, etc., can be used under laboratory conditions in an underground Coude room that gives freedom from the temperature change and differential flexure and weight limitation problems of instruments directly attached to the moving telescope. The Coude mirror train will be 4-mirror rather than 3-mirror, thus giving access to a much larger portion of the sky without loss of light by vignetting.

23.8

AVCO Mfg. Corp., Wilmington, Mass.
THERMAL IMAGING TECHNIQUES, T. S. Laszlo. Project 5634(803A), Contract AF 19(604)-7204; CRRC, AFCRL.

This investigation is a study of the problems encountered in developing a precision solar imager to be used as a high temperature source in research on refractory materials for electronic applications. Emphasis is to be placed on optimum reflecting surfaces, automatic solar energy monitoring and tracking, and on the imaging techniques and instrumentation required for studies involving emissivities, reflectivities, and absorptivities of refractory materials at extreme high temperatures. The purpose of the investigation is to determine the requirements for refractory material research and describe a precision solar imager that meets these requirements.

23.9

Bartol Research Foundation, Franklin Inst., Swarthmore, Pa.
MESON TELESCOPE AT THULE, M. A. Pomerants. Project 8600(804A), Contract AF 19(604)-8061; CRZI, AFCRL.

The design, construction, and operation of a meson telescope at the Thule Field Site of AFCRL. The evaluation of data from this site and correlation with data obtained from neutron piles, Antarctic cosmic ray stations, and other solar and geophysical parameters.

23.10

Bell and Howell Research Division, Consolidated Electrodynamics Corp., Pasadena, Calif.
MODIFICATION OF MASS SPECTROMETER, C. E. Berry. Project 7023(802A), Contract AF 33(616)-8461; ARC, ARL.

This is a research and design study on methods of improving the performance of a consolidated Electrodynamics Model 21-103C mass spectrometer. Design changes are desired so that the instrument can be utilized efficiently for exploratory investigation of ion-molecule reactions of interest to this laboratory. The operation of the mass spectrometer for analytical purposes will not be impaired by these design changes.

23.11

Bell and Howell Research Division, Consolidated Electrodynamics Corp., Pasadena, Calif.
QUADRUPOLE MASS SPECTROMETER, W. M. Brubaker. Project 8602(804A), Contract AF 19(604)-5911; CRZE, AFCRL.

Development of a unique, lightweight, simple mass spectrometer capable of measuring composition of planetary atmospheres and possible interplanetary atmospheres.

23.12

Bendix Corp., Baltimore, Md.
ROCKETSONDE, J. Cosby. Project 6670(770A), Contract AF 19(604)-8433; CRZW, AFCRL.

The first models of the rocketsonde with a 10 mil rod thermistor as a sensor are to be flight tested in March 1962 to determine its feasibility. Further work on refinement of the sonde will emphasize reliable ranging capability, non-interference telemetry and the adaptation of the sonde to receive the various sensors under development. The first of these will be a pressure-sensing hypsometer. Further field testing of more advanced units is contemplated. Coincident with the sonde development will be a study of the AN/GMD-2 data reduction technique as it will be affected by the high speed rocketsonde telemetry.

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23.13

Block Associates, Inc., Cambridge, Mass.
INTERFEROMETRIC STUDIES, L. Mertz. Project 8603 (804A), Contract AF 19(604)-7264; CRZC, AFCRL.

The objective of the work is to provide for research and development of instrumentation such as special optical, mechanical and electrical models for the development of an interferometric modulation technique of high light-gathering power for far-infrared studies. A data acquisition system for converting the electrical output of the modulator to coded punch type was designed and constructed. The design and construction of a monitoring near-infrared interferometer are being carried out.

23.14

Boston Coll., Mass.
AIR FORCE MAGNETIC FACILITY AT WESTON OBSERVATORY, D. J. Linehan. Project 7601(770A), Contract AF 19 (628)-235; CRZI, AFCRL.

The magnetic test facility is maintained to provide a protected area of known magnetic field for testing, operation, and calibration of magnetometers destined for use in rockets and satellites. It also provides support for the in-house portions of this task in the way of machine and carpenter shop facilities for the actual assembly of nose cone racks and serves as a test area for evaluation of overall system performance and interference testing of related telemetry and tracking components.

23.15

Brookhaven National Lab., Upton, N. Y.
CAPTURE GAMMA-RAY STUDIES, J. W. Olness. Project 7112 (802A), Contract DO (33-616)60-11; ARP, ARL.

For these studies, Brookhaven National Laboratory provides access to a beam of thermal neutrons from the BNL reactor and the normal support functions provided to users of the reactor facilities.

23.16

BTU Engineering Corp., Waltham, Mass.
DESIGN, CONSTRUCTION AND TEST OF A HIGH-TEMPERATURE CHAMBER AND CONTROLS, H. Beck. Project 5621(802A), Contract AF 19(604)-7982; CRRC, AFCRL.

This contract is for the design, development, and construction of a high temperature chamber capable of sustained operation at 1600°C in an oxygen ambient. The working chamber is to vary by no more than 1°C at 1500°C, and its temperature is to be programmable to the point that it can be decreased at the rate of as little as 0.2°C/hr. This chamber is to be used for the growth of single crystals of compounds exsolving from high-temperature molten systems, as for instance, lutetium-iron garnet grown from lead oxide-fluoride melts.

23.17

California U., Berkeley.
DEVELOPMENT OF ARC HEATED LOW DENSITY WIND TUNNEL, F. S. Sherman, L. Talbot. Project 9781(806A), Contract AF 49(638)-502; SRE, AFOSR.

A continuous flow, high temperature, low density wind tunnel is to be developed and experimental research is to be performed to produce a flow sufficiently uniform for aerodynamic testing. Studies are to be made to determine the aerodynamic characteristics and composition of this jet. Tests with the plasma generator are to be made to determine jet characteristics which include: (a) simultaneous impact pressure studies and local measurements of stagnation heat transfer and fine wire recovery temperature; (b) high speed photography of the jet to evaluate its steadiness; (c) Langmuir probe tests and independent measurements of electron density and temperature by microwave or magnetic induction techniques; (d) determinations of the jet composition by use of paramagnetic resonance methods and the use of chemical reactions at surfaces and in the stream to provide additional information; (e) Mach angle measurements with cones and wedges; and (f) spectroscopic studies of the flow accompanied by theoretical attempts to explain the spectra observed and the relation of these spectra to the thermodynamic state of the gas. In addition, a traversing mechanism and necessary nozzles are to be designed, fabricated and installed.

23.18

Canadian Commercial Corp., Washington, D. C.
SOLID STATE DETECTORS, R. W. Jackson. Project 7112 (802A), Contract AF 33(616)-8373; ARP, ARL.

The contractor is performing research on solid state charged particle silicon detectors (lithium drift process). In the course of the investigation, the contractor shall attempt to fabricate detectors which (1) detect protons whose energy is greater than 15 Mev, (2) are suitable for counting electrons, (3) have resolution better than 150 kev (some counters with better than 50 kev resolution), and (4) increase the area of detection to at least one (1) cm^2.

23.19

C-E-I-R, Inc., Arlington, Va.
GEOPHYSICAL PROBLEMS. Project 8601(804A), Contract

ARL- Aeronautical Research Laboratories
ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARH- Hypersonics Research Lab
ARI- Solid State Physics Research Lab
ARE- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAE- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESRR- Operational Applications Lab

AF 19(628)-676; CRZI, AFCRL.

The contractor furnishes time on computers (IBM 7090 and 1401), programming and consulting services.

23.20

Centre National de la Recherche Scientifique (France).
SOLAR ROCKET RESEARCH, J. Blamont. Project 7649 (770A), Contract AF 61(052)-415; CRZR, AFCRL.

This contract is in partial support of a large effort by the CNRS to obtain data on the far UV and X-ray spectrum of the sun, with the aid of French Veronique rockets. The funds are used primarily for the purchase of American solar pointing controls. The objective of the work is to determine in detail the profiles of a number of resonance lines rather than to extend the spectral range and the numbers of lines. This type of information leads to a height analysis in the critical transition region between the chromosphere and corona. The profiles will be determined by a resonance absorption technique.

23.21

Colorado U., Boulder.
LUNAR POINTING CONTROL, F. C. Wilschusen. Project 8602(804A), Contract AF 19(604)-7293; CRZE, AFCRL.

This contract provides for research studies and investigations leading to the design of a biaxial pointing control for use on an Aerobee rocket. The device will point instruments toward the moon regardless of the roll, pitch and yaw of the rocket. It will be used to support experiments measuring X-ray radiation from the moon.

23.22

Comstock and Wescott, Inc., Cambridge, Mass.
INSTRUMENTATION DEVELOPMENT, R. Sagalyn. Project 8617(804A), Contract AF 19(628)-253; CRZA, AFCRL.

The contractor supports a program for studying the charge densities in the upper atmosphere. Work includes design of time circuits, automatic sweep generators, special transistorized a.c. amplifiers, generating volt meters, etc., all to be integral parts of experiments carried out under this task.

23.23

Convair, San Diego, Calif.
EQUIPMENT LOAN FOR RESEARCH IN SPACE SCIENCES AND RADIO ASTRONOMY, W. C. Erickson. Project 9768(803A), Contract AF 49(638)-561; SRPP, AFOSR.

The purpose of this equipment loan contract is to enable the Convair Scientific Research Laboratory to perform basic research in space sciences and radio astronomy. This equipment is being used at the following locations: Astronautics Division of Convair; Radio Astronomy Site in Clark Dry Lake; and Balloon Launching Site near Fallbrook, California. Dr. Erickson has performed observations of the occultation of the Crab Nebula by the solar corona using the two-mile long spaced array. These observations were highly successful and showed a decrease in the integrated flux from this nebula during the central portion of the occultation.

23.24

Cook Research Labs., Morton Grove, Ill.
INSTRUMENTATION SYSTEM FOR AERODYNAMIC FREE FLIGHT RESEARCH IN THE RANGE OF MACH 0.8 TO 10.0, A. Tamosaitis. Project 7064(806A), Contract AF 33(616)-4293; ARR, ARL.

The purpose of this contract is to obtain research, development and manufacturing effort required for the construction of a 12-station instrument system to support in-house free flight research. This equipment is to be capable of producing shadowgraphs of test models in free flight with a spark duration of less than 0.5 microseconds and to enable the determination of the linear and angular altitude of a model in free flight with accuracies of $\pm$.02 inch and $\pm$.1 degree, respectively.

23.25

Cook Research Labs., Morton Grove, Ill.
DESIGN, CONSTRUCTION AND TEST OF A POSITIVE ION ACCELERATOR, R. Boyar. Project 5620(802A), Contract AF 19(604)-5552; CRRC, AFCRL.

The purpose of this work is to conduct the research, design, construction, test and evaluation necessary for equipment required for carrying out radiation investigations with known and controllable energy on electronic materials and components.

23.26

Danish Meteorological Inst. (Denmark).
ARCTIC MAGNETIC ACTIVITY, K. Andersen. Project 8601 (804A), Contract AF 61(052)-507; CRZI, AFCRL.

The objective of this contract is the operation of a special magnetograph at Godhavn, Greenland, to provide variable-area magnetograms of high latitude magnetic activity. This is part of a chain of stations which supply data for in-house studies.

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SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZM- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

23.27

Dayton U. Research Inst., Ohio.
ROBIN DATA PROCEDURES, A. Engler. Project 6670(770A), Contract AF 19(604)-7450; CRZW, AFCRL.

Robin radar data consisting of space-time coordinates must be reduced in a proper manner to provide winds, density, pressure, and temperature. Consideration will be given to the physics of the problem, errors in the system, necessary assumptions, and suitability of the method for various Robin system users. The contractor has been and is engaged in this effort to produce a digital computer program and a weather station desk-type of reduction as well as reduce some 200 Arcas-Robin shots. Under FY 62 funds, programs for specific computers and engineering services will be provided AMR and AFGC as well as for AWS standardized use. In addition, Robin meteorological data will be compiled to assist in a climatic study.

23.28

Dayton U. Research Inst., Ohio.
DATA REDUCTION, C. C. Peckham. Project 8604(804A), Contract AF 19(604)-5496; CRZH, AFCRL:

The contractor reduces data into booklet form from the recording instruments and other information received from the probing aircraft. The contractor will also provide services at the field site to effectively obtain and transmit measurements to the data processing center.

23.29

Dayton U., Ohio.
SUBJECTS FOR HUMAN FACTORS BASIC RESEARCH, R. Nolan. Project 7183(805A), Contract AF 33(616)-7863; MRSE, AMRL.

Provide professional personnel, space and facilities for basic research on human factors. Provide personnel to serve as subjects in basic research experiments conducted at the contractor facility and at the Behavioral Sciences Laboratory.

23.30

Directorate of Research Analysis, SRAS, AFOSR, Washington, D. C.
COMPUTER SUPPORT, M. G. Jaenke. Project 7856(806A), Internal.

