USSR Report

PHYSICS AND MATHEMATICS

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USSR REPORT

Physics and Mathematics

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POLARIZED LUMINESCENCE IN THE VISIBLE AND INFRARED AREAS OF THE SPECTRUM
OF COLOR CENTERS IN α-Al$_2$O$_3$

[Article by Ye. F. Martynovich, A. G. Tokharev and S. A. Zilov]

[Abstract] A detailed study is presented of the optical properties of a
color center responsible for generation of radiation with absorption and
luminescence bands with maxima at 830 and 980 nm, respectively. The orienta-
tion of moments of transition in the nonphonon line and phonon limbs are
determined, serving as a basis for determination of the type of electron-
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tions of the color centers is described in the Frank-Condon approximation.
Experiments were performed on specimens of α-Al$_2$O$_3$ single crystals grown
by the method of horizontal directed crystallization, bombarded with reactor
radiation and heat treated at 800 K. The specimens were prepared in cubic
form with polished faces and C_{3v} optical axis of the crystal directed per-
pendicular to two opposite faces. The experiments determined the polarization
relationships and computed the angles of orientation of electrodipole moments
of transitions for color centers in leukosapphire luminescing in the visible
and infrared areas. Figures 4, references 7: 6 Russian, 1 Western.

6508/12955
CSO: 1862/23

STUDY OF THERMOLUMINESCENCE OF YTTRIUM-ALUMINUM-GARNET CRYSTALS DOPED WITH NEODYMIUM NEODYMIUM

[Article by V. M. Garmash, G. A. Yermakov, V. M. Lyubchenko and A. A. Filimonov]

[Abstract] Results are presented from studies of the spectral variation of thermoluminescence in YAG and YAG-Nd^{3+} crystals as well as results of determination of changes in integral thermoluminescence curves upon selective luminescence of capture centers. The studies were performed on pure and Nd-doped (1 at.%) YAG crystals grown in an inert atmosphere. Thermoluminescence experiments were performed in the 77-300 K temperature area. The studies showed that the process of thermoluminescnece in YAG crystals depends on doping. In pure crystals at T<150 K, thermoluminescence is related to radiative breakdown of autolocalized excitons, while at T>150 K it is related to recombination of charge carriers on structural defects. Doping of YAG crystals with neodynium leads to localization holes in the oxygen vicinity of neodynium ions and the appearance of characteristic radiation of ND^{3+} ions with $^2F^2_{5/2}$ at the lowest levels. Peaks of 190 and 210 K apparently result from an iron impurity. Figures 4, references 12: 5 Russian, 7 Western.

HIGH ENERGY LEVELS OF THE Cr^{3+} ION IN $Y_3Al_5O_{12}$

[Article by I. S. Gorban, A. F. Gumenyuk and V. Ya. Degoda]

[Abstract] Results are presented from a study of the absorption spectra, luminescence excitation spectra, photoluminescence and its attenuation in YAG-Cr^{3+} crystals at temperatures of 85, 293 and 550 K. Studies were performed on single crystal specimens with no optical impurities. Absorption spectra were studied by the method of two thicknesses in the 200-400 nm area. Absorption maxima related to the $^4A_2 \rightarrow {}^4T_1$ transition were observed at all temperatures. More reliable information on the observed chromium impurity bands can be obtained from luminescence excitation spectra. Positions of the bands in absorption and luminescence excitation spectra correspond well, the differences in their intensities being explained by different

quantum yield of luminescence upon excitation in the individual absorption bands. Comparative analysis of the two types of spectra indicates the absorption bands, which agree satisfactorily with the calculated positions of Cr^{3+} levels in YAG. Figures 2, references 9: 4 Russian, 5 Western.

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CSO: 1862/44

EPR OF Mn^{2+} - CENTERS IN REGULAR ENVIRONMENT IN A KCl CRYSTAL

[Article by A. G. Badalyan, M. M. Petrosyan and V. A. Khramtsov, Physical-Technical Institute, imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] A report is presented of observation of Mn^{2+} ions in a regular environment in a KCl crystal. The crystal was exposed to x-rays to create Mn ions in the regular environment, then optically irradiated in the absorption band of Mn^+ ions, causing them to be ionized to form the Mn^+ ions. The EPR signal from the Mn^+ ions decreased at this point, with a new isotropic spectrum of Mn^{2+} ions appearing, its isotropic nature confirming the regularity of the environment of the Mn^{2+} ions. Figures 1, references 5: 3 Russian, 2 Western.

6508/12955
CSO: 1862/25

ABSORPTION OF ACOUSTIC WAVES IN $Bi_4Ge_3O_{12}$ CRYSTALS

[Article by S.N. Ivanov, V.F. Kargin, Yu.F. Kargin, I.M. Motelyanskiy, V.M. Skorikov, V.V. Medved and A.V. Khomich, Radio Engineering and Radio Electronics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Data on AV [acoustic waves] absorption in $Bi_4Ge_3O_{12}$ were obtained. Specimens were prepared from crystals that were grown, using Chokhralskiy method, in platinum crucibles, with radiation or high-frequency heating, had 4 x 4 x 8 mm dimensions and were oriented along a <110> or <100> crystallographic axis. Faces of the specimens were polished according to optical standards. Excitation and reception of longitudinal and transverse AV were accomplished with the help of texturized zinc oxyde films. AV absorption was measured at frequencies of 0.5-9.4 GHz in the 4.2-300 K temperature range, using pulse echo-method, by a large number of pulses with controlled exponentiality of their decay. Dependences of absorption of longitudinal AV on temperature and frequency were determined. These dependences were different for different temperature ranges: under 30 K, 30-60 K and over 100 K. In the first range, strong temperature dependence and the absence of frequency dependence was observed. In the third range, temperature absorption dependences were flattening, whereas frequency dependence was linear, which corresponds to AV absorption according to Akhiezer mechanism. In the second range, excessive AV absorption was observed. Temperature status of the excessive AV absorption indicated its relaxation character, due to interaction between the wave and a defect in the crystal. In order to determine the nature of the observed defect, infrared transmission spectra of this group of crystals were examined. The conducted experiments made it possible to assume that hydroxide groups OH constituted the defect that caused the excessive relaxation absorption in $Bi_4Ge_3O_{12}$. Thus, excessive AV absorption peaks, observed in $Bi_4Ge_3O_{12}$, were caused by relaxation interaction of the wave with OH groups, having energy-nonequivalent orientations. The interaction mechanism consists of reorientation of OH groups with participation of thermal phonons with respective energy. Obtained values of AV absorption in $Bi_4Ge_3O_{12}$ crystals indicate rather high acoustic quality of these crystals and the possibility of using them in acoustoelectronic devices. Figures 3, references 8: 3 Russian, 5 Western.

[242-12770]

ON MAGNETOOPTICAL ANISOTROPY OF RARE-EARTH CRYSTALS

[Article by A.K. Zvezdin, A.I. Popov and Kh.I. Turkmenov]

[Abstract] The work solves the problem of relation between magnetooptical and magnetic properties of crystals of rare earth [RZ] compounds in the case of quadratic effects. Components of the tensor of polarizability of an RZ ion in a crystal field were calculated. Field dependence and anysotropy of magnetic birefringence are discussed. Three types of the main state of an RZ ion were examined: a singlet, a Kramers doublet and a quasi-doublet. The examination was limited to low temperatures, when it was sufficient to take into account thermal population of only those levels of the RZ ion that belong to the main state. The singlet main state is realized, for instance, for ions of Tm^{3+}, Pr^{3+} in RZ garnets and Eu^{3+}. The Kramers doublet main state is realized for Kramers RZ ions, located in low-symmetrical points of the lattice and for $gamma_2$-cubic symmetry levels. The quasi-doublet main state is realized, for instance, for ions of Tb^{3+} and Ho^{3+} in RZ garnets and orthoferrites. 1 figure, 15 references: 9 Russian, 6 Western.

[242-12770]

MONTE-CARLO SIMULATION OF Yb^{3+} OPTICAL CENTERS IN SILICATE GLASS

[Article by A.P. Zenkov and A.K. Przhevuskiy, Leningrad Pedagogic Institute imeni A.I. Gertsen]

[Abstract] A Monte-Carlo statistic model of silicate glass, activated by Yb^{3+} ions, was examined. In constructing the model, no initial assumptions on configurations of ligands were made, as these configurations come out automatically and have a stochastic character. The algorithm worked as follows. The main portion of calculations were conducted on a model, comprised of 18 Si$_{4+}$, 9 Na^{+}, 1 Yb^{3+} and 42 O^{2-} ions. In addition, models with a similar composition, but one order of magnitude larger were examined. In a cube with dimensions, determined by density of simulated glass, points, symbolizing atoms, were thrown at random. Energy E of the resulting configuration was calculated under the assumption that interaction of the pair of atoms i and j was described by potential of the Born-Mayer type. The main portion of the algorithm was comprised of model relaxation, directed at getting atom configuration that could be considered a canonic ensemble element at temperature T. The relaxation was accomplished in the form of successive atom shifts, one at a time. Each time, the change of configuration energy, caused by a possible trial shift of one of the atoms by a vector with three random numbers as coordinates, was calculated. Calculated from the model value of energy, required for dividing the configuration into ions with charges, equal to formal ones (lattice energy), was close to the value (2250 kcal/mol), determined, using the additive principle, from experimental data on oxydes. The ytterbium centers model had a purely statistic character. For each ytterbium center of the model, Stark splittings of levels were calculated and energy of optical transitions from lower Stark components were determined. Calculations of Yb^{3+} spectra in this work, as well as calculations of Eu^{3+} spectra, performed earlier by C. Brecher and L.A. Riseberg, and results, obtained in the case of using models, based on the most dense non-ordered packing of balls, bring one to a conclusion that spectra of doped RZE [rare-earth elements] glasses can be satisfactorily interpreted, based on the idea that there are a large number of geometric configurations of centers, characterized by a set of RZE coordination numbers. In silicate glasses, each oxygen ion of RZE polyhedron must be a part of at least one other polyhedron of a modificator cation (not silicon). These cations must be taken into

consideration, when explaining properties, using the model.   Figures 4, references 17: 4 Russian, 13 Western.

[242-12770]

RAMAN SPECTRA AND HIGH TEMPERATURE FERROELECTRIC PHASE TRANSITION IN LiN(H$_x$D$_{1-x}$)$_4$SO$_4$

[Article by V.I. Torgashov, Yu.I. Yuzyuk, F. Smutnyy and M. Polomska, Physics NII [Scientific Research Institute], Rostov-on-Don State University]

[Abstract]   Raman spectra of partially deuterated LAS [LiN(H$_x$D$_{1-x}$)$_4$SO$_4$] (called D'LAS thereafter) in two phases, I and II, were studied, in order to identify microscopic causes of phase transitions [FP] in this crystal.   LAS deuteration does not cause any significant qualitative changes of LAS properties, with the exception of small (by 2 to 3 degrees) shifts of transition temperatures.   However, it helps interprete modes of ammonia ions. Colorless D'LAS monocrystals were grown, using evaporation method, at 303 K. Usually, specimens are sector-twinned. Crystals were cut out form individual sectors, in order to obtain non-twinned specimens. Raman spectra were excited by polarized radiation of argon laser ILA-120 and were registered by spectrometer DFS-24.   For temperature measurements, crystals were placed into an optical cell, where temeperature was stabilized at + or - 0.5 degree. Factor-group analysis of spectra was performed.   Temperature dependencies of spectra were measured in the 288 < T < 493 K range and in the 300-500 cm^{-1} region. The results definitely point out the fact that dynamics of the Li-SO$_4$ frame of D'LAS is related appreciably to the I - II phase transition.   The microscopic cause of the I - II phase transition in LAS (D'LAS) can be the changing character of Li - O interactions, which leads to appreciable increase of swing amplitudes of sulfate ions. LAS can be a good example of a non-rigid crystal. Figures 4, references 23: 8 Russian, 15 Western.

[242-12770]

F_4^+ - CENTERS IN Li-F CRYSTALS

[Article by L.I. Shchepina, Z.I. Myreyeva, Ye.I. Shuralyova, B.D. Lobanov and N.T. Maksimova]

[Abstract] The nature of centers, responsible for a 525 nm band in absorption spectrum, obtained by annealing gamma-irradiated LiF crystals, was examined. LiF crystals, grown in vacuum or in the air, that basically contained OH^- or Mg^{2+} ions, were studied. Optical decolorization was effected by nitrogen laser (LGI-21, 337 nm) radiation. Optical absorption spectra were measured with a computerized spectral complex KSVU-23. The crystals were irradiated by Co^{60} gamma-radiation. Exposure dose was equal to 10^7-10^9 R. The crystals were additionally irradiated by X-radiation in an URS-55 unit. Experiments on thermal annealing, optical decolorization and transformation of color centers (TsO) were conducted. In the 160-280 ^oC temperature range, effective failure of F_3^+ -, as well as F_2^+ - and F - centers was observed. Preliminary experimental results had demonstrated that next to a zero-phonon line of the N_1-center the 522.2 nm line in the absorption spectrum was resolved and that its intensity increased, as the time of irradiation by X-radiation increased. These experimental results and the fact that after additional radiation at -170 ^oC intensity of N_1 - (512 nm) and N_2 - bands decreased led to the assumption that after heating beyond the vacancies localization temperature transformation of TsO takes place. Experiments on optical decolorization of TsO confirmed the assumption that lattice defects, namely F_4^+ centers, were responsible for 525 nm centers. Thus, it was demonstrated that as a result of heat treatment, F_4^+ centers, manifested in optical absorption spectra at 525 nm, had formed in LiF crystals. Figures 2, references 4: 1 Russian, 3 Western.

[207-12770]

POLYMER LASER ELEMENTS WITH ARENONIUM ACTIVE CENTERS

[Article by A.Ya. Gorelenko, I.I. Kalosha and V.A. Tolkachov]

[Abstract] Methods for creating lasing capable active molecular centers in a polymer matrix that are initiated by specific physicochemical interactions, for instance, ion interactions, were developed. It was found that arenonium ions, which are positively charged proton-bound complexes, are also created by adding sulfuric acid to solutions of polycyclic ketones in methyl acrylate. It was demonstrated that with acid content of the order of 8% and higher, active centers form that absorb almost 120 nm further into the long-wave band, i.e. arrenonium ions. Increased acid concentration lowered intensity of short-wave fluorescence (510 nm), and, beginning at 25%, only fluorescence of arenonium ions was observed. Laser polymer elements were prepared that contained arenonium active centers and 25-40% of sulfuric acid. The elements were produced by thermal polymerization under thermostatic conditions of polycyclic aromatic ketone solution in a mixture of methyl acrylate, sulfuric acid and an AIBN initiator in the form of 3 mm thick plates, clamped between two sheets of polished glass. These elements were studied within the longitudinal pumping arrangement. Spectrum generation characteristics of active media, based on arenonium ions of benzathrones in polymethyl acrylate, were obtained. An attempt to create generationally capable active media, based on polymethyl acrylate, doped by a form of aromatic ketones, photoreduced in the excited state, was unsuccessful. Generation in the photoreduced form was observed up to the transformation degree of 60%. It was proved that active laser media, based on polymer matrices with arenonium ions as working centers, are possible. Figure 1, references: 11 Russian.

