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# USSR Report

PHYSICS AND MATHEMATICS

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USSR REPORT  
PHYSICS AND MATHEMATICS

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INFLUENCE OF He-I  $\rightarrow$  He-II TRANSITION ON SUPERCONDUCTIVITY OF  $\text{BaPb}_{0.75}\text{Bi}_{0.25}\text{O}_3$

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 4, Apr 86 (manuscript received 22 Apr 85) pp 55-58

[Article by A.M. Gabovich, D.P. Moiseyev, and V.M. Postnikov, Institute of Physics, UkSSR Academy of Sciences, Kiev]

[Abstract] The current-voltage characteristics of  $\text{BaPb}_{0.75}\text{Bi}_{0.25}\text{O}_3$  superconductor ceramic were measured at temperatures down to almost 1.5 K, the superconducting transition temperature of this material being very close to 10 K. The superconducting transition current of the specimens was of the order of 1 A, corresponding to a critical current density of 10-100 A/cm<sup>2</sup> characteristic of high-grade tunnel junctions with uniform current distribution but not excluding the existence of S-N-S or S-N-I-N-S junctions. The curves were plotted with a PDP4 two-coordinate potentiograph and with an S8-17 oscillograph, while the superconducting transition current was measured more reliably with an R-348 d.c. potentiometer at a minimum voltage of 0.1  $\mu\text{V}$  across the potential terminals. The readings indicate a pronounced change in the trend of the current-voltage characteristic as the temperature of ambient liquid helium crosses the 2.18 K point of helium superfluidity transition. As this point is crossed downward, the superconducting transition current jumps to a much higher level. This jump is suppressed by an external magnetic field and becomes almost negligible in a field of 50 Oe intensity. The plateau voltage of the current-voltage curves, meanwhile, rises remaining proportional to the superconducting transition current and thus with decreasing temperature as well as correspondingly depending on the field intensity when in a magnetic field. Cycling of the ambient temperature about the helium superfluidity transition point, moreover, has been found to be attended by a counterclockwise hysteresis of the current-voltage characteristic. These phenomena are not quite explainable by better heat dissipation in superfluid helium, because calculations based on such a mechanism would yield a density of the transport current in a "hot spot" region higher than the critical current density for a type-II superconductor. Another possible mechanism also explaining the role of a magnetic field is a change of the mode of heat transfer at a sufficiently high current density, namely a jumpwise increase of the heat transfer surface and a change of helium properties during switching from superconducting to

resistive state. Calculations based on Poiseuille's law for helium percolating through a porous ceramic which constitutes a multiply tunneling medium, conforming closely to the Ambegaokar-Baratov relation for the Josephson model, have been confirmed by experiments with current pulses of 0.4 ms duration at a temperature of 1.97 K. Figures 4; references 10: 5 Russian, 5 Western.

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#### VOLUMETRIC CHANGES IN GLASS DURING FORMATION AND ANNIHILATION OF COLOR CENTERS

Leningrad FIZIKA I KHIMIYA STEKLA in Russian Vol 12, No 3, May-Jun 86  
(manuscript received 18 Jul 84) pp 345-351

[Article by L.B. Glebov, V.G. Dokuchayev, N.V. Nikonorov, and G.T. Petrovskiy]

[Abstract] A study of silicate glasses was made for a determination of volumetric changes caused by formation and annihilation of color centers. Specimens of TF-10 and other glasses were colored by treatment with  $\gamma$ -radiation and then discolored segment-by-segment with a parallel beam of a He-Cd laser. Photoanalysis with two orthogonally crossing polarizers revealed cruciform interference patterns in segments discolored after having been colored, background light leaking through the imperfect polarizers causing the interference patterns to be larger than those segments. The results indicate that color centers generated in silicate glasses by  $\gamma$ -radiation, just as color centers generated by two-photon absorption of laser light or by any other known method, cause volume changes and their non-uniform distribution gives rise to mechanical stresses with attendant birefringence. A stress analysis and calculations based on the theory of photoelasticity and photoelectric effects with attendant redistribution of potential energy during interaction of color centers and host material involving energy of elastic deformation confirm the experimental evidence that formation of color centers increases the volume of glass and their annihilation reduces the volume to its original magnitude. Figures 3; references 11: 7 Russian, 4 Western (3 in Russian translation).