The AFMDC computation facility will be required for calculations in connection with the development of appropriate computational procedures for optimization of flight programs and of physical processes characterising the various phases of the motion as well as for a "check out" of proposed solutions regarding their accuracy and uniqueness.

23.31

Directorate of Research Analysis, SRAS, AFOSR, Washington, D. C.
COMPUTER SUPPORT, M. G. Jaenke. Project 7856(806A), Internal.

The computation facility will be requested to program and compute planetary orbits in support of this task.

23.32

Documentation, Incorporated, Washington, D. C.
MULTIPURPOSE INFORMATION SYSTEM DESIGN, E. Leyman. Project 9769(803A), Contract AF 49(604)-3107; SRIR, AFOSR.

This support research provides tabular printouts in connection with the Documentation, Incorporated, research contract under which multipurpose information system design criteria are being studied. The printouts facilitate rapid analysis of modifications made during the conduct of the research.

23.33

Eberline Instrument Corp., Santa Fe, N. Mex.
SOLAR ELECTRON COUNTER, W. Ford. Project 7649(770A), Contract AF 19(604)-5964; CRZR, AFCRL.

To develop and provide a pulse counting spectrophotometer for use with the Littrow 13 meter spectrograph at the Sacramento Peak Observatory. The receiving element is a photomultiplier. The spectrophotometer will count the discrete photoelectrons emitted by the photocathode which in turn measures the light intensity falling on the cell with the greatest possible precision. The photometer will improve accuracy of line profile measurement from the present 0.2% to better than 0.1%. This apparently small difference has proved to be critical in the interpretation of line profiles.

23.34

Electro-Mechanics Co., Austin, Tex.
MAGNETOGRAM ANALYZER, F. J. Morris. Project 8601 (804A), Contract AF 19(604)-5520; CRZI, AFCRL.

The objective is to develop and operate instrumentation for the reduction of variable-area magnetograms and for the observation of geomagnetic variations. The data assimilator, digitaliser, and analyser (DADA) has been completed and is now being integrated with the government-furnished film scanner to provide a

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system for reducing the variable-area film records to numerical form. The sensitivity of the variable-mu magnetometer has been improved and has been used to record time variations of field on pen-and-ink recorders and on magnetic tape. This instrument will also be used in the equipment for recording the time variations of the space-gradients of the geomagnetic field which is now under development. Recordings of earth-current variations are also under consideration. The reduced, numerical data from the magnetograms will be used in in-house studies of magnetic activity. The observational data on magnetic fields and gradients will also be available for in-house research.

23.35

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
HIGH VACUUM TECHNOLOGY, J. H. Bloom. Project 5634 (803A), Internal.

Basic studies are being conducted on purification of gases, analysis of residues, leakage of light gases, degassing, mass spectroscopy, molecular absorption pumps, titanium sputter pumps, vacuum gauging, absorption and attachment of gases on surfaces and within solids and differential pumping.

23.36

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
PLASMA TECHNIQUES FOR GROWTH OF CRYSTALS, W. G. Field. Project 5621(802A), Internal.

The objective of this research is to make a substantial improvement over the present Verneuil type of crystal growth by replacing the oxy-hydrogen heat source with plasma heat sources. The major advantages to be expected are more precise control of heat source, over a larger range of temperatures, and greater control of the ambient environment by wide selection of gases. Two distinct types of plasma torches have been developed and are ready for final assembly in the new crystal physics facility. One is a conventional plasma torch or jet; the other is based on the principle of utilizing the heat from recombination of polyatomic gases dissociated by R.F. energy. Either can vaporize any known substance.

23.37

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
HIGH VACUUM TECHNOLOGY STUDY, R. Phippe. Project 4619(760E), Internal.

The objective of this study is to continually improve the technology in the attainment of ultra high vacuum. Ion pumps have been designed capable of pumping vacua of 10^{-9} millimeters of mercury. Sealing techniques have been investigated with very very low leak rates. Materials that have good vacuum properties are continually being evaluated. New and improved pumping and processing techniques are under continuous investigation.

23.38

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
PYROGENICS, G. P. Ploetz. Project 5634(803A), Internal.

This effort is concerned with the generation, control and utilization of radiant energy. The capabilities and limitations of existing thermal imaging devices were analysed which led to the clam shell mirror arrangements. In addition, two other ellipsoid arrangements are proposed and are being investigated. An improved carbon arc image furnace has been installed having two paraboloid mirrors in a vertical clam shell arrangement. A double clam shell arrangement is being developed which will image two high temperature sources onto a common image volume which will result in higher temperatures than are presently achieved. In addition, the feasibility of a vacuum carbon vapor source has been demonstrated and numerous vacuum image chambers and related techniques have been developed.

23.39

Electronic Material Sciences Lab., CRR, AFCRL, Bedford, Mass.
IMAGING FURNACE FOR CRYSTAL GROWTH, D. L. Stephens. Project 5621(802A), Internal.

A small furnace employing two clam-shell thermal imagers focusing on a crystal rod is being constructed. A specimen stage, providing motions for "float zone" and "pulling" techniques, in vacuum or atmospheres, has been completed. The entire furnace is undergoing preliminary tests prior to final assembly in the new crystal physics facility. This furnace holds promise both for crystal growth and research studies because of the high temperatures attainable with suitable sources, elimination of specimen contamination from the heat source, and ability to control the point of application of the thermal energy.

23.40

Fluid Dynamics Facilities Lab., ARF, ARL, Dayton, Ohio.
HIGH-ENTHALPY AIR SIMULATION METHODS, R. G. Dunn, E. J. Walk. Project 7065(806A), Internal.

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CRRZ- Control Sciences Lab
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CRUA- Photochemistry Lab
CRUC- Thermal Radiation Lab
CRUE- Research Instrumentation Lab
CRUG- Terrestrial Sciences Lab
CRUH- Meteorological Research Lab
CRUI- Ionospheric Physics Lab
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This effort was initiated to accomplish research to determine the most suitable technique(s) for obtaining high enthalpy air (up to 9000°R stagnation temperature) for use in continuous type wind tunnels for hypersonic research at Mach numbers up to 33. The present internal effort is confined to the chemical reaction technique as applied to the decomposition of nitrous oxide (N_2O) to obtain air temperatures between 3000° and 5000°R. The composition of the heated product will be made identical to that of air by the addition of nitrogen and other components as required. A theoretical analysis and experimental investigation is underway.

23.41

Fluid Dynamics Facilities Lab., ARF, ARL, Dayton, Ohio.
HYPERSONIC WIND TUNNEL DESIGN, E. J. Walk. Project 7065(806A), Internal.

This effort provides the research necessary to design a facility which can accomplish hypersonic testing over the Mach number range of 8 to 33. The designs have been divided into three phases. Phase I is the design of a hypersonic wind tunnel having the capability of operating in the Mach number range 8 to 14. Phase II is the design of an advanced hypersonic wind tunnel having the capability of extending the operating range of the facility to Mach number 20. Phase III is the design of an advanced hypersonic wind tunnel having the capability of operating in a range up to Mach number 33. The design, construction, and installation of the 20-inch Mach 14 hypersonic wind tunnel is complete except for installation and check-out of a new shut-off valve for the main tunnel flow. Completion of Phase II has led to a contract for design and construction of the 30-inch Mach 20 Hypersonic Wind Tunnel. Flow tables for the expected conditions in the test cabin are being calculated.

23.42

FluiDyne Engineering Corp., Minneapolis, Minn.
HYPERSONIC WIND TUNNEL FACILITY FOR OBTAINING DATA OVER THE MACH 14-20 RANGE, L. Frame. Project 7065 (806A), Contract AF 33(616)-7526; ARF, ARL.

Design, construction, and installation (at ARL) of a hypersonic research facility for obtaining research data for the range Mach 14 to 20 is underway. The major components of the facility include an air heater, settling chamber and ducting, valving, nozzle, test cabin, diffuser, air cooler, structural supports, temperature and pressure control system, and model test instrumentation system. The instrumentation system includes a six component balance system, model support mechanism, model surface pressure measuring system, model surface temperature measuring system, calibration equipment and rigs, and remote control console.

23.43

FluiDyne Engineering Corp., Minneapolis, Minn.
INSTRUMENTATION SYSTEM FOR OBTAINING DATA WITH 20-INCH HWT OVER THE MACH 8-14 RANGE, L. Frame. Project 7065(806A), Contract AF 33(616)-7543; ARF, ARL.

This contract provides for the design, development, installation and demonstration of the performance of an instrumentation system for obtaining research data with the 20-inch hypersonic wind tunnel of the Aeronautical Research Laboratory over the Mach 8-14 range. The major components of the system will include a three component balance system, model support mechanism, model surface pressure measuring system, model surface temperature measuring system, calibration equipment and rigs, and control console from which all instrumentation will be controlled.

23.44

General Electric Co., Lynn, Mass.
MATHEMATICAL COMPUTATIONS, L. Berkofsky. Project 8604(804A), Contract AF 19(604)-5736; CRZH, AFCRL.

To perform numerical integration on the IBM 704/709 high speed computer of the hurricane models.

23.45

General Electric Co., Cincinnati, Ohio.
COMPUTATIONS ON A HIGH SPEED ELECTRONIC COMPUTER. Project 8604(804A), Contract AF 19(604)-8745; CRZE, AFCRL.

Computations in support of investigations into the relationship between weather and the variations in solar activity.

23.46

General Physics Research Lab., ARP, ARL, Dayton, Ohio.
SOLID STATE DEVICES FOR NUCLEAR RADIATION DETECTION, W. J. Price, M. J. Bina, W. L. Lehmann. Project 7112(802A), Internal.

One objective of this research is to determine if the II-VI compounds being grown and investigated extensively in the Solid State Physics Branch of ARL have properties which make them particularly suitable as a basic material for nuclear radiation detectors. In particular, it is hoped that the high atomic weight materials, such as CdS and ZnS, can be utilized in detectors with thick depletion

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regions, thereby making them useful for detecting higher energy particles than is possible with the conventional silicon solid state detectors. An attempt will be made to fabricate solid state devices for nuclear radiation detection. Both the diffusion type and surface barrier type detectors will be investigated. A separate effort will investigate analytically and experimentally the optimization of a neutron spectrometer design utilizing the $Li^6(n,\alpha)H^3$ reaction, and incorporating two solid state detectors sandwiched around a thin Li film.

23.47

George Washington U., Washington, D. C.
COMPUTING FACILITY; A. M. Griffin. Project 9777 (805A), Contract AF 49(638)-715; SRL, AFOSR.

A Flac II computer, surplus to Air Force operational needs, has been loaned to George Washington University for use in developing a program of research in medical and biological problems. Some of the research will result from collaboration with scientists in other laboratories.

23.48

Geo-Science, Inc., Alamogordo, N. Mex.
INVESTIGATION OF NIGHT AIRGLOW, M. Jones. Project 8627(804A), Contract AF 19(604)-3489; CRZA, AFCRL.

Intensification of effort in the reduction of data, designing and constructing of new instrumentation and assisting GRD scientists during rocket launchings. Maintain and service the instrumentation for the measurement of the night airglow at Sacramento Peak, N. M.

23.49

Geo-Science, Inc., Alamogordo, N. Mex.
SOLAR DATA INTERPRETATION, M. Jones. Project 7649 (770A), Contract AF 19(604)-7993; CRZR, AFCRL.

Contractor performs data reduction (microphotometer tracing, computing, programming for large computer, curve reading, etc.), and experimental electronic work in instrument development.

23.50

Hughes Aircraft Co., Culver City, Calif.
DESIGN AND FABRICATION OF RADIATION DOSIMETRY INSTRUMENTS FOR TISSUE EQUIVALENT MANIKINS, K. Hoalst. Project 8803(805A), Contract AF 29(601)-4607; SWR, AFSWC.

The contractor is responsible for the design and fabrication of radiation dosimetry instruments for installation in the tissue equivalent manikins. The instruments will be designed for insertion in pre-formed holes in the humeri, femurs, spinal column, mediastinum, abdomen, testicles and head of the manikin. Physical design parameters are to be rigidly adhered to in order to meet the weight limitations, environmental conditions and other stresses to be encountered by man in space. The signal output of the devices will be a DC voltage or an integrating pulse system which is compatible with existing space vehicle telemetry.

23.51

Idealab, Norfolk, Mass.
FOURIER ANALYSIS, J. L. Pritchard. Project 7670 (770A), Contract AF 19(604)-8457; CRZC, AFCRL.

The effort is directed toward the study and determination of the best method of obtaining the power spectrum of a function by Fourier analysis of its auto-correlation function which is the output of an interferometric modulator, and the design and construction of necessary instrumentation to obtain Fourier transforms. The study and determination of the optimum method has been completed and the necessary components for an analog instrument are being designed and constructed. This analog instrument will be used to obtain the Fourier transforms of interferometric data obtained from various interferometers in use or being constructed for use.

23.52

Illinois U., Urbana.
DATA PROCESSING AND ANALYSIS OF DATA OBTAINED IN HIGH ENERGY PHYSICS EXPERIMENTS, L. S. Lavatelli. Project 9751(801A), Contract AF 49(638)-661; SRPN, AFOSR.