[207-12770]

GENERATION OF Al_2O_3:Ti^{3+} CRYSTALS IN CONTINUOUS AND QUASI-CONTINUOUS MODE

[Article by G.S. Kruglik, G.A. Skripko, A.P. Shakadarevich, N.V. Kondratyuk, V.S. Urbanovich and P.N. Nazarenko]

[Abstract] Studies were conducted of generation characteristics of lasers, based on Al_2O_3:Ti^{3+} crystals, excited by an YAGiNd^{3+} based laser with intraresonator frequency doubling that operates in various modes, as well as by an argon laser. Energy, space and time characteristics were measured for three types of nonselective resonators: plane-parallel, quasifocal and a resonator with an internal focusing element. Spectral generation characteristics were studied in both selective and nonselective resonators, using crystals with resonance structures, differrent in space period and contrast. The use of a resonator with an internal focusing element made it possible to considerably increase radiation brightness. In the experiments, lasing was accomplished with absorbed energy threshold per pulse < 1 microjoule, which at pulse repetition frequency of 25 kHz was equivalent to average power < 25 mW. In all cases, generation radiation was linearly polarized, wherein orientation of generation radiation polarization plane did not depend on that of pumping radiation. In the case of quasicontinuous excitation, generation had a spike character. In the case of continuous excitation, induced by an argon laser, generation generally had a chaotic spike character. Spectral generation characteristics of Al_2O_3:Ti^{3+} crystals are different for different modes. Spectra in cases of pulse and quasicontinuous excitation are the richest detailwise. Generation spectrum can be controlled, using interference-polarization properties of active Al_2O_3:Ti^{3+} crystals. It was demonstrated that generation spectrum had at least triple modulation. With quasicontinuous lasing on an Al_2O_3:Ti^{3+} crystal, wavelength rearrangement can be accomplished in the 675-950 nm range that can be expanded by using different mirrors. Generation pulse length and time delay thereof, compared to an excitation pulse at constant pumping power, had the minimum value at the maximum of the rearrangement curve and increased at the range boundaries. These features were characteristic of both pulse and quasicontinuous excitation and must be taken into account in using rearrangeable lasers, based on Al_2O_3:Ti^{3+}, in experiments, as well as in various nonlinear transformations. Figures 5, references 12: 8 Russian, 4 Western.

RELATION BETWEEN FORMATION OF UNSTABLE COLOR CENTERS IN LASER CRYSTALS AND EMISSION CHARACTERISTICS OF SUCH CRYSTALS

[Article by L. G. Karaseva, N. Yu. Konstantinov, V. V. Gromov, A. P. Kalagin, V. K. Novikov, V. N. Nikolayev and V. M. Sorokin]

[Abstract] An experimental study of unstable color centers in crystals of YA (yttrium aluminate)+ ND^{3+}, YAG (yttrium-aluminum garnet)+ Nd^{3+}, KGT (potassium-gadolinum tungstate)+ Nd^{3+}, and GSGG (gallium-scandium-gadolinum garnet)+ Nd^{3+}+ Cr^{3+}(stabilizer) was made, for the purpose of determining the dependence of their formation efficiency on filtering of the optical pumping radiation and determining the relation between their concentration and the emission characteristics of these crystals. The optical pumping radiation was passed through BS, ZhS, OS, KS, IKS ladder light filters, with the wavelength corresponding to 50% transmission arbitrarily but accurately regarded as the filtration limit. The lifetime of unstable color centers was known to vary depending on the crystal material, being shortest in KGT crystals and longest in GSGG crystals. Measurements with a modified KSF-176 spectrophotometer have yielded the absorption spectra of unstable color centers in these crystals as well as the dependence of the relative change in the absorption coefficient at the wavelength corresponding to maximum absorption and of the relative change in the laser emission energy on the change of the filtration limit for the optical pump. The results indicate that unstable color centers in different crystals have different absorption spectra, with different. widths of absorption bands and different peak wavelengths. The optimum filtration limits for all crystals were, however, found to fall within the 320-360 nm range and thus to differ not more than by 40 nm. Separate measurements made on YAG:Nd^{3+} crystals with Fe^{3+} impurity ions and with stable color centers absorbing radiation within the 350-500 nm range revealed a dependence of the laser emission energy on the Fe^{3+}-concentration. This dependence is characterized by dipping of the emission energy to a minimum at an Fe^{3+}-concentration of approximately $5 \cdot 10^{17}$ ions/cm^{3}, evidently owing to participation of Fe^{3+}-ions in photoreactions which produce stable hole centers which absorb visible and ultraviolet light. Figures 4; references 11: 6 Russian, 5 Western.

NEW ACHIEVEMENTS IN CRYSTAL SCIENCE

[Article by Academician B. K. Vaynshteyn]

[Abstract] Recent developments in crystal science include new discoveries about the atomic structure of crystals formed by inorganic and organic substances, about topography of real crystals deviating from ideal ones, about phase transitions in crystals such as ferroelectric and paraelectric ones, about physical properties of crystals such as piezoelectric and pyro-electric as well as ferroelectric ones, discovery of solid electrolytes with superionic conductivity (phosphate salts) and photorefractive crystals complementing $LiNbO_3$, synthesis of new laser crystals complementing the classical $Al_2O_3 + Cr^{3+}$ ruby such as $Al_2O_3 + Ti^{3+}$, $Y_3Al_5O_{12} + Nd^{3+}$, rhombic $YAlO_3 + Nd^{3+}$, $BeAl_2O_4 + Cr^{3+}$, compression of alkali-halide crystals (CsI), and crystallization of inert gases (Xe). These developments were made possible respectively by high-precision x-ray diffractometry, high-resolution electron-microscopy, one-crystal as well as two-crystal and three-crystal interferometry, standing-wave x-radiography, and new apparatus for both laboratory and industrial crystal growing based on better knowledge of the crystal seeding process. Figures 12.

2415/12955
CSO: 1862/30

GROWING HETEROEPITAXIAL Ge LAYERS ON GaAs SUBSTRATE FROM COOLED SOLID SOLUTION

[Article by N. P. Yurchenko and G. I. Bagalin, Kiev State University]

[Abstract] The feasibility of growing heteroepitaxial Ge layers on GaAs substrate from a solid solution by cooling the latter was studied experimentally, with the eutectic Ge-Al system as basis. This system has been chosen over other eutectic systems (Ge-Zn, Ge-Sb, Ge-Ag, Ge-Au), because it forms an $\propto$ -phase solid solution (Ge-Zn does not), also because Al does not sublimate (Sb does) and maintains a stable interface with GaAs (more electronegative Ag and Au do not). Epitaxial GaAs substrates with (111)A and (100) orientations were first cleaned chemically for removal of oxide and then further purified by heat treatment at 773 K under vacuum for 10 min. With the substrates at a temperature of 473 K, 2 μm thick Al films were deposited on them by the electron-beam method under a vacuum of $2 \cdot 10^{-4}$ Pa. The resulting GaAs-Al structures were heat treated at 573 K for 30 min, for final purification of the substrate-metal interface. On the Al films were then deposited Ge layers, their thickness h having been determined

on the basis of the relation $h_{Ge} = l_s m_{Al} M_{Ge} \rho_s / M_s \rho_{Ge}$ (l_s – thickness of solid solution, m_{Al} – molar fraction of dissolved Al, M – molecular weight of Ge and of solid solution, ρ – density of Ge and of solid solution at T= 673 K temperature): 50 nm for a 2 µm thick layer of solid solution. The solid solution was formed at 673 K, the temperature limit of GaAs-Al interface stability, and then cooled at a rate of approximately 5 K/min to room temperature. Examination of the resulting structures in a reflection electron-diffractometer as well as under scanning and transmission electron-microscopes, with replicas and with selective chemical etching, revealed imperfections in the form of Ge microtwins and stacking irregularities not found in homoepitaxial Ge layers analogously grown on Ge substrate. Figures 2; tables 1; references 17: all Western (3 in Russian translation).

2415/12955
CSO: 1862/36

PHASE PHENOMENA IN PARAMETRIC GENERATORS AND AMPLIFIERS OF ULTRASHORT LIGHT PULSES

[Article by A. Piskarkas, A. Stabinis, and A. Yankauskas, Vilnyus State University imeni V. Kapsukas]

[Abstract] Progress in generation and amplification of ultrashort light pulses ranging from picosecond to femtosecond duration is reviewed, a recent development being parametric devices. Such devices, using quadratically rather than cubically nonlinear media, combine large bandwidth and high gain with wide tunability from ultraviolet to infrared wavelengths and various means of transforming both amplitude and phase characteristics of light pulses. Parametric pulse compression, first achieved by amplitude modulation with group-velocity separation of interacting light pulses, has been found to be more effective when involving phase modulation. Possible mechanisms of parametric interaction in this kind of device include conversion of quadratic phase modulation of pumping pulses by frequency chirp (linear variation of frequency) into phase modulation of emitted pulses, chirp reversal in real time, and self-compression with intense energy transfer. Theoretical feasibility of these mechanisms is supported by experiments involving principally the use of a YAG:Nd^{3+} laser with passive mode locking and a $LiNbO_3$ crystal for second-harmonic extraction, some experiments having been performed with a $La_2Be_2O_5$:Nd^{3+} laser. Ongoing research in this area deals with use of other quadratically nonlinear high-gain wideband media such as KDP, LiIo , CDA crystals, phase conjugation of light pulses, and control of the chirp slope. Figures 11; tables 3; references 45: 25 Russian, 20 Western.

2415/12955
CSO: 1862/27

DIMENSIONS OF IGNITION ZONES IN BLOW-OUTS OF COMBUSTIBLE GASES FROM RECTANGULAR AND CIRCULAR PORTS

[Article by Yu.A. Kondrashkov, V.P. Tomilin and G.G. Shevyakov, town of Balashikha]

[Abstract] A method for calculating maximum dimensions of ignition zones in blow-outs of combustible gases for axially-symmetric jets, developed by the authors earlier, is rather universal and was expanded to include cases of gas jets, effluent from rectangular and circular ports. Formulae for calculating the dimensions were derived theoretically and tested experimentally by analyzing distributions of hydrogen concentration along axes of turbulent rectangular and circular jets. The concentration was determined, using the thermoanemometry method. The length of sections, where concentration distribution corresponds to plane-parallel discharge, is different for gases with different density, effluent from rectangular ports. Therefore, it is more convenient to determine dimensions of ignition zones as the lowest dimensions, calculated according to proposed formulae; this conclusion was supported by concentration distribution in effluent jets. The obtained results make it possible to calculate dimensions of ignition zones in jet blow-outs from rectangular and circular (fan-type) ports for practically any combustible gas. Figures 2, table 1, references: 5 Russian.

CSO: 1862/57

12770

NEGATIVE ENERGY WAVES IN HYDRODYNAMICS

[Article by L.A. Ostrovskiy, S.A. Rybak and L.Sh. Tsimring]

[Abstract] Some aspects of the theory of hydrodynamic stability, related to the idea of negative energy waves (VOE), are discussed. Several examples of VOE in hydrodynamics were analyzed. Statement of the problem of an elastic membrane, moving with speed U relative to homogeneous incompressible fluid it is in touch with, with the fluid occupying half-space Z < 0, was generalized by assuming that the other half-space is occupied by a compressible medium with density much lower than that of the incompressible liquid and by taking into account losses in the membrane. Gravitational-capillary waves on water surface and internal waves in a stratified liquid (such stratification is present everywhere in the ocean) were also analyzed. It was demonstrated, that wave energy is only a portion of the "true" wave energy. It was suggested that total energy is the sum of "linear" and "nonlinear" energies. Therefore, speaking of negative energy, one only means its "linear" portion, related to linearized equations, whereas the total wave energy can have, generally speaking, a different value and even a different sign. VOE related nonlinear processes were discussed, such as: explosive amplitude rise in a resonance triplet; zero energy waves as a particular case of VOE; the nonlinear stage of dissipative VOE instability; radiation instability; relative motion of two thin viscous layers of liquid. The problem of radiation instability of oscillators in hydrodynamics was solved for the general case. An assumption was made that radiation instability could be a cause of formation of soliton-type internal waves, often observed in various regions of oceans. Figures 13, references 43: 33 Russian, 10 Western.

[72-12770]

ON SURFACE NON-LINEAR ACOUSTIC INTERACTIONS IN FLUIDS

[Article by N.I. Pushkina, Moscow State University imeni M.V. Lomonosov; presented by Academician L.V. Keldysh 12 May 85]

[Abstract] Approximate equations, describing three- and four-wave interactions on the surface of a liquid, were derived. Based on these equations, a particular case, wavefront inversion [OVF] of sound by the surface was examined. The equations were derived, based on a full set of surface hydrodynamic equations of quantum mechanics, with regular liquid as a particular case. Compared to optics, the acoustic case has specific features that can only be described if acoustic properties of the medium are examined in greater detail. The derived equations correspond to following cases: three-dimensional phase modulation of sound reflection factor and amplitude modulation. By comparing these equations, a conclusion was made that the maximum contribution to the inverse wave is made by an equation, corresponding to phase modulation, when non-linear reflection takes place in, so to speak, two stages, excitation due to quadratic non-linearity of a capillary wave at low difference frequency of the reference wave and signal wave (in the case under consideration difference frequancy was equal to zero) and reference wave reflection from profiled liquid surface. References: 7 Russian.

[200-12770]

DEVICE FOR STUDYING THERMAL CONDUCTIVITY OF STRUCTURAL MATERIALS AT HIGH TEMPERATURES

[Article by V.E. Piletskiy and L.G. Patrusheva, High Temperatures Institute, USSR Academy of Sciences]

[Abstract] A device for absolute measurements of thermal conductivity of various substances at above the room temperatures is described. The working portion of the device is a new design of the earlier described arrangement of longitudinal heat flow with a massive heat absorber. Expressions were derived that formed an analytical basis of the method and were used for calculations of thermal conductivity and reference temperature. In order to test serviceability of the device, experiments were conducted with a specimen, made of stainless steel 12Cr18Ni10T. The derived values of coefficient of thermal conductivity are presented, They were compared to another author's results, obtained by summarizing experimental data on this steel. The maximum deviation did not exceed 3-4%. Operation of the device in the area of higher thermal conductivity values was tested, using grade MChVP of molibdenum with mass purity, equal to or better than 99.9%. Deviation of experimental data from calculated ones did not exceed 3-4%. Figures 5, tables 2, references: 5 Russian.

[161-12770]

INSTRUMENTATION FOR STUDYING REFLECTIVITY RATIO OF PARTIALLY TRANSPARENT MATERIALS AT EXTREMELY HIGH TEMPERATURES

[Article by S.V. Krayushkin, A.F. Parfenovich, V.A. Petrov, D.Ya. Svet and A.P. Chernyshov, High Temperatures Institute, USSR Academy of Sciences]

[Abstract] Experimental procedure and instrumentation for determining reflectivity of partially transparent refractory materials, based on oxides of aluminum, magnesium, zirconium, hafnium, silicon, yttrium and compositions and compoundes thereof is described. A CO_2-laser was used as a heating source. The procedure provided for measuring reflectivity and surface temperature both in the course of heating and in a quazi steady-state of melting ablation. Special fast-response recording and measuring instrumentation was developed. The method for measuring directionally-directed reflectivity ratio for discrete wavelengths, determined by probing laser emission, was reduced to comparing energy, reflected by a specimen under investigation and a reference specimen. The latter was made of diffusely reflecting ceramics SiO_2 or Al_2O_3. LG-126 lasers at wavelengths 0.63, 1.15 and 3.39 micrometers, LG-106 M-1 lasers at wavelengths 0.488 and 0.514 micrometers and a LG-70 laser at wavelength 0.44 micrometers were used as probing lasers. As emission receivers, germanium and silicon photodiodes and a Ge: Au photoresistor were used. Pyrometry was conducted in the visible and near ultraviolet spectrum. Control of the experiment and data acquisition and processing were conducted with the help of a measuring and computing complex, based on an SM-4 computer and KAMAK instrumentation. Temperature dependence of reflectivity will be analyzed in the next article. Figures 5; references: 4 Russian.