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THEORY OF PHOTOMAGNETIC EFFECT IN SEMICONDUCTORS HAVING HIGH CONCENTRATION OF PINNING CENTERS BESIDES SECTIONS FOR HOLE AND ELECTRON CAPTURE STRONGLY ASYMMETRIC WITH RESPECT TO THEIR RECOMBINATION LEVEL

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 4, Jul-Aug 86 (manuscript received 19 Jun 85) pp 56-60

[Article by D.A. Aronov and V. Zaitova, Institute of Engineering Physics imeni S.V. Starodubtsev, UzSSR Academy of Sciences]

[Abstract] The photomagnetic effect under nonuniform illumination is evaluated for a semiconductor having not only recombination centers very different sections for hole and electron capture but also pinning centers for minority carriers. The circulating current and the lifetime of a short-circuiting photomagnetic effect are calculated first for a low population of pinning levels (photohole concentration far below the Shockley-Reed constant) under weak excitation and under strong but not excessively strong excitation, then for a high population of pinning levels under strong excitation but with quasi-low injection level and under superstrong excitation. The dependence of the photomagnetic effect on the excitation level as well as on the ratio of surface and volume recombination rates is thus established. At high surface recombination rates the asymmetry of hole and electron capture by deep levels is found to vanish so that the lifetime of the photomagnetic effect becomes constant and equal to the diffusion coefficient divided by the square of the surface recombination rate. References 6: 4 Russian, 2 Western.

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MULTIPHOTON ABSORPTION OF SUBMILLIMETRIC-WAVE RADIATION IN SEMICONDUCTORS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 4(10), Oct 86 pp 1233-1248

[Article by S.D. Ganichev, S.A. Yemelyanov, Ye.L. Ivchenko, Ye.Yu. Perlin, Ya.V. Terentyev, A.V. Fedorov, and I.D. Yaroshetskiy]

[Abstract] Multiphoton absorption of submillimetric-wave radiation in semiconductor crystals at intraband transitions is analyzed from the standpoint of a general theory which also covers a new mode of nonlinear absorption observed experimentally in p-Ge crystals. First are calculated the coefficients of two-photon and three-photon absorption at direct transitions between heavy-hole and light-hole subbands of the  $\Gamma_8^+$  band under conditions of small nonlinearity corresponding to a value of the multiquantum parameter

$\lambda_n \ll 1$ . They are calculated according to the theory of perturbations, particularly for linearly polarized incident light. Next are calculated the coefficients of n-photon absorption at those transitions under conditions of strong incident light corresponding to large nonlinearity with the value of the multiquantum parameter  $\lambda_n \sim 1$ . In this case the theory of perturbations is not applicable and otherwise suitable asymptotic methods become cumbersome, because the energy gap  $E_{1k} - E_{2k}$  between states in those two subbands vanishes for  $k = 0$ . Calculations for this case are therefore made by a new method applicable to any number of photons  $n$ . The method involves an original transformation of the corresponding effective Hamiltonian, takes into account higher-order effects, and yields fast converging series for the absorption coefficients easily compared with experimental data. On this basis is determined the dependence of individual absorption coefficients and the integral absorption coefficient, also of the back-transmission coefficient, on the intensity of incident light. Numerical calculations are made for n-Ge and p-Ge semiconductors. Here the electron drift photocurrent also depends on the intensity of incident light. Its eventual polarity reversal with increasing light intensity, observed experimentally at room temperature with light at the  $\lambda = 90.55 \mu\text{m}$  wavelength, occurs at a light intensity which can be accurately calculated not only by the new method but also upon calculation of one-photon and two-photon currents according to the lowest-order perturbation theory. Figures 5; references 24: 21 Russian, 3 Western (1 in Russian translation).

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UDC 121.373.535.004+548.0

#### EFFECT OF LASER RADIATION AT 10.6 $\mu\text{m}$ WAVELENGTH ON COLOR CENTERS IN KCl, KBr, NaCl SINGLE CRYSTALS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 60, No 6, Jun 86 (manuscript received 20 Aug 85) pp 1211-1214

[Article by K.A. Garibashvili, V.V. Mumladze, M.M. Svanidze, and E.Ye. Timofeyeva]

[Abstract] The effect of laser radiation (10.6  $\mu\text{m}$  wavelength) on color centers in halide (KCl, KBr, NaCl) single crystals was determined in an experimental study using a  $\text{CO}_2$ -laser (ILGN-705, 6 W power). Laser treatment was applied to crystals which had been additively colored and then annealed at 400-570° C prior to irradiation as well as to crystals which had been colored by ionizing - radiation from a Co-60 source. Their optical absorption spectra were measured in an SF-26 spectrophotometer, before laser treatment and 20, 45, 120 min after laser treatment. These spectra reveal generally an initial narrowing but later gradual recovering of F and M bands after laser treatment, no matter by what method the crystals had been colored. They also reveal a new series of absorption bands in the spectrum of KCl crystals, indicating various

aggregations of elementary color centers and formation of complex electron centers, especially when the concentration of F-centers is high. The results of this study may find practical use in holography. Figures 3; references 12: 7 Russian, 5 Western.