Programming of computer for processing data from bubble chamber and other detectors used in studying nuclear reactions. The computer will be the Illiac computer at the University of Illinois.

23.53

Instron Engineering Corp., Canton, Mass.
DESIGN AND EVALUATION FOR NEW AND IMPROVED PHYSICAL TESTING MACHINE, D. Erb. Project 7024(802A), Contract AF 33(616)-8419; ARZ, ARL.

The purpose of this contract is to provide for the research and evaluation leading to the design and construction of an experimental model of a physical testing device for materials research.

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23.54

Instrument Corp. of Florida, Melbourne.
OPTICAL GEODETIC RESEARCH, B. Glass. Project 7600 (770A), Contract AF 19(604)-5967; CRZG, AFCRL.

During the past year, this contractor has completed 6 PC-1000 geodetic stellar camera systems and is now assisting in the field testing of all these units on an AFCRL experiment on the the Pacific Missile Range. The contractor will now do research into the design and fabrication of photo multiplier capabilities for these cameras and will furnish research engineering support to a major in-house test of the camera systems during the spring, 1962.

23.55

International Telephone & Telegraph Corp., Nutley, N. J.
GROWTH OF SINGLE CRYSTALS BY THERMAL FUSION UTILIZING R.F. HEATING, P. Lightly. Project 5621(802A), Contract AF 19(604)-7219, CRRC, AFCRL.

The flame fusion process for the growth of single crystals has several serious drawbacks. This contract was initiated for the purpose of modifying the conventional process in order to obtain more perfect crystals. A method was developed in which the usual flame is replaced by an r.f. heat source which, consequently, permits maintaining a controlled atmosphere. This technique has been developed into a successful method for the growth of single crystals. Crystals of ferrites, germanium, silicon, and other materials have been grown. The equipment has also been developed into a usable configuration.

23.56

Ionospheric Physics Lab., CRZ, AFCRL.
ROCKET EXPLORATION OF THE MAGNETIC FIELD IN SPACE, R. O. Hutchinson. Project 7601(770A), Internal.

This in-house effort includes: (1) the technical inputs involved in initiation, monitoring, and evaluating of the task's contracts; (2) active participation in the small rocket probe program including vehicle assembly and testing and duties as project scientist for the actual launch; (3) participation at the experimental and consultative level in the piggy-back satellite and probe rocket programs; and (4) final analysis, preparation and publication of the results obtained from the data collected.

23.57

Ionospheric Physics Lab., CRZ, AFCRL, Bedford, Mass.
EM INSTRUMENTATION, J. F. Kalliher. Project 7601 (770A), Internal.

Newly developed or acquired magnetic instrumentation is carefully compared with existing units and then modified or incorporated into the existing observatory equipment as required. Special instrumentation is constructed to meet the specific needs of the project and tests are performed to determine the magnetic moments of each component scheduled for installation in vehicles for magnetic measurements. Facilities are designed and constructed to simulate the electromagnetic conditions thought to exist in the ionosphere and in the magnetosphere.

23.58

Iowa State U., Iowa City.
EDDY FLUX MEASUREMENTS, R. M. Stewart. Project 8604 (804A), Contract AF 19(604)-5457; CRZH, AFCRL.

Development of basic instrumentation to measure eddy fluxes of momentum, heat and water vapor.

23.59

Johns Hopkins U., Baltimore, Md.
BALLOON ASTRONOMY, J. Strong. Project 8602(804A), Contract AF 19(628)-202; CRZI, AFCRL.

The contractor will design and develop instrumentation to be flown aboard a stabilized balloon-borne platform for the purpose of astronomical investigations of the moon and planets. The contractor will interpret data obtained during these flights.

23.60

Keithly Instrument Co., Cleveland, Ohio.
CHARGE DENSITIES, J. Praglin. Project 8617(804A), Contract AF 19(604)-5513; CRZA, AFCRL.

The design, development and construction of a variety of micro-microammeters which are an integral part of electrical structure instrumentation. The experiment is to be flown on rockets and satellites. A new expanded constructual program will include the design and development of a special extremely low current electrometer required for deep space probe experiments for the measurement of the concentration, directional dependence and energy distribution of charged particles in the interplanetary gas.

23.61

Kiruna Geophysical Observatory (Sweden).
ACTIVITY RECORDERS, B. Hultqvist. Project 8601(804A), Contract AF 61(052)-237; CRZI, AFCRL.

The objective of the research is the development of a magnetic data digitalizer and operation of a single-component variable-area magnetograph. The digitalizer

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ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

AFD- Aeronautical Systems Division
AFRC- Directorate of Materials & Processes
AFRME- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
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AEDC- Arnold Engineering Development Center
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provides information from the magnetograph directly in the form of punched paper tapes which may be processed on computers to provide the information normally published by magnetic observatories but more promptly than is now current practice. Trial runs have been made, but the digitalizer has not yet reached the stage of routine operation. The variable-area magnetograms will supply data for in-house studies of magnetic activity.

23.62

Lion, K. S., Consulting Engineers.
IMAGE INTENSIFIER, K. S. Lion. Project 7661(770A), Contract AF 19(604)-5704; CRZI, AFCRL.

An image intensifier device is being studied and improved upon for applications in low light level observations such as aurora and airglow spectroscopy and photography.

23.63

Little, Arthur D., Inc., Cambridge, Mass.
COMPOUND IMAGER WITH CONTROLLABLE HIGH POWER HIGH TEMPERATURE SOURCE, P. E. Glaser. Project 5634 (803A), Contract AF 19(604)-8465; CRRC, AFCRL.

The object of this program is to develop a compound imager. This research is needed for the development of high temperature electronic equipment for future air and space craft.

23.64

Little, Arthur D., Inc., Cambridge, Mass.
ACCELERATION OF MACRO PARTICLES, Project 7667(770A), Contract AF 19(604)-7480; CRZA, AFCRL.

Research on means of explosively accelerating pellets to high velocities, and design and development of a suitable configuration shaped charge to be used on a re-entry vehicle for study of meteors entering the earth's atmosphere.

23.65

Lockheed Aircraft Corp., Sunnyvale, Calif.
VAN ALLEN HIGH ENERGY PROTONS, R. D. Moffat. Project 8600(804A), Contract AF 19(604)-8028; CRZI, AFCRL.

Spectrometers will be designed and built for the measurement of high-energy protons in the Van Allen belt. The instruments are to be capable of taking measurements so as to obtain the proton flux above 100 Mev in at least three energy intervals, at least two of which lie above 250 Mev. Cerenkov detectors will be used for the upper energy intervals. Either scintillation counters or Cerenkov counters will be used for the lower energy intervals, depending upon the telemetry complexity and weight permitted in the vehicle and the difficulty in providing in-flight calibration.

23.66

Lowell Technological Inst. Research Foundation, Mass.
ROCKET INSTRUMENTATION, K. Kinnard. Project 7661 (770A), Contract AF 19(604)-8071; CRZI, AFCRL.

Design, fabricate and assist in field operation of optical and electronic equipment for rocket and satellite auroral studies. The studies will investigate the far ultraviolet emissions not observable with ground instruments.

23.67

Lowell Technological Inst. Research Foundation, Mass.
SHOCK TUBE RESEARCH AID, K. L. Rogers. Project 8635 (804A), Contract AF 19(604)-8481; CRZI, AFCRL.

Before the in-house shock tube is available, to provide final design, construction, installation, and preliminary testing and operation of in-house shock tube; to operate, to provide maintenance, and to carry out experiments with the shock tube and auxiliary equipment; to design, construct or otherwise provide and install scientific equipment as needed to achieve the ends of these experiments. These ends are the determination of the fundamental optical properties of astrophysically important gases at the temperatures of the surfaces of stars and in particular to determine the oscillator strengths (f-values) of atomic (and, later, molecular) transitions in order to be able to interpret the observed stellar line strengths to determine the number of atoms or molecules that must be radiating in the source.

23.68

Massachusetts Inst. of Tech., Cambridge, Mass.
DEVELOPMENT OF HIGH FIELD COILS USING CRYOGENIC METHODS, S. Collins. Project 8608(801A), Contract AF 19(604)-7460; CRZC, AFCRL.

To investigate the problems of production of intense magnetic fields using low temperature coils. It is the function of the research to determine whether the saving in power and the increased strength of metals at low temperatures justify the utilization of refrigerants such as liquid nitrogen or oxygen and liquid hydrogen.

23.69

Massachusetts Inst. of Tech., Cambridge.
MAGNETIC SUSPENSION AND BALANCE SYSTEM FOR WIND TUNNEL

AFOSR- Air Force Office of Scientific Research
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SRC- Directorate of Chemical Sciences
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SRM- Directorate of Mathematical Sciences
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AFCRL- Air Force Cambridge Research Laboratories
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CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
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CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

USE, E. E. Covert. Project 7065(806A), Contract AF 33(616)-7023; ARN, ARL.

The contractor is performing theoretical and experimental research on a magnetic model-suspension and balance system capable of magnetically suspending a model in a supersonic and/or hypersonic airstream and simultaneously indicating the lift, lateral and drag forces acting on the model. The whole system is composed of horseshoe electromagnets, which control vertical and lateral position, and an air-core solenoid which balances the drag force. Forces and moments on the model (which has a ferromagnetic core) are obtained through current measurements in the drag coil and in each leg of the horseshoe magnets. Temperatures will be sensed optically and pressures measured through a simple telemetry arrangement.

23.70

Massachusetts Inst. of Tech., Cambridge.
INSTRUMENTATION FOR NUCLEAR PHYSICS RESEARCH, M. Deutsch, P. T. Demos. Project 9751(801A), Contract AF 49(638)-181; SRPN, AFOSR.

This project has had two objectives: first, the development and use of nuclear spectroscopy apparatus, and second, development of electronic apparatus for the more efficient recording, storage, and read out of nuclear data. An additional improvement, a multigap precision analyzing magnet, is being added to the equipment. Since some of the data is taken by means of nuclear emulsions, an automatic scanning system to speed data read out is being developed. The 256 channel, pulse height analyzer permits simultaneous data collection over a wide spectrum or, if but a very narrow band is of interest, the system can be split so that data from several sources may be analyzed simultaneously.

23.71

Massachusetts Inst. of Tech., Cambridge.
RAPID MEASUREMENT OF GAS TEMPERATURES IN THE RANGE OF 4000°K to 8000°K, H. T. Hottel. Project 7021 (802A), Contract AF 33(616)-6570; ASRC, ASD.

This program is for the continuation of the development of a photoelectric pyrometer technique for the measurement of gas temperatures in the range of 4000° to 8000°K at 0.01 to 10 atmospheres pressure. The general techniques are: (a) inter-comparison of the direct radiation from the plasma jet, the direct and the reflected radiation from the plasma jet, and the radiation from a calibrated tungsten lamp; (b) additives to the plasma to increase the radiation of selected spectral lines; and (c) additives to the plasma to increase the radiation of the continuum. A photoelectric pyrometer is nearing completion. The technique or techniques ultimately developed together with the pyrometer will be evaluated thoroughly with respect to accuracy, ability to measure temperature distributions within a plasma, the response time of the instrument, and the adaptability for use by relatively untrained personnel.

23.72

Massachusetts Inst. of Tech., Cambridge.
CLOUD PHYSICS INSTRUMENTATION, D. P. Keily. Project 8620(804A), Contract AF 19(604)-3050; CRZH, AFCRL.

Research on and development of single unit instrumentation for measuring cloud and drizzle drop numbers and sizes from a moving aircraft platform.

23.73

Massachusetts Inst. of Tech., Cambridge.
HIGH MAGNETIC FIELD RESEARCH, B. Lax. Project 9764 (802A), Contract AF 19(604-7344; SRPS, AFOSR.

The aim of this effort is to establish a national magnet laboratory for the purpose of conducting a program of fundamental research on the properties and behavior of matter in very high magnetic fields. Continuous magnetic fields of approximately a quarter-million gauss could be generated by the 8-megawatt power supply. On occasion more intense pulsed fields could be generated by operating the power plant for short periods of 32-megawatts. Research will be conducted on, but not be limited to, (a) optical properties of solids, (b) magneto-optical phenomena in semiconductors, (c) Mössbauer effect on electronic properties of solids in high external fields, (d) galvanomagnetic and thermomagnetic effects in semiconductors and metal alloys, (e) tunneling characteristics of semiconductors in magnetic fields, (f) new techniques for low temperature physics, (g) hyperfine atomic structures, (h) interaction of electrons, ions, neutral-atoms-plasmas-with strong magnetic fields, (i) generation of coherent millimeter and sub-millimeter waves, and (j) superconducting magnets.

23.74

Materiadyne Corp., Avon, N. Y.
METHODS OF CONTROLLING FURNACE TEMPERATURE, W. Crandall. Project 7022(802A), Contract AF 33(616)-8286; ARC, ARL.

The constant strain rate micro-creep apparatus under construction for the internal effort entitled, "Measurement of Surface Free Energy of Solids" requires a constant temperature furnace that involves an improvement of an order of precision in the state of the art of furnace temperature stability circa 1000°C. This furnace has been designed and is being built to include a Robert's control circuit.