[161-12770]

LASERS

TIME CHARACTERISTICS OF ‚TRAVELLING WAVE LASING WITH TWO-PHOTON PICOSECOND
OPTICAL PUMPING

[Article by V. I. Prokhorenko and Ye. A. Tikhonov, Institute of Physics,
Ukrainian Academy of Sciences, Kiev]

[Abstract] An experimental study is presented of the dynamics of formation
of a generated pulse in a travelling-wave laser, indicating that the pulse
length decreases monotonically with increasing pumping intensity. The
maximum compression achieved was by a factor of approximately 6, the minimum
pulse length of 5 ps achieved at a pumping pulse length of 31 ps. Experi-
mental and calculated values agree approximately up to ten times the pumping
threshold for a two-zone energy model of the dye used in the laser with
short oscillation relaxation time. At greater excitation, the pulse breaks
up into two generated pulses, which can be explained by a four-zone energy
model. The compression of the generated pulse is found to be independent
of pumping pulse length, the maximum degree of compression which can be
achieved being determined by the pumping intensity and threshold generation.
Figures 6, references 13: 6 Russian, 7 Western.

6508/12955
CSO: 1862/24

INCREASING TIME RESOLUTION OF PICOSECOND ABSORPTION SPECTROMETER BY
SELECTION OF LENGTH OF LASER LIGHT PULSES

[Article by B. N. Korvatovskiy, V. V. Gorokhov, S. L. Logunov and V. Z.
Pashchenko, Moscow State University, imeni M. V. Lomonosova]

[Abstract] Picosecond absorption spectroscopy requires measurement of changes
in the absorption of light in a specimen studied, induced by an exciting
light pulse. With very rapid relaxation, the signal recorded depends not
only on the amplitude, but also on the time profile of the pulses, so that
fluctuations in pulse length contribute to measurement error. A method
is suggested for monitoring the relative change in picosecond pulse length
and selecting pulses within a predetermined length range based on generation
of a second harmonic. Length selection of pulses in a spectrometer increases
the accuracy of recording of spectrometric curves and improves the time
resolution of the method. The statistical parameters of picosecond spectro-
meter light pulses were measured, demonstrating the possibility of decreasing
measurement error by selection of pulses by length. Figures 3, references
6: 5 Russian, 1 Western.

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CSO: 1862/24

DYNAMIC RESTRUCTURING OF PULSED CO_2 LASER FREQUENCY AND MULTIPLE-PEAK
GENERATION IN A CELL WITH IR-ABSORBING GAS IN THE RESONATOR

[Article by G. N. Makarov, Institute of Spectroscopy, USSR Academy of
Sciences, Troitsk, Moscow Oblast]

[Abstract] There are several methods of producing multiple-frequency radia-
tion in pulsed atmospheric pressure CO_2 lasers operating in the nanosecond
band. This article suggests a new method, consisting in that the frequency
of the laser is dynamically tuned from one line to another by means of a
cell with an IR-absorbing gas within the cavity of the resonator. The method
allows production of a series of pulses at decreasing frequencies, generation
on several lines simultaneously, as well as production of a train of pulses
at the same frequency. Dynamic tuning, multiple-frequency and multiple-peak
generation are achieved by the fact that the IR-absorbing gas is placed in
the cavity, the spectrum of linear absorption of the gas being in the direc-
tion of blue from the laser generating frequency by about 5 to 50 cm^{-1},

depending on the steepness of the low-frequency limb, and the spectrum of absorption of the molecules shifts in the red direction by oscillation excitation. This allows rapid scanning, simultaneous generation at 2 to 5 frequencies, as well as trains of 8 to 10 pulses at the same frequency. Figures 6, references 25: 8 Russian, 17 Western.

CAUSES AND DISTRIBUTION OF FAILURES IN SEMICONDUCTOR LASERS (A REVIEW)

[Article by P. G. Yeliseyev, Institute of Physics, imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] A discussion is presented of the causes of failures in semiconductor lasers based on a review of the (primarily Western) literature. Reliability characteristics are defined and a review of failure statistics is presented. The question of predicting the operating life and techniques for selection of lasers during quality control are studied. This study of the phenomenological aspect of the problem of reliability and durability of semiconductor lasers as reflected in the literature does not cover problems of the physics of failures. A model of failures is suggested in which the failure parameter is described by a normal distribution, while failure statistics correspond to a log-normal distribution. Injection lasers have achieved operating lives of 10^5 hours or more, thus approaching the levels of the most durable semiconductor electronic devices. Figures 7, references 49: 10 Russian, 39 Western.

STUDY OF VIBRATION RELAXATION IN ACTIVE MEDIUM OF CO_2-LASER USING PHASE-ABSORPTION METHOD

[Article by B.F. Kuntsevich, A.N. Pisarchik and V.V. Churakov]

[Abstract] A modification of a phase-absorption method, proposed in an earlier work, was tested, as it applied to studies of the rate of decay of energy, stored in the active medium of CO_2-lasers. The essence of the method was as follows. Current density of discharge, exciting a gas mixture, is modulated with certain frequency. Populations of CO_2 vibration levels will change with the same frequency. The change of populations is controlled, using weak probing radiation, which is resonant, for instance, with the transition between levels 10^00 and 00^01. In this case, an unknown constant is determined from the value of experimentally recorded phase shift between periodic oscillations of current and intensity of probing radiation. Relations that make it possible to find unknown parameters from experimentally measured phase shift were derived. Limiting cases were examined theoretically; they can be easily realized experimentally by appropriate selection of active medium composition and pressure, pumping current and working medium pumping speed. Analysis of experimental results of measuring phase shift as a function of discharge current modulation frequency for three different gas mixtures (CO_2:N_2:He = 1:3:10, 1:1:5 and 3:1:10) demonstrated that they agreed qualitatively with the theoretical expression, with the exception of the low frequency area (not exceeding 200 Hz). Similar experiments were also conducted for mixtures, where 80% of $^{12}CO_2$ was replaced by the $^{13}CO_2$ isotope. For a mixture, containing the isotope, the ratio of effective relaxation rate to gas mixture pressure is approximately 40% higher than for a regular mixture. This demonstrates faster collisional deactivation of effective energy for the $^{13}C^{16}O_2$ molecule, compared to $^{12}C^{16}O_2$ molecule. This fact should be taken into account, when developing laser systems that would use this molecule and operate in a continuous or quasi-continuous mode. The speed of resonance exchange between CO_2 and N_2 was in good agreement with available literature data. The proposed method complements already known methods and has certain advantages. For more purposeful application of the method it is desirable to control simultaneously active medium parameters. Figures 3, references 17: 15 Russian, 2 Western.

[211-12770]

TEA-TE: POWERFUL NITROGEN-BASED LASER SYSTEM

[Article by Yu.V. Zvinevich, I.N. Kazimirchik, N.A. Nemkovich, A.N. Rubinov and V.I. Tomin, Physics Institute, Belorussian SSR Academy of Sciences, Minsk]

[Abstract]   The existing need for affordable and reliable light excitation sources with pulse lengths of less than 1 ns, generating light pulses in a required spectrum, can be rather simply met with the help of nytrogen molecular lasers.   An efficient TEA-TE nytrogen-based system with short generation pulse, designed mainly for kinetic spectroscopy studies, was developed.   In the system, a reliable permanent synchronization of the generator and the amplifier was achieved.   Dependence of output radiation energy of the entire laser system on the energy of generator radiation, injected into the amplifier, was studied, and amplification factor was calculated: it was equal to 0.25 cm^{-1}.   Duration of radiation, generated by the system, was equal to 1 ns in half-width.   Peak generation power, calculated based on this duration, was equal to 300 kW at operating voltage of 16 kV and amplifier pressure of 1.2 x 10^4 Pa.   The system life in this case was equal to 10^8 flashes and was limited by electrical strength of the generator strip line.   A specific feature of the amplifier-generator system is a high stability of output radiation, caused by nonlinearity of the system amplifier.   Stability of radiation pulses was equal to + or - 5%.   Figures 2, references 7: 3 Russian, 4 Western.

[211-12770]

INTRACAVITY SPECTRUM ANALYZER WITH NaF:F_2^+:F_3^- CRYSTAL LASER FOR LONG-WAVE IR WAVE BAND

[Article by V.A. Vratskiy and A.N. Kolerov]

[Abstract]   An intracavity spectrum analyzer with NaF:F_2^+:F_3^- crystal laser was used in order to widen the long-wave application boundary of VRLS [intracavity laser spectroscopy] into the IR waveband and to increase sensitivity.   NaF crystals were used, with color centers [TsO] induced by gamma-irradiatiion by a ^{60}Co source.   As a pumping source of F_2+ and F_3- TsO in the NaF crystal, a ruby laser with duration of continuous lasing of approximately 800 microseconds and energy of up to 15 J was used.   A non-selective resonator provided a "smooth" IR radiation spectrum on F_2+ and F_3- TsO.   For spectral rearrangement, mirrors with reflectivity close to 100% in various spectral ranges and a prism, made of TF-1, and quartz wedges were used.   The spectrum analyzer was used for gas or plasma diagnostics. Spectra of atmospheric air and water steam were studied, as the most universal spectra for the near IR waveband.   A number of new lines was detected in absorption spectra of atmospheric air and carbon arc plasma flame, which meant that real sensitivity of the analyzer was at a (1-3) x 10^{-8} cm^{-1} level.   It was not possible to calibrate the analyzer by reflectivity, because development of reference standards with optical density of the order of 10^{-6}-10^{-8} is a complex problem in its own right.   Using the spectrum analyzer, concentration of molecules and absorption cross-section of low-pressure water steam in a dish was assessed experimentally.   Absorption spectra of complex fluorohydrocarbons were studied.   It was demonstrated experimentally that the spectrum analyzer makes it possible to analyze substances both in gaseous and ionized states. Figures 2, references 7: 5 Russian, 2 Western.

[207-12770]

STUDY OF KINETICS OF INTRACAVITY ABSORPTION IN PULSED DYE LASERS

[Article by V.S. Burakov, V.A. Malashonok, S.V. Nechayev, R.A. Pupko, S.N. Raykov and S.I. Shedenkov]

[Abstract] Kinetics of intracavity absorption in dye lasers with tube pumping (length of generation pulse 3 microseconds) and with ruby laser second harmonic pumping (25 ns) was studied. Time dependence of laser generation intensity I and I_0 for various values of optical density D of selective losses was studied. Water and ethanol solutions of europium nitrate were used as objects that provide selective absorption. Optical density of a specimen, introduced into the resonator, was varied by changing solution concentration or by scanning the recorded area of spectrum along the absorption band contour at a constant concentration. The analytical signal I was recorded with the help of a diffraction monochromator and photodetectors with sufficient time resolution. Experimental data were in satisfactory qualitative agreement with theoretical results. It was concluded that competition of laser modes determined to a large degree the kinetics of intracavity absorption in multimode pulsed action dye lasers with generation length not exceeding several microseconds. These conclusions were confirmed by derived experimental dependencies. The studies made it possible to reach certain conclusions in regard to choosing a method for recording the analytical signal in intracavity laser spectroscopy. The study results demonstrated a complex character of the process of intracavity absorption in pulsed dye lasers with generation length, equal to 10^{-8}-10^{-6} s. The use of a recording system with time resolution of a laser generation pulse makes it possible to increase the sensitivity of intracavity measurements. Figures 4, references 9: 3 Russian, 6 Western.

[207-12770]

EFFECT OF MULTIPLICATION OF SPECTRAL COMPONENTS OF MULTI-FREQUENCY LASING OF PULSED TUNABLE LASER

[Article by V.I. Kravchenko and V.V. Taranov, Physics Institute, Ukrainian SSR Academy of Sciences]

[Abstract] For the first time, characteristics of multi-frequency lasing developed due to simultaneous diffraction of several light beams, incident at different angles onto a common diffraction grating, which is a dispersion element of a laser resonator, were presented and discussed. The effect of the progressive increase in the number of spectral components, as the number of diffracting beams increases, wherein it is difficult to independently control these spectral components, was detected and explained. Lasing spectra of a laser, based on the 6-aminophenolenon solution, pumped by the second harmonic radiation of an YAG:Nd^{3+} laser. Genesis of the structure of the spectrum of multi-frequency generation of a laser with a dispersion resonator is claimed to be determined. Controlling addition spectral components is an independent complex problem. It was emphasized that taking into consideration the effect of multiplication of spectral components taking into consideration the effect of multiplication of spectral components of a multi-frequency laser is necessary in developing tunable lasers and in simulating complex laser spectra for multi-frequency optical communications and correlation analysis. Figures 2, references: 6 Russian.

[71-12770]

CHARACTERISTICS OF LKI-501 TUNABLE DYE LASER WITH DYES IN SOLID MATRIX

[Article by A. I. Zhiltsov, A. G. Klimashina, V. Ye. Mnuskin, V. G. Nikiforov, A. N. Tokareva, and B. F. Trinchuk]

[Abstract] An experimental study of the LKI-501 tunable dye laser was made, with dyes in a solid matrix of polymethyl methacrylate and with pumping by second-harmonic radiation from a YAG:Nd^{3+} laser in pulses of 11 ns duration at a repetition rate of 25 Hz. Nearly longitudinal excitation at an $8° \pm 10'$ angle, through a focusing lens, ensured a high conversion efficiency and a uniform absorption of pumping energy over the active volume. The resonator with an 80 mm long base was formed by two plane mirrors and a touching pair of Brewster prisms made of TF-5 glass set for a resultant refraction angle of 59°20'. Wavelength tuning of the laser emission was effected by rotation of the opaque first mirror. Five dyes were tested: rhodamine 6G, rhodamine 6G - isobutyrate, rhodamine C, oxazine 17, oxazine 1. Radiation within a line not wider than 0.8 nm and tunable over the 548-744 nm range (548-610 nm with rhodamine 6G, 681-744 nm with oxazine 1) was emitted by this LKI-501 laser. Insertion of a Fabry-Perot interferometer with a 100 um long base and 65%-reflection mirrors into the resonator cavity made it possible to narrow the emission line down to 0.08 nm. Maximum conversion efficiency was attained with 350 kW pumping pulses, this being the saturation level. The maximum efficiency was 37% with rhodamine 6G - isobutyrate, 31.5% with rhodamine 6G, 29% with rhodamine C, 10% with oxazine 1, 3.3% with oxazine 17. The characteristics of second-harmonic radiation emission by the LKI-501 with these active media were also measured in that experiment. Figures 5; tables 2; references 10: 6 Russian, 4 Western.

DYE LASER FOR HOLOGRAPHIC INTERFEROMETRY

[Article by I. S. Zeylikovich, A. M. Lyalikov, and N. M. Spornik, Grodno State University]

[Abstract] A dye laser with a diffraction grating is considered for holographic interferometry. In an experimental feasibility study of such a technique, an ethanol solution of rhodamine 6G was used as the active medium, with a resonator formed by two plane mirrors at the Brewster angle to the

optical axis and a diffraction grating (1200 lines/mm) inside the cavity at an approximately 86° incidence angle in the first diffraction order. This laser was pumped by second-harmonic radiation of a ruby laser, for emission of 30 ns pulses with passive Q-switching by means of a KS19 glass plate. Second-harmonic 200 kW pumping pulses were extracted by means of a KDP crystal. Measurements were made with Zender-Mach and Michelson interferometers, auxiliary optics including a cylindrical quartz lens, an OS-12 light filter, a telescopic set of two compound lenses, two light-beam splitting cubes, two plane 45° mirrors, and an LENS, also a spectrograph for monitoring the diffraction. An analysis of space-time coherence indicates the feasibility of holographic interferometry with such a laser. A diffraction grating oriented at the grazing angle facilitates smooth tuning of the emission wavelength near the absorption line of the atomic medium in the test tube and thus makes possible resonance interferometry with sensitivity control. Such diffraction gratings also facilitate multifrequency laser emission, particularly two-frequency emission with two separate resonators and a diffraction grating inside each useful for two-wavelength holography. Figures 4; references 12: 7 Russian, 5 Western.