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UDC 535.34+535.37:548.0

### SPECTROSCOPY OF $Ce^{3+}$ -CENTERS IN $SrCl_2$ -Ce SINGLE CRYSTALS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 60, No 6, Jun 86 (manuscript received 30 Apr 85) pp 1198-1200

[Article by O.T. Antonyak and N.S. Pidzyraylo]

[Abstract] A spectroscopic study of various  $Ce^{3+}$ -centers in various  $SrCl_2$ -Ce single crystals was made, especially of type-II and more complex  $Ce^{3+}$ -centers in crystals variously grown for this purpose. Crystals containing only type-I  $Ce_{4v}$ -centers were heated in an atmosphere of either oxygen or water vapor under a pressure of  $4 \cdot 10^{-3}$  torr to 990 K and held at this temperature for 70-100 h. Their photoluminescence spectra reveal that such a treatment converts  $C_{4v}$ -centers into type-II centers with  $C_{3v}$ -symmetry, owing to compensation of the excess charge of  $Ce^{3+}$ -ions in the  $SrCl_2$ -lattice by  $O^{2-}$  or  $OH^-$  ions penetrating into it. More complex  $Ce^{3+}$ -centers were found in  $SrCl_2$ -Ce crystals which had been synthesized from oxygen-free raw  $SrCl_2$  material, with Ce activator added in small amounts of  $1.2 \cdot 10^{-3}$ - $1.2 \cdot 10^{-3}$  molar fractions. Their photoluminescence and absorption spectra reveal that here, as the Ce concentration increases, the  $C_{4v}$ -centers become converted into  $(Ce^{3+})_n$  cluster centers ( $n - 2$ ). The spectra of all crystals were measured at 77 K temperature. Figures 2; references 7: 5 Russian, 2 Western.

2415/12379  
CSO: 1862/267

## DETECTION OF RESONANT TWO-PHOTON AND THREE-PHOTON SCATTERING BY SUBMICROSCOPIC SEMICONDUCTOR CRYSTALS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 60, No 6, Jun 86 (manuscript received 13 Jan 86) pp 1108-1111

[Article by A.V. Baranov, Ya.S. Bobovich, N.I. Grebenshchikova, V.I. Petrov, and M.Ya. Tsenter]

[Abstract] An experimental study was made for detection of elastic and inelastic resonant three-photon scattering as well as resonant Raman scattering by submicron CdS and CdSe crystals in solid solution, namely in glasses of the  $m\text{CdS} + n\text{CdSe}$  class (KS-10/11/14/17/19, OS-13/14), also by submicron  $\text{As}_2\text{S}_3$  crystals in glass. Specimens of these materials were synthesized by implantation of S, Se, and corresponding oxides in the complex silicate matrix with subsequent reduction and crystallization during founding. Size and shape of the semiconductor crystals were varied by variable secondary heat treatment, during which also pigments were implanted. The dimensions of crystals were measured by the method of low-angle x-ray scattering. The results reveal generally similar spectra of resonant Raman scattering and inelastic resonant three-photon scattering, a much higher intensity of elastic (coherent) than inelastic (noncoherent) resonant three-photon scattering, and an appreciable size effect in both cases but a much stronger one in the case of elastic resonant three-photon scattering. Various mechanisms are involved here, evidently depending on the composition of the material, and defects induced in the crystals during the glass making process probably play a significant role too. The authors thank V.V. Golubkov for making measurements of crystals by the x-ray method. Figures 2; references 8: 7 Russian, 1 Western.

2415/12379  
CSO: 1862/267

UDC 539.19+539.12

## SEPARATION OF COULOMB-BOUND CHARGES IN SOLID BY PHOTOSTIMULATED CHANGE IN ELECTRON AFFINITY OF ITS MOLECULES

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 60, No 6, Jun 86 (manuscript received 29 Nov 85) pp 1097-1100

[Article by Ye.L. Aleksandrova and Yu.A. Cherkasov]

[Abstract] Photogeneration of free charge carriers in solids where the carrier mobility is low, after unlike charges have been electrostatically bound into

pairs, requires that the Coulomb force of attraction be overcome and the charges of a pair pulled apart through a distance equal to several molecular fragments. While separation from some distance further is facilitated by an electric field, according to a modification of the Onsager model, the mechanism of primary separation up to that distance has not yet been definitively established. An analysis of the process indicates that the force which effects this primary separation of unlike charges is a molecular one, traceable to a photostimulated change in the electron affinity of photoexcited molecules. Such a hypothetical migration mechanism is demonstrated on a typical molecular solid material consisting of donor and acceptor molecules which have  $\pi$ -electron systems and form donor-acceptor complexes, namely polyvinyl carbazole. The mechanism evidently operates during spectrochemical sensitization of this material by certain complex dyes. Figures 2; references 8: 4 Russian, 4 Western.