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23.75

McPherson Instruments Corp., Acton, Mass.
INTERFEROMETRIC MODULATOR, P. McPherson. Project 7670(770A), Contract AF 19(604)-8027; CRZC, AFCRL.

The objectives of this contract is the design and construction of a lamellar-grating type interferometric modulator which will be used for spectral measurements in the 10-150μ region. This instrument will be used in in-house researches on far-infrared and interferometric techniques and the study of molecular absorption. It will also supplement the extreme far-infrared lamellar grating instrument which is in operation in the region from 150μ to 1000μ and the shorter wavelength (less than 30μ) prism-grating instruments in use in this laboratory.

23.76

McPherson Instrument Corp., Acton, Mass.
TESTING OF A SUITABLE MECHANICAL MOUNT AND ASSOCIATED AUXILIARY EQUIPMENT FOR A SIX-INCH PLATE MACH-ZEHNDER INTERFEROMETER, P. M. McPherson. Project 8635(804A), Contract AF 19(604)-8845; CRZI, AFCRL.

The purpose of this work is to fabricate, install, and test the performance of a suitable mechanical mount and associated auxiliary equipment for a six-inch plate Mach-Zehnder Interferometer.

23.77

Measurement Systems, Inc., South Norwalk, Conn.
SCATTERING MEASUREMENTS, R. Yoder. Project 7670 (770A), Contract AF 19(604)-8365; CRZC, AFCRL.

This work is concerned with the design and construction of instrumentation for the measurement of the scatter of infrared radiation by atmospheric aerosols. One prototype nephelometer is presently being completed and will be used for scattering studies. The effort will be to continue to improve the measuring techniques and instrumentation.

23.78

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
ANALYSIS OF DIFFUSION AND DEPOSITION DATA, M. L. Barad. Project 8604(804A), Internal.

Analysis of diffusion and deposition data collected in USAF, U. S. Army and U.S.A.E.C. experiments.

23.79

Meteorological Research Lab., CRZ, AFCRL, Bedford, Mass.
LOCAL READOUT, J. C. Sadler. Project 6698(770A), Internal.

Applied research on utilization of local read-out of satellite pictorial data for operational purposes. This included: (1) testing of various read-out equipments to determine effect of read-out quality on photo-interpretation; (2) procedures for earth location and extraction of data; and (3) conveying results to the field in minimum time by use of manuals and field trips.

23.80

Miami U., Coral Gables.
USE OF FLORIDA AUTOMATIC COMPUTER I, J. H. Curtiss. Project 9769(803A), Contract AF 49(638)-963; SRMA, AFOSR.

This contract permits the subject computer to be operated by the University of Miami for faculty research purposes, government requirements, and the general welfare of the region.

23.81

New Mexico U., Albuquerque.
DEVELOPMENT OF OZONE-MEASURING DEVICES, V. Regener. Project 8604(804A), Contract AF 19(604)-7211; CRZH, AFCRL.

Studies and investigations directed toward the development and testing of an inexpensive, balloon borne, expendable, dry-chemical type device for measuring atmospheric ozone concentrations from the surface to 40 kilometers. One hundred sondes will be furnished for testing purposes. The contractor will also be developing an aircraft ozone meter based upon the dry-chemical principle.

23.82

Nobel Inst. for Physics (Sweden).
DEVELOPMENT OF METHODS AND TECHNIQUES FOR INVESTIGATIONS IN THE ULTRAVIOLET (2000 - 20 Å) AND RESEARCH IN THIS REGION OF RADIATION, M. Siegbahn. Project 7073(806A), Contract AF 61(052)-462; AEH, ARL.

The contractor has designed and has under construction two spectrometers, one for normal incidence and the other utilizing ruled toroidal mirrors for grazing incidence, to cover the vacuum ultraviolet radiation region from 2000 to 20 Å. It is designed to have both photographic registration and arrangements for alternatively using a photomultiplier and recorder for registering the spectra. Light sources for a wavelength region 20 - 800 Å are under development.

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23.83

Northeastern U., Boston, Mass.
ELECTRIC FIELD INSTRUMENTATION, L. Nardone. Project 8617(804A), Contract AF 19(604)-7225; CRZA, AFCRL.

The design, development and testing of rocket and satellite instrumentation to measure upper atmospheric electric force fields. To reduce and process automatically the data obtained from these flights. The contractor will provide support for the theoretical analysis of the experimental designs and for the interpretation of results of the experiments carried out under this program.

23.84

Northeastern U., Evanston, Ill.
ROCKET SUPPORT, R. Slavin. Project 8600(804A), Contract AF 19(604)-3506, AF 19(604)-7345; CRZI, AFCRL.

Integration of instrumentation packages and telemetering equipment into rocket vehicles.

23.85

Ohio State U., Columbus.
THERMO-AERODYNAMIC CHARACTERISTICS IN HYPERSONIC FLOW TECHNIQUES, J. D. Lee. Project 7065(806A), Contract AF 33(616)-5593; ARF, ARL.

This research program was established to analyze problems associated with hypersonic aerodynamic simulation. The contractor utilizes a hypersonic wind tunnel facility presently capable of obtaining stagnation temperatures up to 2800°R and stagnation pressure on the order of 3000 psi. Under the new contract extension, the contractor will continue research on methods for heating air up to 10,000°R, methods for reliably sensing and measuring these air temperatures and studies of the thermal decomposition of nitrous oxide to produce high temperature air for wind tunnels. After the ARL 30-inch wind tunnel becomes available for testing, the contractor will perform nozzle flow studies, determine the characteristics of the entire system comprising the 30-inch tunnel, provide the necessary scientific personnel to accomplish a complete calibration of the tunnel facility, and design and fabricate models and probes.

23.86

Ohio State University, Columbus.
UNCONVENTIONAL REFRIGERATION TECHNIQUES, G. MacWood. Project 8503(803A), Contract AF 30(602)-2162; RAUA, RADC.

New and unconventional methods of refrigeration which may be capable of producing cryogenic temperatures are being investigated. A survey and analysis of cooling phenomena during the first year's effort resulted in the following phenomena being proposed for further study: (a) adiabatic absorption of para-hydrogen; (b) thermo-elastic cooling effect.

23.87

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
ELECTRIC FORCE FIELDS, R. C. Sagalyn. Project 8617 (804A), Internal.

Design and development of instruments for measuring electric fields and conductivity of the high atmosphere.

23.88

Photochemistry Lab., CRZ, AFCRL, Bedford, Mass.
METEORITE DAMAGE, R. K. Soberman. Project 6694 (750F), Internal.

Design, test and evaluation of instrumentation and methods to determine possible aerospace environment damage to energy conversion systems.

23.89

Price-Cleveland Corp., Cleveland, Ohio.
CONSTANT STRAIN RATE MICRO-CREEP MECHANISM, P. Price. Project 7022(802A), Contract AF 33(616)-4313; ARC, ARL.

Design and fabrication of a constant strain rate micro-creep apparatus is underway. A feasibility study of different concepts of design has been completed and from the information obtained, the so-called electrodynamic concept has been chosen. This concept consists essentially of (1) a direct acting linear motion magnetic motor which applies a very slow constant rate of strain to the sample fiber, and (2) a differential amplifier whose output measures the resulting continuously varying force on the fiber and whose performance includes continuous sensing and comparison of a remotely generated ramp input and a feedback signal derived from an elongation sensing transducer applied across the length of the fiber.

23.90

Princeton U., N. J.
HYPERSONIC HIGH TEMPERATURE AIR WIND TUNNEL, S. Bogdonoff. Project 9781(806A), Contract AF 49(638)-709; SRE, AFOSR.

The contractor will conduct analytical and experimental research in hypersonic gas dynamics which will include the following studies: (a) design and

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fabricate a hot air hypersonic tunnel capable of providing aerodynamic studies in the mach number range of 12 to 20, correct hypersonic flight, Reynolds number, air temperatures of the order of 5500-6000°F and stagnation pressures of the order of 10,000 p.s.i.; (b) design and fabricate an ultra high pressure system (15,000 p.s.i.) and a high capacity vacuum system to provide the requirements outlined in (a) above; (c) design and fabricate a series of pieces of tunnel equipment (nozzles, plenum chambers, diffusers, etc.) each designed for different temperature, mach number and Reynolds number ranges and provide related instrumentation and calibration equipment to operate the hot air hypersonic tunnel; and (d) concurrently with (a), (b), and (c), do analytical work in hypersonic gas dynamic theory and formulate specific problems which are suitable for experimental study upon completion of the hot air hypersonic tunnel.

23.91

Princeton U., N. J.
SATELLITE TELESCOPE, L. Spitzer. Project 8635 (804A), Contract AF 19(604)-4972; CRZI, AFCRL.

The recent offer of NASA to provide the vehicle in FY 65 with high stabilization capability now allows the contractor to concentrate on the astronomical instrument and associated equipment. A sub-contract for the design of high-reliability pulse counting, data storage, and programming equipment has been completed. The contractor has modified his premises and installed a new concept McPherson vacuum UV monochromator and experimental optical chamber. He is proceeding with an intensive study of the surface properties of optical mirrors in the far UV to try to achieve optical perfection at critically short wave lengths combined with mirrors of vastly less rigidity than normal in the attempt to save weight. The telescope aperture is to be 24 inches. The aim is to detect, and to measure by photomultiplier, new interstellar absorption lines in the spectrum of luminous, hot, distant stars in our galaxy.

23.92

Ramo-Wooldridge Corp., Los Angeles, Calif.
GENERATION AND ELECTROSTATIC ACCELERATION OF HEAVY CHARGED PARTICLES SUITABLE FOR PROPULSION, D. Langmuir. Project 7116(801A), Contract AF 33(616)-6775; ARH, ARL.

This is a research program to obtain new knowledge of the various parameters influencing the generation and charging of multimolecular particles. The effects of conductivity, voltage, surface tension, electrode configuration, polarity, and vapor pressure on such items as electrical field absorption, particle stability, charge/mass ratios, and charge/mass distribution will be investigated for different materials. Studies are being made with organic liquids, fused salts, and liquid metals.

23.93

Reaction Motors Div., Thiolok Chemical Co., Denville, N. J.
ACCELERATION OF HEAVY PARTICLES, H. G. Wolfhard. Project 9752(801A), Contract AF 49(638)-924; SRE, AFOSR.

The purpose of this effort is to study the fundamental aspects of the acceleration of heavy solid particles as related to propulsion by the in situ generation and charging of small particles, studying the properties of very small particles, the generation, focusing and fluid properties of charged particle beams and the utilization of high voltages at low pressure. This year's research is directed to charging discrete particles and overcoming surface effects that cause agglomeration.

23.94

Research Directorate, SWR, AFSWC, Kirtland AFB, New Mexico.
DESIGN AND DEVELOPMENT OF SOLAR FLARE SATELLITE INSTRUMENTATION, R. E. Linkous. Project 8803(805A), Internal.

The contractor will provide concepts, specifications and design drawings for instrumentation capable of measuring ionizing radiations beyond the earth's atmosphere resulting from solar flares. Selected instruments will be fabricated and flown and the data collected used in determining solar flare radiation hazards, shielding design requirements to protect man from these radiations and possibly, solar flare prediction methods. The instrumentation and telemetry systems would be passive except during periods of flare activity at which time they are automatically activated.

23.95

Research Div., AEOR, AEDC, Tullahoma, Tenn. (ARO, Inc.).
CRYOGENIC VACUUM PUMPING, E. S. J. Wang. Project 806A), Internal.

This will be a basic theoretical and experimental study involving cryopumping techniques with the objective of developing theories and generalized relationships which can be subsequently applied to the development and design of future aerospace testing facilities. This will consist of: (a) determination of cryopumping speed per unit area for atmospheric gases and cold surface temperatures from 100°K to 4°K; (b) investigation of the removal of noncondensable

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gases by interaction with condensable gases; and (c) investigation of the cold diffusion pump, i.e., where a condensable gas is used as the working fluid and condensed as a solid.

23.96

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
BALLOON INSTRUMENTATION DEVELOPMENT, R. J. Cowie. Project 6665(850A), Internal.

Studies and laboratory developments are conducted in all phases of electronic and mechanical flight and support instrumentation (telemetry, control, safety, flight assemblies, rigging, etc.) to meet current and future requirements of balloon vehicle R&D. Flight activities for development test of new balloon vehicles are conducted including flight preparation, launching, in-flight performance monitoring, modification and retest.

23.97

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
ENVIRONMENTAL RESEARCH SUPPORT, J. F. Dwyer. Project 6665(850A), Internal.

This encompasses (1) analytical studies to evolve and evaluate balloon design and performance theories, (2) the planning and post flight analysis of balloon flights to test new designs and novel construction practices, (3) the evaluation and modification of manufacturing processes and quality control procedures, (4) the preparation of engineering standards and specifications, (5) the establishment and evaluation of test methods for balloon materials and balloon production controls, (6) the development of balloon employment techniques and associated equipment, and (7) counsel on balloon capabilities, design and employment on an Air Force wide basis.