GENERATION OF LIGHT PULSES IN SEMICONDUCTOR LASER UPON EXCITATION BY SEVERAL ELECTION BEAMS

[Article by K. V. Aleksandrovich, V. V. Druzhinin, V. A. Kovalenko, and M. D. Tarasov]

[Abstract] Excitation of GaAs and CdS semiconductor lasers with several simultaneously acting fast-electron beams in proximity of one another is considered for effectively controlling the duration of generated light pulses. Experiments were performed using three different sources of high-intensity electron beams: RIUS-5 accelerator with transformer for GaAs-lasers, GTI-7 generator with IMA-8E-V cathode-ray tube and MIRA-2D commercial portable x-ray machine with IMA-3-150E cathode-ray tube for CdS lasers. The lasers were produced from single crystals of degenerate n-GaAs and plain CdS. In the GaAs specimens doped with Te and Si the donor concentration was $N_d \approx 2 \cdot 10^{18}$ cm^{-3} and the acceptor concentration was $N_a \approx 10^{18}$ cm^{-3} respectively, while the Cds specimens the residual impurity was $N \leq 10^{16}$ cm^{-3}. The results of these experiments indicate that both amplitude and shape of laser emission pulses depend not only on the excitation level but also on the excitation geometry, particularly on the number and the spacing of electron beams. They reveal different thresholds for emission along and across the electron beams, a change of direction causing an appreciable decrease of the emission pulse duration relative to the excitation period. Qualitative

Qualitative and approximate quantitative theoretical analysis for thin elec-
tron beams, an exact solution of a three-dimensional wave equation being
mathematically prohibitive, confirms the experimentally established feasi-
bility of widely controlling the emission pulses of semiconductor lasers
by using several electron beams for excitation. Figures 5; tables 1; re
references 5: all Russian.

2415/12955
CSO: 1862/12

ON FORMATION OF MASS DISTRIBUTIONS OF FRAGMENTS OF FISSION OF NUCLEI LIGHTER THAN THORIUM

[Article by M.G. Itkis, S.I. Mulgin, A.Ya. Rusanov, A.N. Okolovich (Nuclear Physics Institute, Kazakh SSR Academy of Scineces) and G.N. Smirenkin (Physics and Energy Institute, Obninsk)]

[Abstract] An approach was developed to quantitative analysis of formation of mass distributions of fragments in the process of fission of preactinide nuclei. For quantitative description of mass distributions of fragments, description of level density, based on a superfluidic model, was used, with phenomenological consideration for collective and shell effects and with clarifications, required by analysis of integral fissionability of preactinide nuclei of nuclear deformation V(M) and components thereof. Results of the analysis demonstrate adequacy of the adopted description of rearrangement of shells with energy and of mass distribution of fragments as a whole and reliability of the procedure of restoration of shell corrections. The experimental information on a shell correction in a transient state as a function of asymmetric deformation (mass of fragments) was obtained for the first time; it was compared to a number of previously published theoretical calculations. Experimental data for ^{213}At demonstrated a break in temperature dependencies of variances, which is rather well described by calculated curves; a conclusion was made that variance measurements could become one of the most sensitive methods for studying processes of phase transition of excited nuclei from superfluidity to a normal state. Experimental data on fission mode Y(M) in the case of fission of ^{213}At at excitation energy U = 7.7 MeV were compared to results of various calculations. An attempt was made to calculate Y(M) for heavier nuclei, using the same approach. The ^{227}Ac nucleus was selected, because it is close to ^{213}At and because description of mass distribution of fragments that have a three-hump shape is traditionally used for testing theoretical models of fission asymmetry. On the whole, calculations agreed with the experiment. Figures 6, references 32: 19 Russian, 13 Western.

[213-12770]

MASS DISTRIBUTIONS OF FISSION FRAGMENTS OF HEATED NUCLEI AND DROPLET MODEL

[Article by Ye.N. Gruzintsev, M.G. Itkis, S.I. Mulgin, V.N. Okolovich, A.Ya. Rusanov (Nuclear Physics Institute, Kazakh SSR Academy of Sciences) and G.N. Smirenkin (Phisics and Energy Institute, Obninsk)]

[Abstract] Measurements of fission parameter X, conducted by the authors earlier, were continued in the described work for lower values of X. A group of nuclei, from Er to Os, was studied. The studies were conducted at the Alma-Ata isochronic cyclotron U-150. The method for measuring mass distributions, using spectrometry of twin fragments, was improved in order to obtain the required statistical accuracy. In measurements, spectrometry targets of fissioned isotopes ^{162}Dy, ^{169}Tm, ^{176}Hf, ^{181}Ta, ^{180}W, obtained by vacuum spraying by a high-current electron gun on substrates, made of Al_2O_3, were used. Experimental data were discussed. Stability of saddle forms with respect to mass-asymmetrical deformation in a liquid droplet model (MZhK) was examined. Five principal versions of the MZhK were described. The effect of descent from the barrier vertex was examined. Relation between the stability parameter $Q(X)$ and X was described; the experimental relation was in perfect agreement with the theory, although maximum $Q(X)$ in experiments and in theory did not agree. The characteristic behavior of $Q(X)$ makes it a very useful reference point for testing parameters of fluctuation-dissipative dynamics and the droplet model. Specific character of dependence of Q on nucleon composition of nuclei and comparatively easily achievable high accuracy of variance measurements facilitate application thereof in future studies of the macroscopic mass and energy component. Figures 6, tables 2, references 35: 17 Russian, 18 Western.

[213-12770]

CHERENKOV ATOM RADIATION

[Article by M.Ya. Amusya and A.V. Solovyov]

[Abstract]   It was demonstrated that in moving through a transparent media
with velocity, exceeding the velocity of light in this medium, a neutral atom,
spherically symmetrical in its own frame of reference,   generates
[Cherenkov radiation], comparable in intensity to ChI of a quadrupole. The
causes of ChI generation were explained. The process of ChI of a relativistic
atom in the lower order of the perturbation theory was described.   It was
demonstrated that intensity of ChI of a system of charged particles is
determined by its form-factor features.   In systems with a zero form-factor,
such as positronium, muonium etc., there is no ChI effect whatsoever.
Ionizatio of an ultrarelativistic atom will be hindered by the fact that in a
laboratory reference frame ionization potential of such atom is higher than
its ionization potential in its own reference frame.   1 figure, references: 3
Russian.

[71-12770]

MICROSCOPIC CALCULATIONS OF ENERGY AND TRANSITIONAL DENSITIES OF GIGANTIC MONOPOLISTIC RESONANCES IN NUCLEI

[Article by M.V. Stoitsov, I.Zh. Petkov and S.S. Dimitrova (Nuclear Research and Power Institute, Bulgarian Academy of Sciences)]

[Abstract] Results of earlier works by the authors were generalized. It had been demonstrated that gigantic monopolisitc resonances (GMR) could be successfully interpreted as dinamically related volume and surface oscillations of nuclear density, using wave functions of the local-scale transformation method (MLMP). In this case, results, obtained in chaotic phases approximation, are reproduced with good accuracy not only for heavy, but also for medium and light nuclei. The proposed trial wave function makes it possible to reproduce with good accuracy calculations of the Hartrey-Fock (HF) method for the basic nuclear state. Results for 0^+- excited states, obtained in MGK [genrator coordinate method] and AVZ HF [adiabatic time-dependent Harterey-Fock method] with consideration given to surface and volume oscillations of nuclear density, were compared. The objective of the studies was to demonstrate that, although there are considerable differences between the methods in describing basic nuclear states, their predictions for GMR are in complete agreement. Combination of surface and volume vibrations leads to generation of scaling (SK)-type oscillations, with energy close to surface mode excitation energy, and anti-scaling (ASK)-type oscillations, with excitation energy almost twice that of the volume mode. Energies of the first 0^+-excited states, obtained in MGK and AVZ HF for ^{4}Ne, ^{16}O and ^{40}Ca nuclei, were compared to Skirma forces. Close results were obtained for both methods. The difference between the two methods was only observed for the lightest nuclei. Transitional densities for various excitation types for ^{16}O and ^{40}Ca were studied. Figures 2, references 7: 4 Bulgarian, 3 Western.

12770

FOUR-LEPTON DECAYS AND ELECTROMAGNETIC RADIUS OF K-MESON

[Article by D. A. Mzhaviya, G. V. Mitselmakher and F. G. Tkebuchava,
Joint Institute of Nuclear Research]

[Abstract] Rare decays of a K-meson and the momentum dependence of corresponding decay form-factors are analyzed for information about the structure of particles, simultaneous weak and electromagnetic interactions such as four-lepton decays being particularly informative with regard to the structure of hadrons. The probabilities of $K^+ \rightarrow_1 l^+ \sim l'^+ l'^-$ decays (l,l' - electrons or muons) are calculated on the basis of the D. Yu. Bardin theory, with a matrix element represented as the sum of two terms according to the schematic diagram of these processes. The differential probabilities have been computed according to the SHCOONSCHIP program (H. Strubbe). Data of the CERN 1976 electronic experiment (A. M. Diamant-Berger) have been evaluated for semiempirical relations between decay form factors and decay probabilities. The results indicate that from available data (although they are statistically meager), it is possible to independently estimate the electromagnetic radius of a K-meson. The authors thank B. F. Kostin and N. L. Rusakovich for great assistance, also D. Yu. Bardin, B. M. Pontekorvo, and L. I. Lapidus (deceased) for helpful discussions. Figures 2; tables 1; references 20: 6 Russian, 14 Western.

2415/12955
CSO: 1862/39

GLUON STRUCTURE AND THE STRONG INTERACTIONS OF HIGH-ENERGY HADRONS

[Article by A. V. Kiselev and V. A. Petrov, Institute of High-Energy Physics,
Serpukhov]

[Abstract] The structure of a hadron and the interactions of its components are examined on the basis of a particular model, namely the model of gluon fields based hypothetical gluon dominance, inasmuch as the "inverse problem" of determining them cannot be solved by a model-independent method. Analytical expressions for the distribution of gluon fields in a hadron and for the amplitudes of gluon-gluon interactions, according to this model, yield the total cross-section for hadron A -- hadron B interaction. Analysis of the phenomenological consequences of this model and of experimentally established facts reveals that the gluon dominance model reproduces results based on the additive quark model, despite its different nature here. It also suggests parton-hadron duality. Calculations as well as measurement of a linear trajectory made by the UA4 Group (J. Velasco) and measurement of inelastic diffraction made by the UA5 Group (H. Schmickler), both reported

at the Talk International Conference on High-Energy Physics (Bari, July 1985), indicate some relation between the Pomeranchuk trajectory and the Regge trajectory of a glueball. The authors thank A. A. Logunov for fruitful discussion of basic ideas, also S. S. Gershteyn, M. A. Mestvirishvili, L. D. Solovyev, S. M. Troshin, and N. Ye. Tyurin for valuable comments. References 19: 8 Russian, 11 Western.

OCCURRENCE OF BOSON RESONANCES DURING p̄p-INTERACTIONS AT 32 GeV/s

[Article by Ye. A. Kozlovskiy, V. A. Bumazhnov, L. L. Zakamskiy, A. Ye. Kiryunin, A. I. Kotova, M. S. Levitskiy, A. F. Lukyantsev, A. A. Minayenko, A. M. Moiseyev, D. I. Patalakha, Ye. A. Starchenko, M. N. Ukhanov, and S. V. Chekulayev, Institute of High-Energy Physics, Serpukhov, P. F. Yermolov, L. I. Sarycheva, L. N. Smirnova, and N. A. Kruglov, Scientific Research Institute of Nuclear Physics, Moscow State University, Moscow, A. A. Vinitskiy, B. O. Zhautykov, and K. G. Zaytsev, Institute of High-Energy Physics, KaSSR Academy of Sciences, Alma-Ata]

[Abstract] New experimental data on inclusive formation of the mesons $\rho^0(770)$, f(1270) and the scalar meson S*(975) during pp-scattering at 32 GeV/s have been obtained from the spectra of effective masses of $\pi^+\pi^-$ -pairs, the scalar meson S*(975) evidently forming during the $\pi^+\pi^- \rightarrow K_s^0 K_s^0$ process. Approximation of the measured distributions of these effective masses $d\sigma/dM$, has yielded total inclusive as well as semiinclusive and differential cross-sections. Differential cross-sections of distributions over the longitudinal component and over the transverse component of the momentum have been calculated for each of those resonances on the basis of the LUND fragmentation model of soft collisions. Also the products of meson $\rho^0(770)$ and meson f(1270) fission have been analyzed both qualitatively and quantitatively. Figures 9; tables 1; references 21: 4 Russian, 17 Western.

ELECTROMAGNETIC PROPERTIES OF NEUTRINO IN SUPERSYMMETRIC THEORIES

[Article by T. M. Aliyev, Institute of Physics, AzSSR Academy of Sciences]

[Abstract] The magnetic moment and the life time of a Dirac neutrino as
well as the width of $\nu_H \rightarrow \nu_L \gamma$ decay are calculated on the basis of
supersymmetric theories, taking into account mixing of scalar leptons with
gauge and Higgs fermions. Omission of mixing has been found to result in
appreciable errors. With constraints on the masses of supersymmetric parti-
cles applied here, and assuming oscillations between two neutrino states,
these calculations yield a supersymmetric component of the magnetic moment
50% larger and a neutrino life time one order of magnitude shorter than
according to the standard Glashow-Weinberg-Salam theory. The author thanks
V. I. Zakharov, M. I. Vysotskiy, and V. A. Kuzmin for helpful discussion.
Figures 1; tables 1; references 13: 2 Russian, 11 Western.

INVERSE PROBLEM FOR QUANTUM THEORY OF SCATTERING IN NEW FORMULATION

[Article by I. V. Poplavskiy and A. A. Shiyan, Odessa Institute of Construc-
tion Engineering]

[Abstract] A new formulation of the inverse problem for the quantum theory
of scattering is proposed, a physically as well as mathematically significant
one inasmuch as neither the phase shifts of momentum or energy at a fixed
orbital moment nor the phase shifts of the orbital moment at fixed momentum
or energy are always known. In previous formulations the magnitude of the
Coulomb interaction constant was assumed to be fixed. The new formulations
waives this constraint and restores the nuclear interaction potential involv-
ing either a charged particle and members of an isotopic multiplet or two
isotopic multiplets, when the phase shifts, which depend on the magnitude
of the Coulomb interaction constant, are known at fixed momentum and orbital
moment. Analytical continuation of the Coulomb interaction constant into
the complex space facilitates solution of the inverse problem for the relativ-
istic generalization of the corresponding partial Schroedinger equation
on the basis of measured phase shifts, a phase shift being resolved into
its pure nuclear component and nuclear-Coulomb interference component.
With the aid of the solution are determined the properties of the nuclear
interaction potential and is constructed the $\pi^{\pm}$ p-interaction quasi-potential
in the S_{31}-state at two energy levels 263.7 MeV and 310 MeV in the laboratory
system. The new approach is further demonstrated on pN-scattering in the
$^1S_0$-state and the low-energy phase shift of pp-scattering in that state.