2415/12379  
CSO: 1862/267

UDC 535.373.3:548.0

PROBABILITIES OF INTRACENTER TRANSITIONS AND SPONTANEOUS QUENCHING OF LUMINESCENCE IN  $\text{BaEr}_2\text{F}_8$  AND  $\text{BaHo}_2\text{F}_8$  CRYSTALS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 60, No 6, Jun 86 (manuscript received 1 Jul 85) pp 1201-1210

[Article by A.M. Tkachuk, S.I. Klokishner, A.V. Poletimova, L.M. Mogileva, and M.V. Petrov]

[Abstract] The optical spectra of  $\text{Er}^{3+}$  and  $\text{Ho}^{3+}$  ions in  $\text{BaY}_2\text{F}_8$  crystals as well as the luminescence kinetics in these crystals at a temperature of 300 K are analyzed on the basis of probabilistically calculated and measured characteristics of intracenter transitions. The radiative characteristics of these transitions have been calculated by the Judd-Ofelt method. Experimentally have been determined the lifetimes of radiative energy levels of Er and Ho ions in  $\text{BaY}_{2(1-x)}\text{R}_3\text{F}_8$  crystals ( $\text{R}_3 = \text{Er}^{3+}, \text{Ho}^{3+}$ ), with  $x = 0.005-1$  measured by kinetic methods with selective lamp or laser pumping. The data include strength of  $f_{ij}$  and  $f_{ji}$  oscillators, cross-sections for intermultiplet transitions in  $\text{BaY}_2\text{F}_8 = \text{Er}^{3+}$  and in  $\text{BaY}_2\text{F}_8 = \text{Ho}^{3+}$ , characteristics of spontaneous intracenter transitions in  $\text{BaY}_2\text{F}_8 - \text{Er}^{3+}$  and in  $\text{BaY}_2\text{F}_8 - \text{Ho}^{3+}$ , also transition sequences in transfer processes such as migration, cross-relaxation quenching, and nonlinear interaction as well as the microparameters and the speeds of these processes. Analysis of the data reveals an appreciable contribution of dq- and qq- interactions to some of these transfer processes, the fastest energy migration being associated with the terms  ${}^4\text{F}_{9/2}$ ,  ${}^4\text{F}_{11/2}$ ,  ${}^4\text{F}_{13/2}$  in Er and  ${}^5\text{I}_5$ ,  ${}^5\text{I}_6$ ,  ${}^5\text{I}_7$  in Ho. Strong spontaneous quenching at 300 K is characteristic of the terms  ${}^4\text{S}_{3/2}$  in  $\text{BaEr}_2\text{F}_8$  and ( ${}^5\text{S}_2$ ,  ${}^5\text{F}_4$ ),  ${}^5\text{I}_4$ ,  ${}^5\text{I}_5$  in  $\text{BaHo}_2\text{F}_8$ . The migration rates associated with the long-life terms  ${}^4\text{I}_{11/2}$ ,

$^4I_{13/2}$  in  $BaEr_2F_8$  and  $^5I_6$ ,  $^5I_7$  in  $BaHo_2F_8$  are much higher than the quenching rates and the intracenter relaxation rates of the respective terms. The authors thank A.K. Prezhevusskiy for calculating the quadratic crystal-field invariants for a  $BaEr_2F_8$  crystal, also I.G. Podkolzin and T.S. Semenov for supplying the crystals. Tables 7; references 23: 17 Russian, 6 Western.

2415/12379  
CSO: 1862/267

UDC: 666.246[.248+621.373:535

EXPERIMENTAL OBSERVATION OF CLARIFICATION OF YTTERBIUM-ERBIUM GLASSES UPON NEODYMIUM-GLASS-LASER PUMPING

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian, Vol 61, No 1, Jul 86 (manuscript received 20 Dec 85) pp 187-190

[Article by A.G. Murzin, Ye.G. Pivinskiy, D.S. Prilezhayev and V.A. Fromzev]