23.98

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
ROCKET INTEGRATION, L. Kraff. Project 8600(804A), Internal.

Integration of instrumentation packages and telemetering equipment into rocket vehicles.

23.99

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
BALLOON INSTRUMENTATION, R. A. Van Tassel. Project 8602(804A), Internal.

Develop spectroscopic, radiometric, and photographic instrumentation for use aboard a balloon-borne platform.

23.100

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
BALLOON NAVIGATION DEVICES, W. C. Wagner. Project 6665(850A), Internal.

Study of the extensive navigational research and development conducted within the DOD for possible applications to balloon-borne requirements. An airborne device of cost compatible with other balloon instrumentation is desired that will report in-flight position over long ranges without a requirement for an extensive network of ground based stations.

23.101

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
BALLOON SENSING ELEMENTS, W. C. Wagner. Project 6665(850A), Internal.

Development of sensing elements compatible with the various balloon telemetering systems for measuring all parameters required for balloon performance analysis and environmental studies for balloon design. Establish and maintain calibration and test facilities and standards to guarantee the required accuracy and reliability of the sensing devices.

23.102

Research Instrumentation Lab., CRZ, AFCRL, Bedford, Mass.
GRAVITY AT ALTITUDE, O. W. Williams. Project 8607 (804A), Internal.

This research effort is directed toward the construction of a computational program which will produce an extrapolated model of the gravity field at specified altitudes based on data from surface gravity values.

23.103

RIAS Inc., Baltimore, Md.
SPACE PROBE INSTRUMENTS, J. Martin. Project 8600 (804A), Contract AF 19(604)-7244; CRZI, AFCRL.

Instrumentation will be designed, developed and produced for the measurement of neutrons, heavy primaries and other cosmic ray components of interest in near-earth space. The instrumentation must be so conceived and constructed as to permit installation in rockets and satellites and capable of transferring

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its output into a form suitable to transmission to the ground by telemetry.

23.104

Rutgers U., Brunswick, N. J.
ELECTRONIC VERNEUIL FURNACE, W. H. Bauer. Project 5621(802A), Contract AF 19(604)-8495; CRRC, AFCRL.

In the usual Verneuil growing furnace, it is difficult, if not impossible, to control the environment around the crystal being grown. In order to control the environment, it is desirable to replace the oxy-hydrogen flame with some other source of heat. One excellent method is to utilize a plasma. This contract is to conduct research and development on this type of crystal growing technique. The contractor is conducting a basic study of the physics involved and the design and operation of equipment to investigate these techniques.

23.105

Sacramento Peak Observatory, CRZ, AFCRL, Bedford, Mass.
ECLIPSE EXPEDITIONS, J. W. Evans. Project 7649 (770A), Internal.

Prepare equipment and conduct eclipse expeditions. The next two eclipses will be in February 1962 and in July 1963.

23.106

Southwest Research Inst., San Antonio, Tex.
THERMAL RADIATION MONITORING METHOD, J. C. Cook. Project 6886(802A), Contract AF 29(600)-2449; SRA, AFOSR.

The purpose of this contract is to study methods for sampling of energy flux across the focal area of a solar concentrator. By rapid scanning the energy flux can constantly be monitored and the energy distribution be determined. After theoretical analysis of suitable optical and electrical sampling devices the function of a complete instrument will be studied in an arc furnace. The instrument will finally be applied to research work using the AFMDC 5-Foot Solar Furnace.

23.107

Spectrolab, Inc., N. Hollywood, Calif.
CONSTRUCTION OF SOLAR SIMULATOR, A. Mann. Project 6694(750F), Contract AF 19(604)-8492; CRZA, AFCRL.

Design and construction of a laboratory device for simulating the energy and spectral distribution of solar radiation. The approach used by this contractor utilizes high intensity incandescent sources singly and combined with various types of variable band pass filters.

23.108

Stanford Research Inst., Menlo Park, Calif.
PHOTOCHEMICAL REACTIONS, R. Marcus. Project 6694 (750F), Contract AF 19(604)-7302; CRZA, AFCRL.

Studies are being performed on photochemical reactions of potential use in solar conversion systems using the concentrated rays of the sun as the light source. Work is also being done on development of solar furnace components of simple light weight design with absorption cutoffs in the ultraviolet region.

23.109

Sydney U. (Australia).
INTENSITY INTERFEROMETRY, H. Messel. Project 8635 (804A), Grant AF-AFOSR-61-98; CRZI, AFCRL.

To set up a 600-foot stellar intensity interferometer having twin 25-foot reflecting mirror collector apertures at the field station at Narrabri, New South Wales, Australia, and use it for carrying out measurements of stellar angular diameters, temperatures, and variation over the star disks of surface brightness of nearly 250 bright stars in the Southern Hemisphere. Each of the two 25-foot light collectors is built like a solar furnace of some 252 identical hexagonal mirrors. Each collector is continuously moveable about a 600-foot diameter circular track so that both can "look" simultaneously at the same star for many minutes or hours while maintaining a constant separation of up to 600 feet from the other collector, the required pointing and coordinated motions to compensate the earth's rotation being controlled by a computer. Each concentrates the starlight upon its own photomultiplier tube, the two photomultiplier currents being led to a central control hut for comparison. By studying the varying degree of "partial coherence" between the fluctuations in the two photocurrents at different mirror separations one is able to deduce the stellar parameters, provided the star is not too cool.

23.110

Temple U., Philadelphia, Pa.
MICROMETEORITE INSTRUMENTATION, L. Bohn. Project 6694(750F), Contract AF 19(604)-5870; CRZA, AFCRL.

Design, test and calibration of acoustic devices for research in the upper atmosphere to determine particle flux.

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CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

23.111

Terrestrial Sciences Lab., CRZ, AFCRL, Bedford, Mass.
AIRBORNE INSTRUMENTATION, C. E. Molineux. Project 7628(770A), Internal.

To evaluate capabilities and limitations and develop sensor instrumentations for the systematic collection of terrain and environmental data throughout the year over wide representative geographic areas; to instrument a ski-equipped C-130 aircraft as an airborne research vehicle; to extend the scientific knowledge of remote areas of the world by use of airborne reconnaissance surveys. Representative instrumentation will include airborne gravity meters, magnetometer, radiometers, cameras, infrared and radar equipment, radio and electro-magnetic propagation equipment, air-droppable devices for determining surface properties, and precise navigation equipment.

23.112

Texas A and M Research Foundation, College Station.
MESOSCALE ANALYSIS, K. C. Brundidge. Project AF 19 (604)-7455; CRZH, AFCRL.

Collect and store meteorological data and plot and prepare detailed mesometeorological analyses.

23.113

Texas A and M Research Foundation, College Station.
CEDAR HILL TOWER SUPPORT, W. Clayton. Project 7655 (770A), Contract AF 19(604)-6200; CRZH, AFCRL.

Provide measurements of various micrometeorological parameters near the Cedar Hill tower installation to supplement, in the lower levels, those which are made on the tower system.

23.114

Texas A and M Research Foundation, College Station.
SPATIAL VARIABILITY, W. Clayton. Project 7655(770A), Contract AF 19(604)-5527; CRZH, AFCRL.

Analysis of green glow micrometeorological data to determine the spatial variability of various micrometeorological parameters in an area of similar terrain and vegetation.

23.115

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
PRODUCTION OF SUPER-INTENSE MAGNETIC FIELDS, M. A. Levine. Project 8608(801A), Internal.

To study and develop methods of producing super-intense magnetic fields in the mega-gauss region and to apply principles of force free geometries to coil design. To study theoretically the limitations in terms of heating and mechanical stresses to the production of ever-increasing magnetic fields. To determine methods of using magnetic fields as a basis of energy storage and to consider geometry problems of Air Force interest in which intense magnetic fields might be used to simplify existing designs to make them light weight and less expensive.

23.116

Thermal Radiation Lab., CRZ, AFCRL, Bedford, Mass.
INTERFEROMETRIC STUDIES, R. G. Walker. Project 7670 (770A), Internal.

The effort here has been to develop instrumentation of the interferometric type for obtaining measurements of hot gases. These data will be analyzed in terms of presently known theory and models. A small interferometer of the Michelson type with calibration source and monitoring beam has been constructed and data reduction and computational techniques are presently being worked out.

23.117

Tufts U., Medford, Mass.
STABILIZED PLATFORM, A. H. Howell. Project 8602 (804A), Contract AF 19(604)-6630; CRZE, AFCRL.

The contractor is constructing a stabilized balloon-borne platform with automatic pointing control for use at altitudes above 100,000 feet. The platform will carry a telescope system which will be suitable for use with spectrometers or radiometers in order to determine the spectral and thermal characteristics of the moon and planetary atmospheres. It is anticipated that two or more improved platforms carrying larger telescopes will be constructed.

23.118

TYCO, Inc., Waltham, Mass.
SURFACE BARRIER EFFECT IN PHOTOVOLTAIC CONVERSION, A. J. Rosenberg. Project 6694(750F), Contract AF 19(604)-8506; CRZA, AFCRL.

Design of an efficient solar energy converter is being studied consisting of either a polycrystalline semiconducting film or the interface of a semiconductor with a metal, a conducting glass, or an electrolyte. The materials under study include silicon, cadmium sulfide, cadmium telluride, gallium arsenide, etc. Techniques of preparing such thin films and establishment of criteria for energy conversion efficiency are being developed.

23.119

Virginia U. Charlottesville.
ELECTROMAGNETIC SUSPENSION SYSTEM FOR THE MEASUREMENT OF AERODYNAMIC CHARACTERISTICS, H. M. Parker, B. J. Gilpin. Project 9783(806A), Grant AF-AFOSR-62-92; SREM, AFOSR.

A small electromagnetic suspension system has been designed and fabricated. This balance is being tested to obtain measurements of the aerodynamic characteristics of a model suspended in a wind tunnel. Initially, the balance is being calibrated by means of sphere drag measurements in high density, low speed flow. These measurements will be extended to include sphere drag tests in low density flow. On the basis of the experience gained with this balance system, a second larger balance will be designed and built. It will be used to study the dynamic stability of a body mounted in an air stream with only its center of gravity fixed and otherwise free to roll, pitch and yaw. These measurements will be carried out in the continuum regime at Mach numbers less than 5. Theoretical studies will be made to explore various improvements to the balance system including an oscillating C.G. suspension, a multi-point suspension which will permit measurements with the body set at some arbitrary angle with respect to the air stream, and the use of the balance system in hypersonic flows.

23.120

WacLine, Inc., Dayton, Ohio.
ULTRA-SENSITIVE SCHLIEREN OPTICAL SYSTEM FOR ARL MACH 14 HYPERSONIC WIND TUNNEL, M. Goll. Project 7065 (806A), Contract AF 33(616)-8427; ARF, ARL.

A program has been initiated to provide a Schlieren system with a very high level of sensitivity for use in the ARL Mach 14 hypersonic wind tunnel.

23.121

Watertown Arsenal, U. S. Army, Watertown, Mass.
DEVELOPMENT, CONSTRUCTION AND TESTING OF A 1.76-INCH SQUARE CROSS-SECTION STAINLESS STEEL SHOCK TUBE AND THE AUXILIARY STRUCTURAL MOUNTS, W. Iodice. Project 8635(804A), Contract PRO 61-566; CRZI, AFCRL.

The design of a 1.76-inch square cross-section stainless steel shock tube and the auxiliary structural mounts, etc., is well underway. The special facilities at the Watertown Arsenal are being used to fabricate the shock tube by the cold swaging process so as to obtain the necessary high precision in the dimensions, finish, alignment, and the total strength of the different sections of the shock tube. The high pressure driver transition section, associated diaphragm section, connecting flanges for the shock tube sections, the dump tank, the supporting structural mounts for the entire assembly will now be fabricated and the entire assembly hydraulic tested for strength.

23.122

Wentworth Inst., Boston, Mass.
BALLOON INSTRUMENTS, M. J. Davin. Project 6665 (850A), Contract AF 19(604)-7467; CRZE, AFCRL.

This contract is for the design, development and testing of electro-mechanical instruments for balloon carriers. The objectives include flight control and termination, data gathering, telemetering, communications, and safety control of balloons.

23.123

Wentworth Inst., Boston, Mass.
SOLAR SYSTEM STUDIES DATA ANALYSIS, M. Davin. Project 5629(803A), Contract AF 19(604)-7468; CRRK, AFCRL.

Eclipse observations and solar burst measurements have been analyzed. The observations have been made by in-house personnel utilizing the Sagamore Hill radio telescopes and field observations and initial reduction. Interpretation of the paper tape and magnetic tape is done by data analysts under this contract. Operation of data systems for the 84 foot, the 150 foot, and the log periodic antennas at Sagamore Hill will be assisted by contractor personnel. Instrumentation of automatic data equipment, receiver refurbishment and antenna improvements will be accomplished as well as fabrication and test of analyzing instrumentation.