PASSAGE OF FISSILE NUCLEUS THROUGH BARRIER TO SCISSION IN MULTIDIMENSIONAL
DIFFUSION MODEL

[Article by G. D. Adeyev and N. I. Pischasov, Omsk State University]

[Abstract] The dynamics of a fissile system and particularly evolution from
the ground state are analyzed on the basis of the multidimensional Fokker-
Planck equation, with the fission process described in the Kramers sense.
As model has been selected the Fokker-Planck equation in functions represent-
ing the distributions of collective coordinates and conjugate moments.
The case of three collective coordinates c, h, α is considered, these being
the most important ones in fission dynamics (c- elongation parameter).
The equation is solved by the method of a reduced propagator, solution by
the two methods of a propagator and finite differences for several degrees
of freedom not being feasible at the present state of the art. The apparatus
is applied first to a simple problem, namely passage of a nucleus through
a multidimensional potential barrier with negligible quantum effects, assuming
a constant effective temperature of 1 MeV. It is then applied to passage
of a cluster of nuclei through such a barrier with relativistic effects
taken into account by appropriate coefficients in the Fokker-Planck equation.
An analysis of the results indicates that for determining the distributions
of fragments produced by fission of heavy nuclei, including an astatine
nucleus, it is permissible to ignore the initial state at the saddle point
and to consider only the descent from saddle point to scission. The authors
thank Yu. A. Lazarev and V. V. Pashkevich for helpful discussions. Figures
2; tables 1; references 24: 5 Russian, 19 Western.

SEARCH FOR NEW MECHANISM OF NUCLEAR FISSION BY HIGH-ENERGY PROTONS BASED ON ISOTOPE DISTRIBUTIONS OF FRAGMENTS

[Article by B. N. Belyayev, V. D. Domkin, and V. S. Mukhin, Radium Institute imeni V. G. Khlopin]

[Abstract] Nuclear fission of iridium by high-energy protons was studied in an experiment, the purpose being to find traces of a reaction channel producing fragments with various N/Z ratios. The target, natural Ir with a nucleus much lighter than that of ^{238}U, was bombarded with 1 GeV protons. The fission fragments were analyzed on a mass-spectrometer "in line" with the synchrocyclotron at the Leningrad Institute of Nuclear Research. Qualitative analysis has revealed an Ir(p,X)Rb reaction and quantitative analysis has yielded the cross-sections for formation of $^{76-92}$Rb isotopes. The excess yield of $^{88-92}$Rb isotopes, above the level according to a Gaussian distribution and approximately 4% higher than the sum of yields of all Rb isotopes according to projections based on the $^{76-86}$Rb yields made by the method of least squares, is attributable to an additional new fission mechanism. This preequilibrium mechanism (B. D. Wilkins and associates: PHYSICS REVIEW LETTERS Vol 43, 1979, p 1080) would also explain the asymmetric distribution of Rb isotopes resulting from bombardment of a target with A $\lesssim$ 200 by protons with an energy as high as 1 GeV. Figures 4; tables 1; references 19: 7 Russian, 12 Western.

IMAGE RECORDING IN NEUTRON MICROSCOPE

[Article by S. S. Arzumanov, S. V. Masalovich, A. N. Strepetov, and A. I. Frank, Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] An experiment with a neutron reflection microscope was performed including for the first time all components necessary for recording the image of an object, namely a source of ultracold neutrons, a pair of achromatic concave mirrors, and a scintillator-detector. The liquid-hydrogen neutron source from the Leningrad Institute of Nuclear Physics generated a flux of $6 \cdot 10^3$ neutrons/(cm$^2 \cdot$s) intensity passing to the object through an L-guide with a 45° plane mirror inside under the stage. The pair of concave mirrors, spherical ones with 20 cm and 30 cm radii of curvature respectively, formed a cavity above the stage with center holes of a 0.25 numerical aperture for passage of rays reflected first by the upper one and then by the lower one so as to produce a 1.4x magnification. Both mirrors were coated with a ^{58}Ni-Mo film limiting the speed of neutrons to approximately

8 m/s. The scintillator-detector above the mirrors consisted of three layers: 10-15 μm thick ZnS + 0.2-0.3 μm thick Al + 10 μg/cm^2 thick LiF containing ^{6}Li and ^{7}Li in 1:1 ratio. This detector was placed at the entrance to a fiber-optic light guide leading to an image converter tube above with a photographic film on top. Two-dimensional images of two objects were recorded with this equipment, namely a cruciform diaphragm and a 200 nm thick Ni-film pattern deposited on a 0.35 mm thick silicon wafer. The authors thank A. P. Serebrov at the Leningrad Institute of Nuclear Physics for support and hospitality, also P. S. Yaydzhiyev, A. V. Vasilyev, A. I. Ioffe for assistance, N. V. Borovik for coating the mirrors, and V. G. Nikolskiy as well as his coworkers for preparing the test objects. Figures 2; references 10: 3 Russian, 7 Western.

UNIVERSAL LIQUID-HYDROGEN SOURCE OF POLARIZED COLD AND ULTRACOLD NEUTRONS IN VVR-M HYDROGEN-MODERATED HYDROGEN-COOLED REACTOR AT LENINGRAD INSTITUTE OF NUCLEAR PHYSICS

[Article by I. S. Altarev, N. V. Borovikova, A. P. Bulkin, V. A. Vesna, Ye. A. Garusov, L. A. Grigoryeva, A. I. Yegorov, B. G. Yerozolimskiy, A. N. Yerykalov, A. A. Zakharov, S. N. Ivanov, V. Ya. Kezerashvili, S. G. Kirsanov, E. A. Kolomenskiy, K. A. Konoplev, I. A. Kuznetsov, V. M. Lobashev, N. F. Maslov, V. A. Mityukhlyayev, I. S. Okunev, B. G. Peskov, Yu. V. Petrov, R. G. Pikulik, A. N. Pirozhkov, G. D. Porsev, A. P. Serebrov, Yu. V. Sobolev, R. R. Taldayev, V. A. Shustov, and A. F. Shchebetov, Institute of Nuclear Physics imeni B. P. Konstantinov, USSR Academy of Sciences]

[Abstract] A universal source of polarized cold and ultracold neutrons is operating in the VVR-M hydrogen-moderated hydrogen-cooled intermediate-power reactor at the Leningrad Institute of Nuclear Physics since the end of 1985. The liquid-hydrogen moderator with a 1 dm^3 capacity is located at the center of the reactor core, surrounded by a lead shield which reduces the radiative heat load. The flux of thermal neutrons is $(1.5-2) \cdot 10^{14}$ n/(cm^2·s), the total heat release in the source is 2 kW (800 W in the core, 1200 W in the hydrogen). The neutron source is cooled with 6 dm^3 of liquid hydrogen circulating with a velocity as high as 1 m/s at full reactor power between a reservoir and a helium refrigerator, driven by the temperature gradient and the heat exchanger asymmetry. The spectrum of cold and ultracold neutrons is determined by the moderator and also by the bent neutron duct responsible for the short-wave cutoff. The spectrum was measured by the transit method with an ionization fission chamber for recording cold neutrons and with a He proportional detector for recording ultracold ones. The advantage in neutron yield attained by using liquid hydrogen (16.3 K) instead of gaseous hydrogen (300 K) was found to increase with increasing neutron wavelength, reaching a factor of 40-50 for 10-20 Å neutrons, and to shift the maximum flux intensity from 3 Å neutrons to 4 Å neutrons.

Having cooled the hydrogen below the 25·3 K boiling point had increased the yield of long-wave neutrons by 25%. With 90+5% polarization and velocities up to 7·8 m/s, this source produces cold neutrons at a rate up to $3 \cdot 10^{10}$ n/s (flux intensity up to $6 \cdot 10^8$ n/cm^2·s) and ultracold neutrons at a rate up to $5 \cdot 10^5$ n/s (flux intensity up to $6 \cdot 10^3$ n/cm^2·s). The authors thank A. V. Strelkov (Joint Institute of Nuclear Research) for supplying detectors specially designed for ultracold neutrons, also P. S. Yaydzhev (Institute of Nuclear Research and Nuclear Power Engineering, BSSR Academy of Sciences), A. V. Vasilyev, V. V. Nesvizhevskiy, V. G. Syromyatnikov, N. K. Pleshanov, V. A. Priyemyshev, M. S. Lasakov, Yu. V. Borisov, and A. B. Brandin for assisting in various stages of the project. Figures 3; references 2: Western.

2415/12955
CSO: 1862/37

PROPAGATION OF RADIATION ALONG A CONSTRICTING OPTICAL WAVEGUIDE

[Article by V. M. Andreyev, K. F. Yeskin and Ye. Ye. Glukhova]

[Abstract] The parabolic equation approximation was used to analyze the
propagation of radiation along a constricting planar waveguide. The use
of the parabolic equation approximation is analogous to the paraxial approxi-
mation of geometric optics. The major advantage of the parabolic equation
is a decrease in order with respect to z. The method outlined was used
to calculate the distribution of the field of the electromagnetic wave in
various cross sections of a constricting planar waveguide with the parameters
of air, vinyl trimethylsilane and plexiglass, angle of constriction 1:120,
.initial thickness 0.65 µm, wavelength 0.63 to 8 µm. The time of computation
· of one step with respect to z was 1.2 seconds on a YeS-1050 computer. The
parabolic equation approximation is found to describe the process of radia-
tion from a constricting planar optical waveguide with sufficient accuracy,
allowing determination of the distribution of the field in any cross section
of the waveguide. Figures 3, references 8: 6 Russian, 2 Western.

6508/12955
· CSO: 1862/23

CROSS SECTION OF RESONANT RAMAN SCATTERING OF LIGHT BY POLYENES

[Article by V. V. Verdyugin, K. Ya. Burshteyn and P. P. Shorygin]

[Abstract] An experimental study is presented of the resonant Raman spectra .
of β-carotene. Absolute differential cross sections are obtained for the
most intensive Raman spectral lines with excitation at the absorption maximum,

and a theoretical analysis is presented of the variation in absolute differential cross section as a function of a number of conjugate double bonds in the polyenes. Absolute differential cross sections were measured for $2 \cdot 10^{-6}$M solutions of -carotene in cyclohexane. The calculations indicated values of $\sigma^{max}_{C=C}$, close to the experimental values, indicating that the predicted variation in specific absolute differential cross section as a function of number of double bonds with a maximum at M=5 actually does occur. Future studies are planned to refine these results still further. Figure 1, references 12: 8 Russian, 4 Western.

6508/12955
CSO: 1862/23

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Cr^{3+} SPECTROSCOPY IN POSITION WITH CENTER OF SYMMETRY IN ALEXANDRITE

[Article by A.P. Yeliseyev, A.M. Yurkin, Ye.N. Fyodorova and Ye.G. Samoylova]

[Abstract]   Spectroscopy characteristics of $Cr(C_i)$ ion in alexandrite $BeAl_2O_4$:Cr were studied, as information thereon in literature was practically non-existent.   Synthetic alexandrite monocrystals, grown according to Chokhralskiy method in the [001] direction, were studied.   Specimens had the form of polished cubes with edges, parallel to crystallographic axes; chrome concentration was equal to 0.005-0.25 mass %.   Photoluminescence (FL) spectra of alexandrite at 80 K are characterized by a rich fine structure.   Judging by the presence of resonance analogs in luminescence excitation spectra (SVL), four most intensive lines can be interpreted as non-phonon lines (BFL), each accompanied by a structured phonon wing.   In order to determine diagrams of energy levels of $Cr(C_i)$ under the conditions of low absorption rate of the center of symmetry and well developed and reliably identified BFL in FL spectra, luminescence excitation spectra, obtained at 80 K, were used.   The conducted studies of luminescence in alexandrite made it possible to come to a conclusion that in the case of the process of stimulated radiation generation $Cr^{3+}(C_i)$ ions should be considered parasite centers, responsible for external quenching of FL of $Cr^{3+}(C_s)$ ions, wherein quenching efficiency increases, as activator concentration (Cr^{3+} is the activator ion) increases.   Figures 2, references 9: 3 Russian, 6 Western.

[211-12770]

CERTAIN LUMINESCENT PROPERTIES OF GaN:(Zn-O) STRUCTURES

[Article by M.D. Shagalov and Ya.D. Lebedev]

[Abstract] In order to test the truthfulness of an assumption of homogeneous distribution of the zinc-oxygen complex over the thickness of an m-i-n GaN:(Zn-O) structure, experiments were conducted on distribution of luminescence centers in the structure. Photoluminescence (FL) was excited by a mercury lamp (365 nm line) and an LPM-11 laser (446.1 nm line) radiation. Because of the different degree of excitation FL penetration in the two cases, an assumption can be made of heterogeneous distribution of additives over the thickness of the structure. Centers of the zinc-oxygen complex are concentrated in the i-n junction area. Despite this conclusion, the possibility of excitation of the zinc-oxygen complex by radiation with quantum energy, corresponding to the area of principal absorption of hallium arsenide, is not precluded; one should just select the wavelength of exciting FL radiation, wherein GaN absorption factor would make possible penetration into the structure. However, studies of this type, conducted in this work, still had not detected FL, similar in polarization properties to EL [electroluminescence]. Excitation FL of the i-n structure in the case of its illumination from the surface in the boundary area of principal absorption cannot develop in a region, where centers of the zinc-oxygen type are concentrated. Figures 3, references 5: 4 Russian, 1 Western.

[211-12770]

EXCITATION SPECTRUM OF VISIBLE LIGHT - SIMULATED RECOMBINATION LUMINESCENCE OF GAMMA-IRRADIATED COPOLYMERS OF METHYL METHACRYLATE WITH DIMETHACRYLOXYMETHYL ANTRACEN

[Article by S.V. Lotnik, V.N. Korobeynikova, V.P. Kazakov and L.Kh. Bikchurina]

[Abstract] Antracene is an efficient electron trap. It was hoped that introducing an antracene fragment, that has bright fluorescence and a characteristic absorption spectrum in the anion-radical state, into a polymer would facilitate identification of an electron trap, if the fragment behaved as the trap. In order to do this, a copolymer of methyl methacrylate (MMA) with dimethacryloximethyl antracene (DMOMA) was produced, wherein polymethyl acrylate chains were cross-linked by antracene fragments. Copolymer 9,10-bis (methacryloximethylene)-antracene was synthesized. Product yield was equal to 58% of the theoretical yield. After gamma-irradiation at 77 K, the copolymer gets blue coloration, which completely dissappears, when heated to 250-300 K. It was obvious that the antracene fragment was the acceptor of electrons in the copolymer. Radiothermoluminescence of the polymer was caused by recombination process, wherein electrons, captured by the antracene fragment, participated. It was found that a singlet-excited antracene fragment was the only emitter of recombination luminescence photons. Two components, a rapid and a slow one, were identified in glow build-up and decay curves, which could be attributed to the presence of two types of hole traps ($PMMA^+$ and A^+), separated in space. Figures 2, references 15: 10 Russian, 5 Western.