23.124

Wentworth Inst., Boston, Mass.
SPECTROSCOPIC STUDIES, M. Davin. Project 8627(804A), Contract AF 19(628)-246; CRZA, AFCRL.

Develop instrumentation and laboratory experimental set-ups in support of the in-house spectroscopic study program. Participate in performance of experiments and in the analysis of results.

23.125

Williamson Development Co., Concord, Mass.
BAND INTENSITIES, I. A. Nichols. Project 7670 (770A), Contract AF 19(628)-286; CRZC, AFCRL.

The purpose is to carry out research and development of instrumentation for obtaining measurements of infrared absorption band intensities. In particular, they have designed and constructed high pressure (up

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to 1000 psia) absorption cells of variable path length, and a unique method for measuring the distance between the windows of the cell and the associated gas handling system. They have also developed improved equipment for obtaining and reducing the data.

23.126

Williamson Development Co., Inc., Concord, Mass.
TRANSIENT OPTICAL PHENOMENA ASSOCIATED WITH HYDROMAGNETIC EXPERIMENTS, I. Nichols. Project 8608 (801A), Contract AF 19(604)-4091; CRZC, AFCRL.

To study the application of high magnetic fields to a new type of high energy particle accelerator known as a plasma accelerator. The beams in these accelerators are electrically neutral, consisting of both negative and positive charged particles, so that extremely high currents may be obtained without the usual problems of space charge defocussing. To interpret into mechanical design, theoretical results on methods of constructing high magnetic field coils.

23.127

Winzen Research Inc., Minneapolis, Minn.
LOAD CAP STUDY BALLOONS, J. R. Nelson. Project 6665 (850A), Contract DO (19-628)-62-1179; CRZE, AFCRL.

Fabrication of balloons, uncapped, but otherwise identical in load carrying structure to a capped design configuration being evaluated for relative cost and capability.

23.128

Wolf Research and Development Corp., Boston, Mass.
PROCEDURES FOR PROCESSING VOLTAGE-TIME DATA. Project 8602(804A), Contract AF 19(604)-8428; CRZE, AFCRL.

Research in the unique computer programming problems associated with the handling of large amounts of digitalized voltage-time data being acquired in the Geophysics Research Directorate's rocket probe and satellite instrumentation programs.

23.129

Yerkes Observatory, Williams Bay, Wisc.
STELLAR IMAGE CONVERTERS, W. A. Hiltner. Project 8635(804A), Contract AF 19(604)-4951; CRZI, AFCRL.

The objective of the work is to design, construct, test and use image converters that will operate efficiently and feasibly on faint sources at the focus of an astronomical telescope.

23.130

Yeshiva U., New York.
KUGELBLITZ PHENOMENA, D. Finkelstein. Project 5635 (803A), Grant AF-AFOSR-61-101; CRRD, AFCRL.

Design and construction of 100,000 joule capacitor bank which can discharge in 10-100 nanoseconds. Experiments with this facility attempting to construct confined plasmas.

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ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab

RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division

AFSWC- Air Force Special Weapons Center
SWR- Research Directorate

AMRL- 6570th Aerospace Medical Research Laboratories

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24. CONSULTANTS, CONFERENCES AND PUBLICATIONS

Publications; Research Assistance Programs; Review Committees; Conferences.

24.1

American Inst. of Physics, New York, N. Y.
PHYSICS OF FLUIDS, W. Waterfall, F. N. Frenkiel. Project 9783(806A), Contract AF 49(638)-275; SRM, AFOSR.

This contract is to assist the American Institute of Physics in collecting, collating, interpreting and editing original current research papers for publication in the monthly journal The Physics of Fluids. Topics include kinetic theory, statistical mechanics, structure and general physics of gases, liquids and other fluids, as well as certain basic aspects of physics of fluids bordering geophysics, astrophysics, biophysics and other fields of science.

24.2

American Mathematical Society, Providence, R. I.
MATHEMATICS ADVISORY AND EVALUATION SERVICES, G. L. Walker. Project 9783(806A), Contract AF 49(638)-204; SRM, AFOSR.

This contract provides for an evaluation service to the Mathematics and Applied Mathematics Divisions of the Mathematical Sciences Directorate. Upon request, distinguished mathematicians review and evaluate proposed new directions for mathematical research, new mathematical ideas, and the importance of contemporary mathematical results. The contract also provides for an AFOSR Mathematics Advisory Committee which weighs the general direction of mathematical research, in particular of research supported by the Mathematics and Applied Mathematics Divisions of the Mathematical Sciences Directorate. Present membership consists of Professor M. H. Stone, Chairman, and Professors S. Bochner, S. Goldstein, M. Morse, J. L. Walsh and R. L. Wilder.

24.3

American Meteorological Society, Boston, Mass.
METEOROLOGICAL ABSTRACTS, M. Rigby. Project 8604 (804A), Contract AF 19(628)-285; CRZH, AFCRL.

A continuous survey is made of the scientific literature published throughout the world. Papers on meteorology and related geophysical fields are analyzed and articles of interest to Air Force scientists are abstracted and published. Special annotated bibliographies are prepared on subjects of special interest to AFCRL personnel. Annual author and subject indices are prepared and published for articles abstracted during the preceding year.

24.4

American Society of Mechanical Engineers, New York, N. Y.
APPLIED MECHANICS REVIEWS, S. Juhasz. Project 9783 (806A), Grant AF-AFOSR-62-368; SRIR, AFOSR.

This project is for the production of a technical journal, Applied Mechanics Reviews, which provides critical reviews of over 900 periodicals, domestic and foreign, as well as summary and feature articles, in the overall field of applied mechanics, specifically including the mechanics of solids and fluids, and heat.

24.5

American Vacuum Society, Inc., Boston, Mass.
SECOND INTERNATIONAL SYMPOSIUM ON VACUUM TECHNOLOGY; L. E. Preuss. Project 9782(806A), Contract MIPR 62-3; SREM, AFOSR.

This symposium was co-sponsored by the ARO, ONR, and AFOSR. Its objective was to bring together scientists and engineers working in the fields of space technology, vacuum metallurgy, thin films, and environmental simulation.

24.6

Armour Research Foundation, Chicago, Ill.
ANALYSIS OF PUBLISHED DATA LEADING TO PREPARATION OF ANNUAL REVIEWS OF BINARY ALLOYS, R. P. Elliott. Project 7021(802A), Contract AF 33(616)-7592; ARZ, ARL.

A continual search, review and critique on the literature pertinent to binary equilibria in metallic systems is being conducted in order to prepare an annual supplement to "The Constitution of Binary Alloys." The procedure utilized is to read and compare all references on binary metallic phase equilibria and to analyze new and existing data and, if

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required, revise the diagrams in the light of the best available evidence. In addition to equilibrium data, the crystallographic and parametric data of solid solutions, intermediate phases and intermetallic compounds is being reviewed and evaluated.

24.7

Batelle Memorial Inst., Columbus, Ohio.
SEMICONDUCTOR ABSTRACTS, C. S. Peet. Project 9769 (803A), Contract AF 49(638)-495; SRIR, AFOSR.

The abstracts, compiled in annual publication form, include reports from technical journals, symposia proceedings, and AFOSR technical reports and notes.

24.8

Brown U., Providence, R. I.
INTERNATIONAL CONFERENCE ON IRREVERSIBLE THERMODYNAMICS, J. Ross. Project 9751(801A), Grant AF-AFOSR-62-60; SRPP, AFOSR.

To conduct an international conference on irreversible thermodynamics in honor of the thirtieth anniversary of two famous articles initiating research in this area which were published in 1931 by Lars Onsager. These papers established the Onsager reciprocal relations which gave impetus for the study of the general theory of irreversibility as well as studies in diffusion, chemical reactions, electrochemistry and electro-mechanical effects and certain magnetic phenomena. The most recent advances in this field will be presented by leading workers in the course of lectures and presentations to be given during this conference.

24.9

California U., Berkeley.
SYMPOSIUM ON MATHEMATICAL STATISTICS AND PROBABILITY, J. Neyman. Project 9783(806A), Contract AF 49-(638)-738; SRM, AFOSR.

This symposium was designed to provide a bird's eye view of recent achievements in statistical and probabilistic research and the new avenues suggested by these achievements. In addition to theoretical papers, discussions were held on applications to subjects such as wave analysis, astronomy, biometry, econometrics, health problems, and traffic engineering.

24.10

California U., Berkeley.
CONFERENCE ON VERBAL LEARNING AND VERBAL BEHAVIOR, L. J. Postman. Project 9778(805A), Grant AF-AFOSR-62-389; SRLB, AFOSR.

This investigator will convene a work conference of ten pre-eminent research leaders to exchange information and ideas on current research developments, with special emphasis on methodological and theoretical problems arising from the research of the participants. Major attention will be given to the future direction of research. During the last ten years, there has been a rapid advance in research on verbal learning and verbal behavior, including the analysis of language and the development of mathematical models for the conceptualization of verbal behavior, and new techniques for study of the associative processes and of short-term and long-term memory have been developed. There has also been a rapid increase in laboratory experimentation in this field. This conference will assess the present research position and develop research strategies for the further advancement and integration of knowledge in this field.

24.11

Cambridge U. Press, N. Y.
JOURNAL OF FLUID MECHANICS, G. K. Batchelor. Project 9783(806A), Contract NONR 254800; SRM, AFOSR.

The Journal of Fluid Mechanics is an international periodical covering theoretical and experimental research investigations of all aspects of fluid mechanics. The journal complements The Physics of Fluids by making European papers more easily accessible to U. S. scientists.

24.12

Cincinnati U., Ohio.
AEROTHERMODYNAMIC INVESTIGATIONS, T. Li. Project 7064(806A), Contract AF 33(616)-8453; ARR, ARL.

It is the intent of this contract to establish a three-year contracted aerothermodynamic research program which utilized the ARL hypersonic research study facilities. In this contracted effort, the contractor will plan and conduct his own research program. It is intended that the contractor's effort will be reduced in the third year at which time ARL research personnel groups will have been built up to the point that outside assistance is not required to accomplish the research program.

24.13

Colorado U., Boulder.
CONFERENCE ON THE PHYSICS OF ELECTRONIC AND ATOMIC COLLISIONS; JUNE 1961, W. Brittin. Project 9751 (801A), Contract MIPR 61-10; SRPP, AFOSR.

The conference was concerned primarily with experimental and theoretical aspects of two-body, non-nuclear interactions.

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24.14

Columbia U., New York, N. Y.
REVIEW AND EVALUATION OF SOLID STATE SCIENCES, M. Gensamer. Project 9760(802A), Contract AF 49(638)-881; SRPS, AFOSR.

The primary function of this contract is to provide the advice and guidance of the outstanding experts in the various areas of solid state sciences. These are provided in the following ways: (a) Solid State Sciences Program Review - This is a continuing effort performed on an ad hoc basis to discuss and review the program of the Solid State Sciences Directorate, to consider new areas of solid state research that should be explored to coordinate and promote a functional relationship between the Directorate and the scientific community; and to evaluate special ideas or proposals. The principals currently involved in this effort are: Professors Seitz, Duwez, Maurer, Read, Gensamer and Dr. Hebb. Special members are added on a temporary basis from time to time to assist on particular problems. (b) Evaluation of Research in the Solid State Sciences - From time to time the Solid State Sciences Directorate requires expert advice on and evaluation of special problems or research proposals that can be handled more effectively and expeditiously by individuals. Such individuals may either be selected from the principals above or may be obtained elsewhere because of their special qualifications and capabilities.

24.15

Cornell U., Ithaca, N. Y.
CHEMISTRY ADVISORY SERVICE, F. A. Long. Project 9760 (802A), Contract AF 49(638)-736; SRC, AFOSR.

This project is to make available to the Directorate of Chemical Sciences competent and recognized experts in the chemical fields of interest to the Air Force. This project assists the Directorate of Chemical Sciences in the performance of its Air Force mission by making available specialized knowledge in pertinent field of science and technology, and by offering advice and counsel on research projects and planning of research programs.

24.16

Cornell U., Ithaca, N. Y.
NON-ISENTROPIC GAS DYNAMICS, W. R. Sears. Project 9781(806A), Contract AF 49(638)-674; SRE, AFOSR.

Under the general direction of Dr. W. R. Sears, visiting professors from Japanese Universities perform research in non-isentropic supersonic flows, aerodynamic heating, chemical effects in real-gas flows, and magnetohydrodynamics. Specifically this year: (a) Dr. Humis Naruse of Tokyo University has been performing theoretical studies of the so-called inviscid boundary layer in magnetohydrodynamics, including Hall effects. (b) Professor Ko Tamada of Kyoto University has been studying transonic magnetogasdynamic flow, especially in the sub-Alfvenic regime. He has also investigated the flow pattern and magnetic field of inviscid-aligned-fields flow past a circular cylinder at large Alfven number (weak fields). (c) Dr. Hakuro Oguchi of Tokyo University carried out research on the blunt leading edge problem in hypersonic flow.

24.17

Department of State, Washington, D. C.
PERIODIC INVENTORY OF RESEARCH ON FOREIGN AREAS, W. Cronin. Project 9779(805A), Contract ISSA 61-7; SRL, AFOSR.