[211-12770]

HEATING OF HELIUM PLASMA BY POWERFUL PROTON BEAM FOR SPECTROSCOPIC PURPOSES

[Article by M.S. Arteyev, A.A. Kuznetsov and S.S. Sulakshin]

[Abstract] An ion gun was developed specifically for generation of gas plasma, and experiments on helium plasma spectroscopy were conducted. Current density of a proton beam was measured at the axis of a gas tube with the help of a collimated current collector. It was possible to measure the full beam current and relations between current density and the longitudinal electron component. The lateral distribution in the beam was not studied, but it is possible to derive it from distribution of helium plasma glow. The ion gun was tried out in helium plasma excitation. VCh helium at a pressure, equal to $(0.2-1) \times 10^5$ Pa, was used. Gas and vacuum chambers were divided by 4.5 micrometers thick mylar film. Rubber seals caused small leakages of nytrogen and other additives from air into the gas. In order to eliminate intense glow that was due to considerably higher ionization potential of He, compared to that of additives, gas was slowly (at the speed of 0.04 l/s) pumped through the tube. Using a MDR-4 monochromator, FEU-140 and an S8-12 oscilloscope, Stark contour of He II 468 nm ion line was measured. Electron plasma concentration was assessed by contour widening, and electron temperature was assessed, using the maximum plausibility method. The derived data confirm calculations of kinetics of helium plasma, excited by a proton beam. It was concluded that the ion gun met requirements of the spectroscopic plasma experiment and that it made it possible to excite plasma of inert gases at atmospheric pressure at the length of up to 100 cm with high uniformity and stability. The first results of spectroscopic measurements of electron concentration of helium plasma were derived; they agree with theoretically predicted results. Recombination disbalance of helium plasma, excited by a proton beam, was confirmed. Figures 4, references 11: 9 Russian, 2 Western.

[207-12770]

DMITRIY SERGEYEVICH ROZHDESTVENSKIY: FOUNDER OF THE FIRST SOVIET OPTICAL SCHOOL (ON THE 110-TH BIRTHDAY ANNIVERSARY)

[Article by Yu.A. Khramov]

[Abstract] D.S. Rozhdestvenskiy (1876-1940), a Soviet physicist, not only made a tremendous contribution into the theoretical and applied optics, but also in organization of scientific research, by founding the State Optics Institute (GOI), one of the first scientific research institutes in the country, and the first Soviet optical school. He performed fundamental works on anomalous dispersion, on atom structure theory, on microscopy; he presented a complete analysis of magnesium ion spectrum and forecasted magnetic origin of doublets and triplets. D.S. Rozhdestvenskiy scientific school originated in 1915, when he was a Peterburg University Professor. Before the Great October Socialist Revolution there were only about 100 physicists in Russia. GOI was created on D.S. Rozhdestvenskiy's initiative in December, 1918. A number of new trends in optics, both purely scientific and technical, were developed in GOI. At the same time, GOI was educating new young physicists-opticians, combining studies and research work. In 1922, GOI had 86 employees. A block-diagram in the article shows evolution of the D.S. Rozdestvenskiy school, listing his disciples and scientific trends they develop. References: 14 Russian.

[207-12770]

INTERFEROMETRY METHOD FOR MEASURING COEFFICIENT OF RADIATION TRANSMISSION

[Article by A.P. Burmakov, A.V. Kolesnik and A.Yu. Zhumar]

[Abstract]   The nature of the interferometry method was studied and its error and sensitivity were assessed.   The proposed method was based on connection between luminosity of interference bands of a double-reflecting interferometer near the observed point of the interference pattern and ratio of intensities and the degree of reciprocal coherence of beams, interfering in the vicinity of this point.   It was determined that for optically dense materials accuracy of measurement of transmission ratio, using the interferometry method, could be significantly higher (by more than two orders of magnitude) than accuracy of the method, based on recording ratio of of passing and incident beams intensities.   At low optical densities and in areas of special points, error of the interferometry method increased sharply.   The interferometry method makes it possible to simultaneously measure transmission ratio and refractive index of a material, placed into the interferometer.   The method was used for measuring absorption index of a pulse flow of dense copper plasma, created by a generator on the basis of electrical explosion of a conductor.   It was suggested that the interferometry method could be spread to reflectivity measurements and that, in addition to the optical range, the examined features of the method are valid in other electromagnetic and acoustic wavelength ranges.   Figure 1, references: 4 Russian.

[Article by L.V. Levshin, G.A. Ketsle and Yu.A. Soynikov]

[Abstract]   Known explanations of triplet-triplet annihilation (TTA) do not reveal the full set of elementary acts, responsible for transformation of excitation energy in contact complexes of triplet molecules and features thereof. At the same time, a triplet pair can serve as a good model in search of a solution of the problem of controlling decay of excited contact complexes in order to obtain reaction products with specified properties.   Studies were conducted in order to solve this problem.   Systems, comprised of dyes and aromatic hydrocarbons (AU), were used as objects. Retarded fluorescence (ZF) of solutions of acridine dyes (energy donors) and antracene (acceptor) were studied.   In order to compare efficiency of TTA for different systems, concentration of triplet donor molecules was maintained constant. Sensibilized population of antracene triplet levels was achieved due to T-T [triplet-triplet] transfer of energy from acridine orange (AO), roduline orange (RO) and tripaflavin (TF).   Velocity constant of transfer of triplet energy from the donor to the acceptor, calculated acording to Schtern-Fohlmer formula under the assumption of the absence of reverse transfer of energy, was practically the same for the three systems.   As concentration of triplet molecules increased, contribution of a mixed type TTA to ZF TF increased much faster than its contribution to RO and AO glow. The studies demonstrated that for the TF-antracene system ZF of the acceptor was practically determined entirely by TTA of its own molecules, whereas when paired with AO, a mixed type TTA contributes to antracene ZF intensity, in addition to its own TTA contribution.   Velocity constant of tripaflavin ZF intensity decay was less than deactivation velocity of triplet states of its molecules.   New data on properties of triplet pairs were obtained by establishing a relation between characteristics of a singlet channel of contact complex decay, energy of a pair and energies of excited states of molecules, comprising the pair. It was shown that annihilation processes were controlled by diffusion motion of molecules.   At the same time, probability of decay of antracene triplet pair with acridine dyes by populating the S_I state of donor molecules increases from the AO-antracene to TF-antracene system.   This increase was explained by employing the proposed complement to the well known model of spin-spin

evolution in a triplet pair. The studies of the mixed type TTA in systems, comprised of molecules of acridine dyes and AU, made it possible to substantiate the assumption that probability of decay of a triplet pair according to a singlet channel scheme strongly depends the size of energy range between energy levels of the contact complex of triplet molecules and excited singlet levels of molecules of dyes and AU, closest energywise to the level of a mixed type triplet pair. Figures 3, table 1, references 5: 4 Russian, 1 Western.

CSO:1862/59

12770

EFFECT OF ADDING TO XENON OTHER INERT GASES ON LUMINESCENCE YIELD OF Xe_2^*-
MOLECULES EXCITED BY ELECTRON BEAM

[Article by Yu. I. Dymshits and V. A. Korobitsyn (deceased)]

[Abstract] In an experiment with electron-beam excitation of xenon, other
inert gases were added and the resulting luminescence yield of Xe_2^*-molecules
within the 170+7 nm band was evaluated. The electron-beam parameters were:
cross-section $\overline{2}x0.5$ cm^2, electron energy 300 keV, current density 140 A/cm^2,
pulse duration 5 ns. Tests were performed with pure Xe, its pressure varied
over the $(0.1-6) \cdot 10^5$ Pa range, and with Xe+ $(1-9) \cdot 10^5$ Pa of another gas (Kr,
Ar, Ne, He). Measurements and graphical integration of oscillograms have
yielded the dependence of the maximum luminescence intensity, the radiation
pulse energy, and the conversion (electron-beam energy to vacuum-ultraviolet
radiation) efficiency on the Xe pressure or partial pressure. The results
indicate that small additions of Kr, Ne, He increase both the conversion
efficiency and the luminescence intensity, maximally when approximately
10^5 Pa of Ne or He or $9 \cdot 10^5$ Pa of Kr is added to $(1-2) \cdot 10^5$ Pa Xe, but addi-
tion of Ar increases both only when the Ar pressure exceeds the Xe pressure
and does not change them or even decreases them less Ar is added. Figures 4;
references 8: 4 Russian, 4 Western.

SOLITON MODE OF PROPAGATION OF LIGHT PULSES THROUGH SINGLE-MODE OPTICAL
FIBERS AND PROBLEMS OF ITS EXPERIMENTAL REALIZATION

[Article by V. Yu. Petrunkin, A. V. Selishev, V. M. Sysuyev and A. S.
Shcherbakov, Leningrad Polytechnic Institute imeni M. I. Kalinin]

[Abstract] Transmission of data over fiber-optic communication lines in
the form of solitons appears to be a promising way to increase the speed.
Such a mode of data transmission requires proper matching of light source
and light guide parameters, to ensure self-compression of anomalously
scattering wave packets and formation of steady one-dimensional solitons.
Theoretically, propagation of a soliton through a real optical fiber can
be described by the cubic Schroedinger equation $ju_z + u_{tt} + 2u|u|^2 = -j\Gamma u$
(u- normalized amplitude of electric field intensity in waveguide, z- normal-
ized space coordinate in direction of propagation, t- normalized time, Γ -
attenuation index) with the right-hand side representing dissipation. For
the boundary condition $u(z= 0,t)=u_0 sech(u_0 t+ \phi)e^{j\theta}$ this equation can be

solved as an inverse problem of scattering with the aid of perturbation theory, which ensures exact integration of the corresponding system of Marchenko equations. The solution indicates the requirements for formation and propagation of solitons. An optical data transmission system built experimentally on this basis for design and performance analysis includes a source of ultrashort light pulses (duration $-$ = 7-30 ns, wavelength λ= 1.3-1.6 μm), namely a parametric light generator without resonator, a more that 20% efficient coupling, a single-mode quartz fiber 600 m long with a core diameter of 7 μm and a loss factor not exceeding 1.5 dB/km, and a device for recording solitons within the 1.06-1.60 μm range of optical wavelengths by the method of a second-harmonic beam with a $LiNbO_3$ crystal followed by a photoreceiver with 1 ps resolution per element for display. This apparatus has yielded necessary data indicating the feasibility of building such a system with Soviet-made components. Figures 2; references 3: 1 Russian, 2 Western.

ABSORPTION POWER OF SiO VAPOR IN $X^1\Sigma$ A^1II and $X^1\Sigma$ $E^1\Sigma$ ELECTRON BANDS AT HIGH TEMPERATURES

[Article by V. S. Matveyev]

[Abstract] The absorption characteristics of SiO vapor in the most intense $X^1\Sigma - A^1II$ and $X^1\Sigma - E^1\Sigma$ electron bands at temperatures of 2000-10,000 K have been calculated on the basis of the Elsasser random model. This model, representing a band as a statistical superposition of various Elsasser subbands, was approximated for composite spectral-line contours. The energy levels and the frequencies at centers of rotational lines were accordingly evaluated from known values of the spectroscopic constants (electronic terms T_e, vibrational frequencies ν_e, anharmonicity constants $\nu_e x_e$, rotational constants B_e, vibrational-rotational interaction constants α_e) for the lower states $X^1\Sigma$, A^1II, $E^1\Sigma$, with the aid of Henley-London and Frank-Condon factors as well as data on the wavelength dependence of cross-sections for absorption, the Morse function, and recurrence relations allowing extension of available tables. The integral absorptance in each of those two bands of the 27,000-67,300 cm^{-1} range was then calculated for specific masses ranging from 0.001 to 0.1 cm atm under pressures ranging from 0 to 10^6 Pa at several temperatures covering the 2000-10,000 K range. Figures 3; tables 1; references 16: 5 Russian, 11 Western.

PICOSECOND SPECTROSCOPY OF INTERMOLECULAR PROTON PHOTOTRANSFER

[Article by G. M. Yesayan, O. V. Kalaydzidis and L. B. Rubin, Scientific
Research Institute of Nuclear Physics, Moscow State University imeni
M. V. Lomonosov]

[Abstract] A spectroscopic study of intermolecular proton phototransfer
in dyes during transition to the excited state was made, the purpose being
to determine the mechanism of this phenomenon and to utilize it for produc-
tion of effective fluorescent light concentrators. As test objects were
selected benzene and tetrahydrofurane solutions of 3-methoxybenzanthrone,
both capable of accepting protons, with 3-fluoroacetic acid or toluenesulfonic
acid added as proton donor to various concentrations. For recording of
the absorption spectra with a "Hitachi-557" spectrophotometer and the fluores-
cence spectra with a "WP-4" optical multichannel spectrum analyzer, speci-
mens were excited with light of the appropriate wavelength coming from a
xenon lamp through a VM-25 monochromator. The kinetics of the fluorescence
spectra were measured with a special spectrofluorimeter, for which the speci-
mens were excited with third-harmonic radiation (wavelength λ = 355 nm)
in pulses of 5 mJ energy and 35-45 ps duration coming from a picosecond
YAG:Nd^{3+} laser with passive mode locking, through an ML-102 electrooptical
modulator for extraction of single pulses, a 2-stage amplifier, a KDP crystal
for extraction of the third harmonic, and a set of light filters. The con-
centration dependence of the fluorescence spectra and the fluorescence kin-
etics were found to be qualitatively analogous for the dye in each solvent
with each proton donor. A quantitative analysis of the data has yielded
the concentration dependence of the fluorescence life time, also the proton
transfer constants characterizing the rate of forward and reverse proton
transfer at molar concentrations of the proton donor over the 0.3-0.5 range
(3-fluoroacetic acid) and over the 0.3-0.8 range (toluenesulfonic acid).
A quantitative analysis of the photochemical reactions, with the aid of
these data, indicates the advantages of using fluorescent light concentrators
other than the conventional rhodamine 6G dye as well as the optimum mix
of dye and proton donor. Figures 7; tables 3; references 6: 3 Russian,
3 Western.

NON-LINEAR MODE OF OPTICAL EXCITATION OF RAYLEIGH WAVES IN SILICON; THERMO-ELASTIC AND CONCENTRATION-DEFORMATION MECHANISM

[Article by S. M. Avanesyan, V. E. Gusyev, B. V. Zhdanov, N. I. Zhyoludyev, V. I. Kuznyetsov and Ye. G. Petrosyan, Moscow State University imeni M. V. Lomonosov]

[Abstract] The process of generating surface acoustic waves (SAW) during fundamental absorption of light in silicon under the influence of nano-second optical pulses was studied, both experimentally and theoretically. It had been established, that changes in SAW profile, caused by increased intensity of disturbance, are determined by non-linear processes of the evolution of electron-hole plasma and by competition between a thermoelastic and concentration-deformation processes of generation of acoustic waves. The article for the first time studied the effect of the above mechanisms and of non-linear recombination of photoexcited electron-hole pairs (EDP) on the process of optical excitation of SAW. Generated radiation was focused on a crystal by a cylindrical lens; it had a shape of an 8 mm long and 1 mm wide stripe. λ=1.06 um, Quories between B.1   0 5J/cm. Distribu-tion intensity of optical radiation was described by a nonlinear set of equations, for which the following assumptions were made: concentration of photoexcited carriers was considerably higher, than the equilibrium con-centration; relationship between physical parameters and temperature, as well as diffusion of carriers and photon thermal conductivity could be dis-regarded; lattice heating from the energy, absorbed by free carriers, and from the non-radiating recombination of electron Holepair prevailed over heating in the process of intrazone relaxation of photo-generated pairs. Approximate solutions of the above set of equations were derived, that are good enough for qualitative analysis of experimental data. Experiments were conducted with monocrystal silicon, cut out along the <111> direction in the form of a 30 mm diameter and 10 mm thick cylinder. Radiation of Q switches an Nd^{3+} YAG laser with Q-modulation was used. Rayleigh wave velocity was determined experimentally from the change in PAV pulse arrival time, when the distance between the photoexcitation area and a piezoelectric transducer changes. Joint analysis of experimental results and the proposed excitation model made it possible to present a picture of SAW generation in silicon. Figures 2; references 4: 3 Russian, 1 Western.

RESOLVING POWER OF TUNNELING MICROSCOPE

[Article by M. V. Krylov and R. A. Suris]

[Abstract] The characteristics of a scanning tunneling-electron reflection microscope for examination of conductor and semiconductor surfaces are evaluated on the basis of a simple model of surface roughness and its image, with consideration of the energy transfer through the scanning aperture and across the vacuum clearance. The wave function for tunneling electrons is expressed as the integral of the product of the wave function for incident electrons and the normal gradient of the Green function for a vacuum gap. The resolution attainable with such a microscope is calculated, assuming a constant potential energy of electrons in the vacuum clearance and thus also constant attenuation distance for the wave function, also disregarding shade effects. Calculations are first based on small-scale roughness, ideally a shallow sinusoidal surface ripple or low step, and then extended to large-scale roughness. Figures 2; references 6: 3 Russian, 3 Western.

FLUORESCENCE OF OXAZINE-17 IN PROTON DONOR AND PROTON ACCEPTOR SOLVENTS UPON STEADY OR PICOSECOND-PULSE EXCITATION

[Article by B. A. Bushuk, A. N. Rubinov, A. A. Muravyev and A. I. Zhukovskaya]

[Abstract] A spectroscopic study of the dye oxazine 17 was made using two methods of excitation, steady excitation and kinetic excitation with pico-second time resolution, for a determination of its luminescence (fluorescence) characteristics and mechanism in two kinds of solvents. The solvents of the first group were proton donors (heptane, butanol, propanol, ethanol, methanol, glycerin). The solvents of the second group were proton acceptors (pyridine, acetone, dimethyl formamide, DMSO). Measurements have revealed that both absorption and emission spectra in a nonpolar solvent such as heptane shift in the long-wave direction and retain a structure, while in polar solvents such as alcohols they also shift in the long-wave direction but their structure vanishes. In proton acceptor solvents the trends were

found to be generally similar, but the long-wave shift is smaller. Measurements made over the -130-(+30)°C temperature range revealed a generally nonmonotonic shift of the maximum-fluorescent wavelength, with a large long-wave shift in butanol (with a temperature change from -50°C to 30°C) and in glycerin (with a temperature change from -30°C to -10°C) capable of forming an intermolecular hydrogen bond. Measurements were also made with oxazine 17 in a composite solvent, 97% n-heptane (nonpolar) + 3% n-butanol (polar) and 94% n-heptane (nonpolar) + 3% n-butanol (polar, forming intermolecular hydrogen bond) + 3% pyridine (polar, proton acceptor, forming a hydrogen bond with alcohol molecules). In the latter case the fluorescence spectrum shifted not further in the long-wave direction but in the short-wave direction. Picosecond excitation for study of the fluorescence kinetics was provided by single pulses of second-harmonic radiation from a Nd-laser on phosphate glass, extracted by heavy water. The results reveal a long-wave shift occurring in a single stage according to the universal mechanism in proton acceptor solvents and in two stages in alcohols, where fast formation of an exciplex is followed by slower interaction of this complex with surrounding molecules according to the universal mechanism. Figures 3; tables 1; references 13: 6 Russian, 7 Western (1 in Russian translation).

2415/12955
CSO: 1862/26

LASER PHOTIONIZATION SPECTROSCOPY OF SELF-IONIZATION STATES OF THULIUM ATOM

[Article by A. A. Atakhodzhayev and V. N. Fedoseyev]

[Abstract] A spectroscopic study of the thulium atom by the method of multistage laser photoionization was made, for the purpose of determining the optimum schemes of its 3-stage photoionizaiton. The spectrometer for determination of high and self-ionization states had three standard dye lasers emitting radiation within 1 cm^{-1} bands in pulses of 1-10 uJ energy and 7 ns duration. They were all pumped by radiation from a N_2-laser in pulses of 1.5 mJ energy at a repetition rate of 10 Hz. They were tuned to resonance with atomic transitions by means of an MDR-3 monochromator, manually or with the aid of a stepped motor. Atoms were excited into any intermediate state by radiation from two of the dye lasers tuned to corresponding transitions, whereupon radiation of the third dye laser was scanned by recording of photoions with a secondary-electron multiplier for determination of the self-ionization spectrum. Signals were fed through three amplifiers to an SM-3 minicomputer for data processing. The experiment revealed 111 transitions to a self-ionization state within the 49,872-53,395 cm^{-1} band. The cross-sections for the most intense transitions in the second stage corresponding to 10 optimum 3-stage photoionization schemes for the thulium atom were calculated by the saturation method so that the relative cross-sections

for transitions from various levels to a self-ionization state could be determined. Figures 2; tables 2; references 22: 13 Russian, 9 Western (1 in Russian translation).

PLASMA PHYSICS

CONFINEMENT OF IONS IN MAGNETIC-MIRROR TRAP WITH SMALL MIRROR RATIO

[Article by V. I. Yerofeyev and D. D. Ryutov, Institute of Nuclear Physics,
Siberian Department, USSR Academy of Sciences]

[Abstract] The confinement problem for ions in an array of magnetic-mirror
traps is solved analytically for a mirror ratio R such that $R-1 \ll 1$, this
case being characterized by a shorter than standard plasma lifetime and
a self-consistent ambipolar electric field. It is assumed that the traps
are shorter than the zones of uniform magnetic field, that injection of
ions proceeds within those zones only and normal to the magnetic force lines,
that the mean-free-path of ions in scattering at an angle of approximately
$\sqrt{R-1}$ is longer than the distance between traps, and that electrons have
a Boltzmann distribution with the electron temperature sufficiently high
to make the braking of ions negligible during their lifetime in a trap.
Smallness of the mirror ratio allows retention of the Landau collision in-
tegral with respect to velocities $v_{\parallel}$, $v_{\perp}$ only those terms which contain
the second derivative of the distribution function with respect to $v_{\parallel}$.
A small mirror ratio yields a plasma lifetime shorter than does standard
theory, but this effect can be partly compensated by injection of ions with
a large energy variance $\Delta W \gg W_0 (R_{eff}-1)$. Figures 3; references 3: 2 Russian,
1 Western (in Russian translation).

EQUILIBRIUM OF PLASMA WITH FINITE LARMOR RADIUS IN OPEN TRAPS

[Article by G. V. Stupakov, Institute of Nuclear Physics, Siberian Department, USSR Academy of Sciences]

[Abstract] The equilibrium problem for a collisionless plasma with finite
Larmor radius in a magnetic-mirror trap is solved by the perholation method
this   parameter being the ratio of the Larmor radius to plasma confinement
radius. First is considered plasma equilibrium in a rectilinear magnetic
field, solution to the corresponding two-dimensional equation on the basis
of kinetic theory revealing the property of isotropy. Next is considered
plasma equilibrium in the curvilinear magnetic field of a paraxial qualrupole-
mirror trap. Effects of a finite Larmor radius associated with rotation
of the plasma are taken into account in the equilibrium equation, in terms
of the same order of magnitude as those accounting for a finite Larmor radius
of ions. Equilibrium established in this case is found to destroy the axial
symmetry of the preceding MHD solution. Figures 3; references 14: 8 Russian,
6 Western.

CONVERSION OF OPTICAL WAVEGUIDE MODES IN GYROANISOTROPIC PLANAR WAVEGUIDES

[Article by A. A. Solomko, Yu. A. Gayday, A. V. Dovzhenko, M. V. Antonishin
and A. T. Yanishevskiy]

[Abstract] A study is made of the phenomenon of TE-TM mode conversion in
the case of arbitrary film magnetization, in which the role of quadratic
magnetooptical coefficients is significant. A three-layer dielectric wave-
guide is studied, unlimited in the Y direction, consisting of a gyroaniso-
tropic film of cubic ferrite-garnet and isotropic layers with different die-
lectric permeabilities. The method of coupled modes is used to obtain equa-
tions for conversion effectiveness and numerical estimates are presented
of wave Te-TM conversion effectiveness in the same waveguide. Optimal con-
version conditions are defined. The studies allow determination of optimal
mode conversion conditions in arbitrarily magnetized ferrite films.
Figures 3, references 7: 2 Russian, 5 Western.

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CSO: 1862/44

PHOTOEMISSION METHOD OF IDENTIFICATION OF NARROW-BAND SPECTRA IN RAPID
PROCESSES

[Article by A. I. Terpuloyeskiy and K. N. Kasparov]

[Abstract] The photoemission method of measurement of optical spectra re-
quires calibration of photomultipliers based on known spectral lines. The
major contribution to the error of photoemission measurements is that of
disagreement between the half width of the spectra studied and the calibration

spectra. A method is described allowing determination of the position of
narrow-band radiation spectra on the energy scale by transmission of an in-
hibiting potential to the control electrode of the photomultiplier. The
major advantages of the method are speed, sensitivity and simplicity. A
device has been made to implement the method which can use any photomultiplier
as the light receiving device. The time resolution of the device is limited
only by the frequency properties of the photomultiplier, the best models
of which can record light pulses with lengths of 10^{-9} seconds. Figure 1,
references 3: Russian.

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MULTILAYER HOLOGRAPHIC FUNCTIONAL ELEMENT IN ANALOG-DIGITAL CONVERTER

[Article by N. N. Yevtikhiyev, D. I. Mirovitskiy, N. V. Rostovtseva and
O. B. Serov, Moscow Institute of Radio Engineering, Electronics and Automation]

[Abstract] The possibility is demonstrated of controlling the intensity
of all beams in an optoelectronic analog-digital converter utilizing a multi-
layer hologram by means of a single parameter of the restoration system.
The nature of variation in diffraction effectiveness of various orders of
the parameter is studied. Several examples are used to illustrate the opera-
tion of multilayer holograms as functional holographic memory elements.
The studies show that a multilayer thin hologram can be used to divide laser
radiation and control the intensity of each beam formed. Design based on
two- and four-layer holograms are suggested. It is reported that an experi-
mental device has been developed and used to convert an analog signal to
a five-bit digital signal using a two-layer hologram. Figures 6, references
11: 5 Russian, 6 Western.

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CSO: 1862/24

INFLUENCE OF SOUND ON DIFFUSION OF INTERSTITIAL IMPURITY ATOMS IN A SOLID

[Article by A. S. Bakay and N. P. Lazarev, Physical-Technical Institute,
Ukrainian Academy of Sciences, Kharkov]

[Abstract] Mechanisms of acceleration of diffusion resulting from the inter-
action of impurity atoms with mobile edge dislocations and bends on helical
dislocations are studied as applicable to the case when the dislocations
oscillate in the field of a standing sound wave. The variation in diffusion
coefficient as a function of frequency and amplitude of dislocation oscilla-
tions is calculated by following an individual atom which diffuses through
a regular grid making individual jumps of the same length at characteristic
time intervals determined by the energy of migration of the atom in the
lattice. References 6: Russian.

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CSO: 1862/25

ASSESSMENT OF ANOMALOUS GRAVITATIONAL FIELD OF ELASTIC EARTH

[Article by Zh.S. Yerzhanov, A.A. Kalybayev and A.N. Isayev, Seismology
Institute, Kazakh SSR Academy of Sciences]

[Abstract]   The   problem of determination of stressed-deformed state and
density of Earth, simulated by a rotating elastic self-gravitating sphere, was
examined.   Using the mass conservation law,   Lame equations were solved,   so
that the equilibrium figure and force function of the external gravitational
field of the model were close to the figure and external Newton potential of
the real Earth.   As Earth model, a stratified sphere with centrally-symmetric
mass distribution was examined;   the sphere was represented by an absolutely
solid core and a mantle,   enclosed by an elastic isotropic lithosphere.   Mass
distribution in the mantle and lithosphere was derived, based on the
characteristic equation of bowels of stars.   The selection of Earth model was
based on preservation of interfaces, values of density jumps at the interfaces
and prehistory of gas-dust origin of Earth, as well as of principal elements
of the figure and the external gravitational field and elastic potential of
Earth.   Because at a given field of mass forces the problem has only one
solution,   construction of a quasi-solution within the limits of the selected
model is correct in the Tikhonov sense.   References 11: 8 Russian, 3 Western.

CSO: 1862/61

12770

PRESSURE AND MASS VELOCITY MEASUREMENTS IN SOLIDS SUBJECTED TO DYNAMIC LOADINGS

[Article by P.A. Urtiew, R.M. Erikson, B. Hayes and M.L. Parker, Lawrence Livermore National Laboratory, California, USA (translated from English)]

[Abstract]   The work was prompted by the need to measure pressure p and mass velocity u in reacting medium.   Manganine pressure and mass velocity transducers were used for conducting measurments in the reacting medium, as well as for detailed studies of Taylor waves in powerful detonating VV [explosives].   In special cases, when transparent media and free surface movement into vacuum were studied, mass velocity was recorded with a Fabri-Perot velocity meter.   Mass velocity measurements were conducted, using foil transducers.   Two types of mass velocity transducers were used: Faraday and Lorentz.   Depending on application, they can be made from copper or aluminum. Although copper does not agree in impedance as well as aluminum, it operates better than aluminum in detonation products.   Experimental results were compared to results of calculations, using the proposed reaction velocity model.   In order to avoid physical contact with the studied material surface, a Fabri-Perot velocity measurement system was used.   An argon laser with maximum capacity of 4 W in a single-mode single-frequency mode and wavelength equal to 514.5 nm was used as a light source.   In order to get a sufficiently good idea of the unloading isenthropy behind a detonation wave [DV], experiments in water were conducted.   Pressure measurements were conducted, using manganine foil transducers.   They were etched according to the standard procedure and made from annealed foil, 0.001 inch thick.   They were connected according to a four-point arrangement.   One or several transducers, placed between teflon layers, formed a "station".   A fluoroethylenepropylene film was used as a bonding medium.   Experimental data for pressure and mass velocity in a reacting medium can be used in calculating reaction progress under moderate dynamic loading.   A polyvinylidenfluoride (PVF$_2$) based transducer was used for dynamic velocity measurements.   At present, it is only in the early development stage.   Its operating principle is very simple; unlike foil transducers, it does not need power source, as it uses its own acumulated energy, released under compression. Despite the fact that development of the transducer has not been finished yet, experimental results demonstrated monotonic dependence between pressure and the charge.   The four described diagnostic procedures can be used together in the same experiment and even in

the same plane, which is important for cross-testing experimental results. The only exception is the combination of manganine pressure and mass velocity transducers that cannot be used in close proximity to each other due to unavoidable interference of two magnetic fields, induced by currents that power the transducers. Figures 17, references 20: 1 Russian, 19 Western.