Provide periodic inventories of research projects in the fields of the social and psychological sciences as they apply to foreign areas and cultures, international problems and national security problems. These inventories will continue the comprehensive surveys of research projects in these fields in order to provide a guide to sources of current knowledge about foreign area problems and help in the planning of research. The inventories will contain information on projects dealing with (a) substantive problems in the fields mentioned, and (b) problems of method, theory, and technique in the behavioral sciences which affect interaction with foreign populations.

24.18

Electromagnetic Radiation Lab., CRR, AFCRL, Bedford, Mass.
KUGELBLITZ PHENOMENA, E. M. Dewan. Project 5635 (803A), Internal.

A "book" of Kugelblitz references, translations and eyewitness observations will be compiled as an AFCRL report. Editorial comments will be made and a summary of the situation will be given. All the references have been collected. Also, many letters from eyewitnesses have been received. Experimental work includes duplication of old German experiments based on the combustion theory.

24.19

Electron Microscope Society of America, Philadelphia, Pa.
FIFTH INTERNATIONAL CONGRESS FOR ELECTRON MICROSCOPY, J. A. Reisner. Project 9763(802A), Grant AF-AFOSR-61-74; SRPS, AFOSR.

The Fifth International Congress for Electron Microscopy will be held in Philadelphia from the 29th of

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ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAEW- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAS- Directorate of Engineering
RAVA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
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PGWR- Ballistics Directorate
ESD- Electronics Systems Division
ESWR- Operational Applications Lab

August to the 5th of September 1962 under the auspices of the Electron Microscope Society of America. The program of the Congress will consist of many submitted papers of original research, invited papers of particular merit, and a variety of symposia. Symposia will be on such topics as electron diffraction, thin films, metallurgy, radiation damage, polymers and fibers, cytology, viruses, macromolecules, and the cancer problem. Symposia of broad interest will be held on electron optics, methods of specimen preparation, electron scattering and contrast, bombardment introduced changes in specimens, and techniques of electron microscopy.

24.20

Federation of American Societies for Experimental Biology, Washington, D. C.
SYMPOSIUM ON ACCLIMATION TO COLD AND HEAT, M. O. Lee. Project 9777(805A), Grant AF-AFOSR-62-89; SRLA, AFOSR.

The symposium will be held in Leiden, Holland, 6, 7, and 8 September 1962. It will be organized by a committee consisting of Dr. Loren Carlson, University of Kentucky; Dr. Robert Smith, University of California; Dr. O. G. Edholm, Medical Research Council, London, and others whom they may enlist. The meeting is a follow-up of the very successful symposium held in Buenos Aires in July 1959 which was published as "Proceedings of the International Symposium on Cold Acclimation." In the forthcoming meeting problems of heat as well as cold will be discussed. Scientists from universities and government laboratories world-wide will participate.

24.21

General Electric Co., Schenectady, N. Y.
INTERNATIONAL CONFERENCE ON THE FERMI SURFACE IN METALS, 1961, R. W. Schmitt. Project 9762(802A), Contract AF 49(638)-926; SRPS, AFOSR.

The concept of the Fermi surface (the energy surface in momentum space that bounds the occupied electronic states) was formulated about three decades ago when quantum theory was first applied to metals. In the following years the shape of this surface could only be inferred indirectly from measurements of properties that depended on averages over the whole Fermi surface. Within the last few years, however, some striking new developments have occurred that enable one to obtain quite direct information about the Fermi surface. The pace of developments being as rapid as it is, an invitational conference was held of 100 scientists actively doing research in this area.

24.22

General Electric Co., Schenectady, N. Y.
INTERNATIONAL CONFERENCE ON SEMICONDUCTING COMPOUNDS, 1961, W. W. Tyler. Project 9760(802A), Contract AF 49(638)-997; SRPS, AFOSR.

Perhaps the most intensively studied compound semiconductors are those formed by elements of the third and fifth columns of the periodic table such as GaAs and InSb. Many of the theoretical concepts and research groups in industrial and government laboratories and in universities have active theoretical and experimental research programs on III-V compounds. One particular purpose of the conference was to foster an exchange of ideas between scientists working on the large band gap II-VI compounds and those working on the lower band gap III-V compounds. Although at present there is rapid progress in both areas, to some extent in the past these groups have been isolated because of the preoccupation of the II-VI workers with luminescence and optical properties and the concentration of III-V workers on transport and electrical properties. The commingling of workers and ideas will be beneficial to both groups.

24.23

Georgia U., Athens.
ANALYSIS OF BIOLOGICAL SCIENCES RESEARCH, H. Zimmer. Project 9777(805A), Contract AF 49(638)-1011; SRLA, AFOSR.

Assemble and administer review committees consisting of distinguished scientists in the biosciences area for the purpose of providing critical reviews and guidance for the bioscience research program. Special teams will be provided for the preparation of reports and materials on special subjects of importance to the biosciences research program specifically, and to the Air Force at large as required. Provide a vehicle and personnel for the review of research proposals submitted to the biosciences program to insure the ablest evaluation of such proposals.

24.24

Harvard U., Cambridge, Mass.
E. M. RADIATION, MICROWAVE CIRCUITS, PHYSICAL ELECTRONICS, WAVE PROPAGATION AND LONG RANGE NAVIGATION, H. Brooks, R. W. King, J. Pierce. Project 4751(803A), Contract NONR 1866 (16) (32) (07); SRPP, AFOSR.

This is a broad theoretical and experimental program sponsored by the Joint Services at the Laboratory of Applied Science (Harvard). This program includes: (1) study of electromagnetic radiation, microwave circuits and processes; (2) electron and solid state physics; (3) wave propagation; and (4) related microwave research.

24.25

Hoecker, K. H., Stuttgart (Germany).

AFOSR- Air Force Office of Scientific Research
SRA- Directorate of Research Analysis
SRC- Directorate of Chemical Sciences
SRE- Directorate of Engineering Sciences
SRI- Directorate of Information Sciences
SRL- Directorate of Life Sciences
SRM- Directorate of Mathematical Sciences
SRP- Directorate of Physical Sciences

AFCRL- Air Force Cambridge Research Laboratories
CRR- Electronic Research Directorate
CRRB- Computer & Mathematical Sciences Lab
CRRC- Electronic Material Sciences Lab
CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

FIFTH INTERNATIONAL CONFERENCE ON IONIZATION PHENOMENA IN GASES, 1961, K. H. Hoecker. Project 7073 (806A), Contract AF 61(052)-489; ARH, ARL.

This conference was attended by more than 500 scientists from countries all over the world. The program consisted of more than 250 lectures and papers, which were presented in five parallel sessions. These sessions were concerned with plasma physics, plasma diagnostics, discharge breakdown, electric arc, and elementary processes. The sessions on plasma diagnostics were concerned with short time spectroscopy and short time probe measurements.

24.26

Institute for Advanced Study, Princeton, N. J.
INTERNATIONAL CONFERENCE ON PROBLEMS OF THE DISTRIBUTION AND MOTION OF INTERSTELLAR MATTER IN GALAXIES, B. Strongren, R. Oppenheimer. Project 9774(804A), Grant AF-AFOSR-61-46; SRPP, AFOSR.

An extended (10-day) closed or invitational conference of the alternate formal paper-discussion session type to take up in exhaustive detail the recent findings relating to the distribution and motion of interstellar matter in galactic planes of galaxies including our own Milky Way. The recent scientific findings include radio astronometric measurements of galactic mass-volume distributions, precise optical astronomy measurements of mass distribution in non-dusty galaxies, measurements of non-thermal radio emissions in expanding galactic regions; finally dynamic, hydrodynamic and magnetofluiddynamic phenomena relating to mass transfer, shockwaves, cosmic radiation and galactic growth mechanisms.

24.27

Institute of the Aerospace Sciences, Inc., New York, N. Y.
REVIEW AND ANALYSIS OF AERONAUTICAL RESEARCH INFORMATION, S. P. Johnston. Project 9783(806A), Grant AF-AFOSR-62-88; SRIR, AFOSR.

The establishment and maintenance of tools which provide research scientists with a current awareness capability in the disciplines of their interest are necessary to productive advancement of scientific knowledge. This project furnishes these tools in the fields of aerospace research and related disciplines through the publication, International Aerospace Abstracts.

24.28

Institute of the Aerospace Sciences, Inc., New York, N. Y.
THE AFOSR LECTURES IN HONOR OF THE 80TH ANNIVERSARY OF DR. TH. VON KARMAN, E. W. Robinson. Project 9750 (801A), Grant AF-AFOSR-61-47; SRE, AFOSR.

In coordination with the AFOSR, the grant is for organizing and managing an aerospace sciences symposium of distinguished lectures, in support of basic research, on the occasion of the 80th anniversary of Dr. Theodore von Karman.

24.29

Library of Congress, Washington, D. C.
AIR FORCE SCIENTIFIC RESEARCH BIBLIOGRAPHY, C. R. Brown. Project 9769(803A), Contract ISSA 62-2; SRIR, AFOSR.

This effort is funding the compilation of abstracts and other descriptive information pertaining to the reports issued under the Air Force basic research program. Starting with the entries for Volume II, the information will be recorded on paper tape which can be used in other efforts under this task in research into novel techniques of indexing, coding, and machine storage, search and retrieval.

24.30

Little, Arthur D., Inc., Cambridge, Mass.
THERMAL PROTECTION SYMPOSIUM, P. Glaser. Project 9782(806A), Contract AF 49(638)-1026; SREM, AFOSR.

The contractor and the AFOSR co-sponsored a symposium on thermal protection. The objectives of the symposium were (1) to assess the state-of-the-art of thermally protected construction; (2) to assess research and development required for high and low temperature insulations; and (3) identify areas requiring further research and developmental effort.

24.31

Long Island Biological Association, Cold Spring Harbor, N. Y.
SYMPOSIUM ON CELL REGULATORY MECHANISMS, A. Chovnick. Project 9777(805A), Grant AF-AFOSR-61-73; SRL, AFOSR.

The Cold Spring Harbor Symposium on Quantitative Biology is an established institution for international biological meetings. The 26th session, in June 1961, was devoted to "Cell Regulatory Mechanisms." Major emphasis was placed upon biochemical control mechanisms, and their relationship to the genetic material which regulates cell activities.

24.32

Long Island Biological Association, Cold Spring Harbor, N. Y.
CONFERENCE ON ANIMAL VIRUSES, A. Chovnick. Project 9777(805A), Grant AF-AFOSR-62-275; SRLA, AFOSR.

The Cold Spring Harbor Symposium on Quantitative Biology is an established institution for international

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ARC- Chemistry Research Lab
ARF- Fluid Dynamics Facilities Lab
ARP- General Physics Research Lab
ARH- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARN- Thermomechanics Research Lab
ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
ARZ- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRNE- Electronics Technology Lab
RADC- Rome Air Development Center
RAKW- Intelligence & Electronic Warfare Div.
RAOR- Advanced Studies Office
RAS- Directorate of Engineering
RAUA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AEGR- Research Division
AFWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGWR- Ballistics Directorate
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biological meetings. The 27th session, in June 1962, was devoted to "Virus Biology." Major emphasis was placed upon biochemical control mechanisms, and their relationship to the genetic material which regulates cell activities.

24.33

Lowell Technological Inst. Research Foundation, Mass.
CONFERENCE ON EXPLODING WIRE PHENOMENON, NOV. 1961, H. K. Moore. Project 8608(801A), Contract AF 19(604)-8345; CRZC, AFCRL.

The contractor, in addition to arranging the conference, will compile the information reported and will arrange for publication and dissemination.

24.34

Massachusetts Inst. of Tech., Cambridge.
INTERNATIONAL CONFERENCE ON HIGH MAGNETIC FIELDS, NOV. 1961, B. Lax. Project 9763(802A), Grant AF-AFOSR-61-31; SRPS, AFOSR.

It was the purpose of the conference to bring together workers from a variety of research areas who are concerned with the generation and use of very high magnetic fields. These areas included primarily plasma physics, solid state physics, low temperature physics, nuclear physics, and electronics. The emphasis in all papers was on basic concepts and new techniques in the generation and experimental use of high magnetic fields. Invited papers were aimed at reviewing the broad scope of the various specialized research programs, while contributed papers were more specialized. Magnetic materials per se and the design of conventional magnets were not considered to be within the scope of the conference. Proceedings are to be published in book form by Technology Press and John Wiley Sons.

24.35

Massachusetts Inst. of Tech., Cambridge.
ELECTRIC AND MAGNETIC PROPERTIES OF MATTER, A. von Hippel. Project 4751(803A), Contract NONR 1841 (10); SRPP, AFOSR.

The Joint Services program at the Laboratory for Insulation Research covers broadly the field of molecular science and engineering, and includes areas such as: molecular electronics; dielectric spectroscopy; excitation, conduction, and breakdown; ferroelectrics and ferromagnetics; single crystal and ceramics research, and generation and modulation of coherent optical frequencies.

24.36

Michigan U., Ann Arbor.
VELA UNIFORM ADVISORY PANEL, J. T. Wilson. Project 9774(804A), Contract AF 49(638)-1050; SRPP, AFOSR.

A panel of professionally qualified persons will be provided to serve as an advisory committee to the AFOSR in order to establish and maintain an efficient program of sponsored research into problems associated with the Vela Uniform Program. Recommendations will be made to the AFOSR on projects and tasks which should be undertaken to support Vela Uniform and on competent investigators, research groups and institutions to undertake these tasks.

24.37

Michigan U., Ann Arbor.
ENVIRONMENTAL SENSING, G. H. Suits. Project 7628 (770A), Contract MIPR 62-709; CRZG, AFCRL.

To evaluate the capability for remote sensing of the environment within the present state-of-the-art of sensory devices and means for their use; to determine fields for application of remote sensors and investigate potentials and limitations in these fields; to solicit interest in remote sensing in the earth sciences community, acquaintance with techniques and applications, and stimulate recognition of remote sensing of environment as a science cutting across many disciplines and both military and civilian requirements and applications.

24.38

National Academy of Sciences, National Research Council, Washington, D. C.
AFOSR-NAS POSTDOCTORAL FELLOWSHIP PROGRAM, D. W. Bronk. Project 9783(806A), Grant AF-AFOSR-62-27; SREM, AFOSR.

This is a grant to the NAS to provide approximately 15 postdoctoral fellowships in the basic sciences to be undertaken at any university in the world. The selection of fellows is made by the NAS with final approval of AFOSR. This is an annual program which is renewed yearly by AFOSR.

24.39

National Academy of Sciences, National Research Council, Washington, D. C.
INTERNATIONAL PHYSIOLOGICAL CONGRESS, R. K. Cannan. Project 9777(805A), Grant AF-AFOSR-62-357; SRLA, AFOSR.

This is the triennial meeting of the Congress, to be held in Leiden, Holland, in September 1962. There are over twenty symposia held in connection with the Congress and several before and after its meeting. The meeting serves as the international coordinating body for physiology.

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CRRD- Electromagnetic Radiation Lab
CRRI- Astrosurveillance Sciences Lab
CRRK- Propagation Sciences Lab
CRRS- Communications Sciences Lab
CRRZ- Control Sciences Lab
CRZ- Geophysics Research Directorate
CRZA- Photochemistry Lab
CRZC- Thermal Radiation Lab
CRZE- Research Instrumentation Lab
CRZG- Terrestrial Sciences Lab
CRZH- Meteorological Research Lab
CRZI- Ionospheric Physics Lab
CRZR- Sacramento Peak Observatory

24.40

National Academy of Sciences, National Research Council, Washington, D. C.
INTERNATIONAL CONFERENCE ON SOLID STATE NUCLEAR PARTICLE DETECTORS, OCT. 1960, J. S. Coleman. Project 9751(801A), Grant AF-AFOSR-61-9; SRPM, AFOSR.

Some of the subjects discussed at the conference were: (a) properties of solid state devices; (b) present state of the art; (c) extension of the art to high and to very low energy particle detection; (d) application of the device to the problems of the various disciplines represented; and (e) the amplifier problem.

24.41

National Academy of Sciences, National Research Council, Washington, D. C.
NOMENCLATURE OF ORGANIC CHEMISTRY, R. C. Elderfield. Project 9763(802A), Grant AF-AFOSR-61-103; SRC, AFOSR.

This is a grant to support several symposia on the nomenclature of organic chemistry. Included are or were the IUPAC Commission meeting, IUPAC Symposium, IUPAC ad hoc Steroid Nomenclature Committee meeting, and a Symposium on Biochemical Nomenclature.

24.42

National Academy of Sciences, National Research Council, Washington, D. C.
SURVEY OF EXISTING STATE OF FUNDAMENTAL KNOWLEDGE OF POLYMER SCIENCE AND OF UNSOLVED PROBLEMS IN THIS FIELD, C. O. Miller. Project 7021(802A), Contract AF 33(616)-8161; ASRC, ASD.

This contract encompasses a critical survey of the fundamental knowledge in polymer science. The survey is being conducted by the National Academy of Sciences but will include the individual contributions of the world's outstanding polymer scientists. It is hoped that the final compilation will indicate the general areas of strength and weakness in the basic science underlying polymer synthesis, characterization and physical chemistry. It should point the way for rewarding basic research in areas of scientific endeavor which directly or indirectly contribute to our understanding of the science of macromolecules.

24.43

New Mexico U., Albuquerque.
SUMMER SEMINAR (1962): TOPICS IN GEOPHYSICS, J. R. Foote. Project 9774(804A), Grant AF-AFOSR-62-165; SRPP, AFOSR.

This is the fifth in a series of Air Force-University of New Mexico two-week seminars on advanced topics in physical sciences. Topics in geophysics will emphasize terrestrial geophysics, tides, meteorology, climatology and atmospheric radiation belts. Participation is expected of a few hundred scientific and engineering personnel from universities, industry and government.

24.44

Ohio State U. Research Foundation, Columbus.
CHEMISTRY OF FUELS AND PROPULSION, V. G. Ward. Project 7013(801A), Contract AF 33(616)-7022; ARC, ARL.

This contract provides a means whereby capable scientists are brought into the Chemistry Branch, Aeronautical Research Laboratory, to live and work for a year with our scientists and collaborate on selected in-house problems. The visiting scientists -- typically either young post-doctoral men or professors with a sabbatical year to spend -- are appointed to the staff of the Ohio State University at our request and sent here to work. To date, seven appointments have been made -- two from abroad -- and more are being negotiated. This contract is a very effective two-way channel of contact and cross-fertilization between the Chemistry Branch and the world scientific community.

24.45

Ohio State U. Research Foundation, Columbus.
CONTRIBUTIVE RESEARCH IN THERMOMECHANICS, V. G. Ward. Project 7063(806A), Contract AF 33(657)-7722; AEM, ARL.

The contractor will provide qualified scientists and aides at the request of the Thermomechanics Research Branch to pursue independent studies or investigations in the field of thermomechanics at the Aeronautical Research Laboratory. Specific research investigations desired will cover a broad range of activity pertaining to energy conversion, propulsion, heat transfer, plasmajet technology, and structures.

24.46

Pennsylvania State U., University Park.
CRITICAL RESEARCH EVALUATION OF MODERN CRYSTALLOGRAPHY, R. Pepinsky. Project 9760(802A), Contract AF 49(638)-416; SRPS, AFOSR.

This work has been undertaken as a program to collect, correlate and interpret in the light of modern techniques and procedures all available significant information on the physical and chemical properties of crystals. It is extremely important to correlate

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ARR- Plasma Physics Research Lab
ARM- Applied Mathematics Research Lab
ARH- Thermomechanics Research Lab
ARA- Hypersonics Research Lab
ARZ- Solid State Physics Research Lab
ARB- Metallurgy & Ceramics Research Lab

ASD- Aeronautical Systems Division
ASRC- Directorate of Materials & Processes
ASRLM- Electronics Technology Lab
RADC- Rome Air Development Center
RAEM- Intelligence & Electronic Warfare Div.
RACR- Advanced Studies Office
RAE- Directorate of Engineering
RAEA- Advanced Development Lab
RAW- Directorate of Intelligence & Electronic Warfare

AEDC- Arnold Engineering Development Center
AERR- Research Division
AFSWC- Air Force Special Weapons Center
SWR- Research Directorate
AMRL- 6570th Aerospace Medical Research Laboratories
APGC- Air Proving Ground Center
PGBR- Ballistics Directorate
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physical properties, insofar as possible, with crystal structural information. Such correlation, not previously made just because no modern unified compendium of this sort is available, will serve as the ultimate source of guidance to scientists in search of materials with new and improved physical behavior to satisfy future requirements. Also, all known superior methods for crystal preparation will be recorded in one place. Data will be collected from the published literature, from collaborating investigators and from new research supporting this effort. New and up-to-date physical measurements on all known crystalline materials will include structural data from morphological and X-ray studies, optical measurements within and beyond the visible range, thermal and electrical measurements over the full temperature range, solubilities in various media, phase equilibria information, nuclear resonance phenomena, elastic and dilatometric properties, hardness, cleavage behavior, dielectric measurements, and radiation effects. This data will be processed by means of modern electronic handling methods so that time required for the project will be vastly less than it once would have been, and the number of errors will be minimized.

24.47

Polytechnic Inst. of Brooklyn, N. Y.
ADVISORY SERVICES, A. Ferri. Project 9781(806A), Contract AF 18(600)-1008; SRE, AFOSR.

The contractor arranges for the review and evaluation of proposals, review and analysis of reports, and provides consulting services in fluid mechanics.

24.48

Queens College, Flushing, N. Y.
MATHEMATICAL APPROXIMATION METHODS, A. Sard. Project 7071(806A), Contract AF 33(616)-5304; ARM, ARL.

The objective of this research effort is to write a comprehensive report on approximation methods applicable to multi-dimensional domains and to perform related mathematical research in function theory. The report by Professor Arthur Sard will be entitled "The Approximation of Functionals, Functions and Operators" and will consist of ten chapters. That such a report is now necessary is evident from the fact that most problems of physics involve two or more dimensions, and with the availability of modern computers, it is now feasible to attack such problems. The theory of approximating functions in more than one variable is more difficult than the corresponding theory for functions of one real variable, so Sard's contribution will benefit others in developing the necessary tools for solving multi-dimensional problems.

24.49

Research Directorate, SWR, AFSWC, Kirtland Air Force Base, N. Mex.
ANALYSIS OF PHYSICAL MEASUREMENTS OF AMBIENT SPACE RADIATION, R. E. Linkous. Project 8803(805A), Internal.

The objectives of this research are to collect, compile, critically analyze, and correlate all meaningful space radiation measurements that can be applied directly or indirectly to the delineation of personnel hazards associated with ambient space. A permanent source of space radiation data and the results of theoretical investigations will be established through this research.

24.50

RIAS Division, Martin-Marietta Corp., Baltimore, Md.
SYMPOSIUM ON NONLINEAR DIFFERENTIAL EQUATIONS AND NONLINEAR MECHANICS, S. Lefschetz. Project 9783(806A), Contract AF 49(638)-930; SREM, AFOSR.

The subject matter included the following topics: theory of automatic control; the stability of motion; nonlinear oscillations; and qualitative control. The symposium proceedings will be published in September 1962.

24.51

Stanford Research Inst., Menlo Park, Calif.
SYMPOSIUM ON CHEMICAL REACTIONS IN THE LOWER AND UPPER ATMOSPHERE, APR. 1961, R. D. Cadle. Project 9760(802A), Contract AF 49(638)-955; SRC, AFOSR.

The program of the symposium concerned itself with fundamental studies of chemical reactions occurring in the atmosphere in connection with at least three different aspects of atmospheric research and separated in part by considerations of altitude. These three aspects are (1) air pollution; (2) the geochemistry of the troposphere and the stratosphere; and (3) ionosphere research.

24.52

Stanford U., Calif.
PHYSICS ADVISORY COMMITTEE, L. I. Schiff. Project 9751(801A), Contract AF 49(638)-458; SRPP, AFOSR.

This contract provides a committee that consists of scientists qualified professionally or otherwise, in various fields of physics to supply technical assistance to the AF Office of Scientific Research and to make recommendations concerning scientific policies and programs in the area of physics.

24.53

Tufts U., Medford, Mass.
INFORMATION ANALYSIS SURVEYS IN PSYCHOLOGY, E. Saul. Project 9778(805A), Contract MIPR-62-1; SRLB, AFOSR.

Acquisition, collation, coding, and descriptive abstracting of research studies in physiological, engineering and experimental psychology to meet the needs of scientists engaged in basic and applied research in these areas.

24.54

Wayne State U., Detroit, Mich.
SIXTH INTERNATIONAL CONFERENCE ON COORDINATION COMPOUNDS, S. Kirschner. Project 9760(802A), Contract AF 49(638)-739; SRC, AFOSR.

The program of the conference covered current problems in structure and stereochemistry of coordination compounds, the nature of bonding in coordination compounds, the mechanisms of reactions of coordination compounds, the synthesis and properties of coordination compounds, catalysis and coordination compounds, and thermodynamic properties of coordination compounds.

24.55

Wentworth Inst., Boston, Mass.
GROUP STUDY ON ULTRAPURIFICATION OF SEMICONDUCTOR MATERIALS, APR. 1961, R. J. Young. Project 5620(802A), Contract AF 19(604)-8364; CRRC, AFCRL.

The conference included papers on the chemical purification and preparation of silicon, boron, tellurium, gallium, rare earths, and aluminum nitride; in addition, new techniques such as gas chromatography were reported. Also included were the most recent developments in activation analysis, spectroscopic techniques, and method of preparation and purification of crystals of silicon, III-V compounds, and ternary alloy systems.

See also: 3.115

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ARR- Hypersonics Research Lab
ARX- Solid State Physics Research Lab
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AEDC- Arnold Engineering Development Center
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