CSO: 1862/57

12770

MULTIPLY CHARGED PARTICLES IN PRIMARY COSMIC RAYS WITH ENERGY $\geq$ 2 TeV

[Article by I. P. Ivanenko, N. L. Grigorov, V. Ya. Shestoperov, Yu. V. Basina,
P. V. Vakulov, Yu. Ya. Vasilyev, R. M. Golynskaya, L. B. Grigoryeva,
D. A. Zhuravlev, V. I. Zatsepin, A. Ye. Kazakova, V. D. Kozlov, I. P. Kumpan,
Yu. A. Laputin, L. G. Mishchenko, V. M. Nikanorov, L. P. Papina, V. V.
Platonov, D. M. Podorozhnyy, I. D. Rapoport, G. A. Samsonov, L. G. Smolenskiy,
V. A. Sobinyakov, V. K. Sokolov, G. Ye. Tambovtsev, Ch. A. Tretyakova,
Yu. V. Trigubov, I. M. Fateyeva, L. A. Kheyn, L. O. Chikova, V. Ya. Shiryayeva,
B. M. Yakovlev, and I. V. Yashin, Moscow State University imeni M. V.
Lomonosov]

[Abstract] In a 1984 experiment on the "Kosmos-1543" satellite were measured,
with a "Sokol" instrument, the energy spectra and the charge contents of
particles in primary cosmic rays with energy $E \geq$ 2 TeV. The instrument
included a segmental ionization calorimeter with an absorber sufficiently
thick (5.5 mean free paths) to allow proton-proton   interaction
and two Cerenkov-radiation detectors above the calorimeter. The lower de-
tector consisted of 11 directional counters made of 5 cm thick Plexiglas
for measurement of charges with multiplicity z= 1-5, the upper one consisted
of 4 counters made of 1 cm thick Plexiglas for measurement of charges with
multiplicity z= 5-50. The longitudinal axis of the "sokol" instrument was
oriented vertically throughout the experiment. Events were recorded in
which the pulse amplitude in at least one of the detectors exceeded 30%
of the probable amplitude of a pulse produced by a single-charge relativistic
particle, in which the total energy released in the calorimeter exceeded
1 TeV, and in which at any 8 out of 10 monitored calorimeter energy levels
the energy released in the absorber exceeded 35 GeV. The amplitudes of
pulses in all 95 "Sokol" probes were read when all these three conditions
had been satisfied simultaneously. The total net time of measurements was
accordingly 257 hours, in which over 10,000 events were recorded. With
a geometrical factor of 325 cm^2. steradians, only 2000 of those events
occurred within the space sector of the instrument and were used for the
analysis. Only consistent readings of the two detectors in the path of
a primary particle were used for the analysis. The results of that analysis
indicate that the charge content of primary nuclei with charge multiplicity
z $\geq$ 2 and energy $E \geq$ 2 TeV does not significantly differ from the charge
content of those with energy E > 1-10 GeV per nucleon. Figures 3; tables
1; references 8: 3 Russian, 5 Western (1 in Russian translation).

EXPLOSIVE ABSORPTION OF LASER BEAM OF FINITE DIAMETER

[Article by A. N. Orayevskiy and I. Ye. Protsenko, Institute of Physics
imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] Explosive absorption of an infrared laser beam such as a CO_2-laser beam by molecules during transitions between excited states is analyzed, assuming a quasi-equilibrium distribution of molecules over levels of the absorbing mode approximately identical to the Boltzmann distribution for a harmonic oscillator with the VT-relaxation time for the n-th level $\tau_{VT}^{(n)} = n\tau_{VT}^{(1)}$.. This model is adequate for a system with small anharmonicity of the absorbing mode $\omega_n - \omega_{n+1} \ll kT$ and with the characteristic time of each other process much shorter than that of VV-exchange. First the effect of heat transfer within the laser beam of finite diameter on the dynamics of explosive absorption is evaluated, on the basis of the system of two equations of kinetics for vibrational energy E_V and translational temperature T of molecules. The stability limit of its steady-state solution for boundary conditions $E_V(0,t)$ and $T(0,t)$ is determined in accordance with the theory of thermal explosion. Next are determined the characteristics of explosive absorption related to finiteness of the VV-exchange rate, not so much higher than the VT-relaxation rate, and consequent departure of the Boltzmann distribution over vibrational levels from equilibrium. Analysis and solution of the corresponding system of three equations of kinetics, for vibrational energy E_V and populations N_1, N_2 of levels n, n+1 respectively, reveal that the threshold of explosive absorption depends on both the laser beam diameter and the laser pulse duration. Estimates indicate the possibility of explosive absorption of CO_2-laser radiation by molecules such as D_2O, O_3, NF_3, and NH_3. Pumping of NH_3 molecules with a CO_2-laser is of particular interest, in connection with development of a transverse-excitation high-pressure NH_3-laser. A cell containing any such gas can also be used as an "absorbing lock" not passing a laser beam of intensity higher than the absorption threshold, or for smoothing laser intensity fluctuations. The hysteresis of the $E_V(P)$ relation, dependence of the vibrational energy on the laser pulse power, can be utilized for a new class of logic devices. Figures 1; tables 1; references 10: 7 Russian, 3 Western.

STUDY OF RESONANCE ELECTRON TUNNELING UNDER SCANNING ELECTRON-TUNNELING
MICROSCOPE

[Article by M. Yu. Sumetskiy, Leningrad Institute of Electrical Communications
Engineering imeni M. A. Bonch-Bruyevich]

[Abstract] A theory of resonance electron tunneling through point defects
in an insulator film is constructed, applicable to microstructural examina-
tion of thin films under a scanning electron-tunneling microscope. The
theory is based on quasi-classical electron ballistics, including the
Hamiltonian of electron motion and the electron wave function. The potential
distribution is assumed to be axisymmetric within the vacuum clearance separat-
ing the film on a substrate from the tip of the microscope needle and to
be uniform around a well of zero radius simulating a defect. The correspond-
ing Schroedinger equation for the film region has separable variables and
is solved by continuation of a spherical standing wave from the film surface
up to the microscope needle as well as down into the substrate. The tip
of the needle, closest to a defect, is assumed to be a paraboloid of revolu-
tion. The needle, usually with feedback, tracks a constant electron current
equal to the integral of the product of the electron states density and
the Fermi distribution function. An expression is obtained accordingly
for the trajectory of the microscope needle above a defect in the film,
this trajectory being independent of the temperature and of the electron
states density. The author thanks B. L. Al'tshuler for helpful discussion
and G. N. Fursey for support. Figures 2; references 14: 5 Russian, 9
Western (1 in Russian translation).

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ANOMALOUS THERMAL DIFFUSIVITY AND CONDUCTIVITY OF V, Nb, Ta NEAR MELTING
POINT

[Article by V. Ye. Zinovyev, V. F. Polev, S. G. Taluts and P. V. Geld,
Institute of Mining imeni V. V. Vakhrushev, Sverdlovsk]

[Abstract] A method has been developed for measuring the thermal diffusivity
of any metal near its melting point not only in the solid state but also
in the liquid state. The method combines use of a plane heat wave with
a fast change of the mean temperature. Measurements are made in a configura-
tion where a flat specimen melts only at the center while its thickness

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elsewhere is maintained constant for a fraction of a second by a hydrodynamic mechanism. This method was applied to subgroup-5b metals V, Nb, Ta within the $(0.6-1.05)T_{melt}$ temperature range of each. The specimens were disks, 8-10 mm thick and 5-6 mm in diameter, of polycrystalline V, Nb, Ta with respectively 0.05%, 0.11%, 0.10% impurity and of high-purity Nb, Ta single crystals oriented with the 110 axis in the direction of heating. A disk was heated at a rate of 200-1000°C/s up to 50-150 K above the melting point under a vacuum of the order of 10^{-4} Pa and formation of a 0.2-0.3 mm thick liquid film at the center, with modulation of the heat wave at a frequency of 150-500 Hz. The phase of the heat wave was measured automatically during each modulation period and the readings were processed by an Elektronika-60 microcomputer. The results reveal a decrease of the thermal diffusivity of all three metals as the temperature rises toward the melting point, with an anomalous increase immediately before the point at which the center melts followed by a steep decrease to a constant level up to the point at which the thickness begins to change. Calculation of the thermal conductivity and its electronic component according to the Wiedemann-Frantz-Lorentz law yields an almost purely electronic thermal conductivity at temperatures $T < 0.9$ T_{melt}, also at temperatures $T > T_{melt}$, but a thermal conductivity higher than that by an amount increasing as the melting point is approached. This increment of thermal conductivity cannot be attributed to the phonon mechanism of heat transfer but, because of its exponential temperature dependence, could probably be regraded as a vacancy thermal conductivity. Figures 2; references 11: 10 Russian, 1 Western.

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THEORETICAL PHYSICS

TWO-PHOTON ABSORPTION OF IONS IN A TWO-DIMENSIONAL CLOSED TRAP

[Article by V. A. Ulybin and V. P. Chebotayev]

[Abstract] A discussion is presented of the possibility of producing narrow
optical resonances with high intensity by two-photon absorption of ions
in a two-dimensional closed trap. Such a trap is obtained from a linear
quadrupole mass filter by bending the electrodes into a racetrack configura-
tion. The racetrack configuration increases the number of particles inter-
acting with the light beam, increasing intensity. Two-photon absorption
of ions in a racetrack trap is a very promising method for the production
of optical resonances with bandwidth determined by the radiation lifetime
of particles in the metastable state. The intensity of the two-photon
resonance is primarily determined by the number of ions in the trap and
may be as much as 100 times greater than the amplitude of resonance in ordin-
ary three dimensional electromagnetic traps. This high intensity of reson-
ance gives hope for successful use of such a device as a standard for laser
frequency stabilization, achieving frequency stability of 10^{-15} or better.
Figures 2, references 17: 5 Russian, 12 Western.

6508/12955
CSO: 1862/23

INFLUENCE OF PERMANENT MAGNETIC FIELD ON RELAXATION CHARACTERISTICS OF AN
ATOM IN A RESONANT FIELD OF RADIATION

[Article by T. Ya. Karagodova]

[Abstract] The elements of the scattering matrix are determined for atoms in
a strong resonant field of radiation and a constant magnetic field. The
elements can be used to determine the relaxation characteristics of the system.
The variation of these elements as a function of magnetic field intensity is
studied. The system of equations for the elements of the scattering matrix
obtained for the case of an alkaline atom breaks down for circular polari-
zation of the radiation. An analytic solution is obtained for two magnetic
sublevels coupled by the field of radiation. The results show that the
magnetic field intensity not only influences the applicability of a given
approximation for determination of the elements of the S matrix, but also
is included in explicit form in the expression for these elements, influenc-
ing the relaxation characteristics of the system. References 5: Russian.

THEORETICAL CALCULATION OF EINSTEIN COEFFICIENTS OF NEW VIBRATIONAL
TRANSITIONS IN CO_2 MOLECULE

[Article by S. M. Zavoruyev, V. A. Pivovar, R. I. Rakauskas and Yu. K.
Shulskus]

[Abstract] The electron wave functions of 51 different geometric configura-
tions were calculated for the base electron state of the CO_2 molecule.
The lengths of the O-C bounds were varied from 2.0 to 2.4 atomic units, the
angle O-C-O was varied from 140° to the equilibrium position of 180°. The
numerically calculated potential surface was approximated analytically by
the method of least squares to produce values of partial derivatives in
the internal coordinates up to the fourth order. The vibrational problem
in its nonharmonic approximation was solved by a variational method. The
calculated values thus obtained were slightly higher than experimental values,
but of the same order of magnitude, indicating the reliability of the calcu-
lated values of the Einstein coefficients for new, as yet unstudied experi-
mental transitions with high vibrational levels. References 10: 5 Russian,
5 Western.

CHANNELLING OF ULTRARELATIVISTIC ELECTRONS: DOES THIS PHENOMENON EXIST?

[Article by V.A. Bazylev, V.I. Glebov and V.V. Goloviznin, Atomic Energy Institute imeni VI.V. Kurchatov; presented by Academician S.T. Belyayev 30 May 85]

[Abstract]   The idea of channelling of electrons and of channeling emission, that presumes the presence of adiabatic invariants of motion and seems rather natural for positively charged particles, is not so obvious for negatively charged particles; therefore, additional studies of the problem of existence of adiabatic invariants of motion were conducted. For simplicity, the case of plain electron channelling was examined. A conclusion was made that the generally accepted idea of channelling of high energy electrons as a quasiperiodic motion, accompanied by relatively slow particle "diffusion" in the transverse energy space is invalid, as there is no electron channelling in this sense. The only meaning this term could have would be the presence of strong bending of electron trajectory in the atomic chains (planes) field. Detailed calculations for the case of axial channelling will be presented in forthcoming publications. References 10: 9 Russian, 1 Western.

[200-12770]

STUDIES OF MONOPOLISTIC EXCITED STATES OF ^{12}C NUCLEUS IN 3 ALPHA-PARTICLE MODEL

[Article by R.I. Dzhibuti, T.Ya. Mikhelashvili (Physics Institute, Georgian SSR Academy of Sciences) and K.V. Shitikova (Scientific Research Institute of nuclear physics, Moscow State University imeni M.V. Lomonosov]

[Abstract] Binding energy, energy of excitation of monopolistic states, mean square radii, a form factor and the energy-weighted monopolisitic sum of the ^{12}C nucleus in an alpha-particle model were calculated, using a microscopic approach, based on solving a three-particle Schrodinger equation, using expansion in terms of a translation-invariant oscillator basis (TIMO). The oscillator basis method was based on expanding the wave function of the studied nucleus in terms of a complete set of eigenfunctions of a translation-invariant oscillator hamiltonian. In order to derive binding energy of the basic and first excited 0^+-states of the ^{12}C nucleus, the energy matrix was diagonalized. The derived wave functions were used for calculating the mean square radius, elastic charge form factor and density of the ^{12}C nucleus. Also derived was the monopolistic operator. In order to study the basis convergence and assess the accuracy of derived results, the dependence between the energy of the basic and the first excited 0^+-state, the mean square radius and the charge form factor, on one hand, and the oscillator parameter and excitation quantum N, on the other, was studied. It was determined that, as N increases, the dependence between binding energy and the oscillator parameter weakens and practically disappears at N = 22. Calculation results demonstrated that theoretical curves of charge form factor for various values of the oscillator parameter hardly differed from each other and that they equally well described the first diffraction minimum, observed in experiments. On the whole, calculations had demonstrated that results of theoretical studies, obtained when using the TIMO method within the framework of the alpha-cluster model, agreed with results of calculations that used the hyperspheric functions method. The examined method makes it possible to perform all calculations in an analytical form. Figures 4, tables 3, references 6: 3 Russian, 3 Western.

COHERENT EMISSION OF HIGH-ENERGY PHOTONS AND PI-MESONS IN REACTIONS WITH HEAVY IONS

[Article by I.S. Batkin and I.V. Kopytin (Voronezh State University)]

[Abstract]   A microscopic approach was proposed to describing subthreshold generation of pions and high-energy photons in ion-ion collisions, which does not use any adjustment parameters. The range of colliding ions energy from 40 to 100 MeV per nucleon and emitted particle energy from 50 to 150 MeV was examined. The model was based on the assumption that the initial collison stage (the "braking" stage), that had been previously paid little attention in theoretical studies, plays an important role in forming the output of emitted particles. Under this approach, cooperative properties of colliding systems that are manifested in collision dynamics, play the main role in the energy transmission   mechanism,   and   the   result depends   on   charge   or   spin distributions, two-nucleon correlation functions and properties of the potential of internuclear interaction of colliding nuclei. Based on derived formulae, calculations of differential cross-sections were performed in the case of collisions of ^{12}C and ^{238}U ions with kinetic energy of relative motion 84 MeV per nucleon; the calculations were perfomred in the gamma-quantum energy range from 40 to 180 MeV and pion kinetic energy range from 40 to 160 MeV. Results of calculations were compared to experimental data, obtained earlier by H. Noll, E. Grosse et al. The calculations were in good agreement with the experiments. Similar formation mechanisms of high-energy emission and subthreshold pion generation in nucleus-nucleus collisions, detected in the abstracted work, point to the possibility of integrated studies of these reactions. Figures 2, references 21: 2 Russian, 19 Western.

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