[Abstract] The purpose of this work was direct experimental observation of the clarification of the absorption band of  $Ib^{3+}$  ions  $4F_{7/2} - 4F_{5/2}$  ( $\lambda=1.055 \mu m$ ) during a high-power laser pumping pulse, and quantitative comparison of the results produced with theoretical models describing the processes which occur upon accumulation of an inversion of  $Er^{3+}$  ions in these glasses. The specimens of Yb-Er glass were pumped with a neodymium glass laser in a 2-pass scheme: the specimens studied were placed between a positive lens, through which the pumping radiation moved in one direction, and a convex spherical mirror with reflection factor  $R=0.965$  at  $\lambda=1.055 \mu m$ . Results of calculation by a model considering only a 1 mechanism of nonlinear losses, clarification with respect to  $Yb^{3+}$  ions, agrees well with the experimental data. Introduction of additional nonlinear losses to the model results in significant deviation from the experimental curve in the final stage of pumping. The experiments unambiguously confirm the basic conclusion of a previous work by the same authors, the clarification of  $Yb^{3+}$  ions under the influence of laser pumping at high powers significantly influences the energy characteristics of Yb-Er glass lasers. Figures 2, references 6: 3 Russian, 3 Western.

6508/12379  
CSO: 1862/289

PICOSECOND RELAXATION AND UNSTEADY SPECTRA OF  $Z_2$  COLORATION CENTERS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian, Vol 60, No 4, Apr 86 (manuscript received 17 Dec 84) pp 773-775

[Article by R.A. Gadonas, V.V. Krasauskas, A.S. Piskarskas, I.A. Parfianovich, E.E. Penzina, M.G. Popova, L.M. Sobolev, and K.A. Makushev]

[Abstract] Measurements were performed at 300K, recording changes in the adsorption spectra of crystals in the process of relaxation. Excitation was by 15-20 ps high-power laser pulses at 1.06  $\mu\text{m}$  wavelength. The probing radiation was provided by a picosecond continuum source, 0.42-1.2  $\mu\text{m}$ ). Probing pulse intensity was recorded using a monochromator in the 0.45-0.95  $\mu\text{m}$  range. The experimental results indicate that the induced absorption bands in the 560-635 nm area belong to a  $Z_2^+$  color center. It is suggested that ionization of  $Z_2$  centers upon exposure to high-power picosecond pulses may be caused by cooperation of dipole-dipole interaction energy of  $Z_2$  centers, causing one of the centers to shift to a highly excited state in the conductivity zone and ionize. The electrons liberated upon ionization of a color center may be located on F centers, converting them to F centers, or  $Z_2^+$  color centers, leading to partial restoration of the concentration of  $Z_2$  color centers. Additional studies are suggested to determine the relative contributions of nonradiative, radiative and recombination processes in the kinetics of restoration of the base  $Z_2$  center state.  
Figures 3, references 8: 7 Russian, 1 Western.

6508/12379

CSO: 1862/288

UDC: 548.0:539.184.25:546.661

## FINE STRUCTURE OF OPTICAL SPECTRA OF EUROPIUM IMPURITY CENTERS IN KCl-KF CRYSTALS AT 4.2K

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian, Vol 60, No 4, Apr 86 (manuscript received 10 Jul 85) pp 769-772

[Article by V.V. Bryukvin, Ye.S. Voropai, V.V. Nizhnikov, I.A. Parfianovich and E.E. Penzina]

[Abstract] A study was made of the excitation, adsorption and emission spectra of bivalent europium in KCl crystals doped with KF at 4.2 K. The fluorine impurity influences the mobility of impurity-vacancy dipoles, thus preventing the creation of Z-type color centers. In annealed crystals with over 2 wt.% KF

the luminescence spectra include a broad band with a maximum around 510 nm, attributed to complex aggregates of impurity-vacancy dipoles, plus narrow lines at 450.5 and 456.5 nm with an oscillating limb, probably resulting from simple dimer-type aggregates. The luminescence spectra of crystals with 0.25wt.% KF does not include luminance of aggregate centers, but does include bands of radiation of centers with nonphonon lines at 410.2, 410.6 and 427.5 nm. Hardening of such crystals from 550°C to room temperature causes the 410.6 nm line to be converted to centers with nonphonon lines at 410.2 nm and the 427.5 nm band becomes somewhat less intense. The KCl-KF crystals doped with europium can thus probably be used as active media for solid state tunable lasers in the 430-450 nm area. Figures 4, references 9: 4 Russian, 5 Western.

6508/12379  
CSO: 1862/288

UDC: 535.37

FORMATION OF HOMOGENEOUS AND MIXED EXIMERS IN SOLUTIONS OF 9,10 BIS  
(PHENYLETHINYL) ANTHRACENES

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian, Vol 61, No 1, Jul 86 (manuscript received 19 Aug 85) pp 78-83

[Article by T.V. Veselova and A.S. Cherkasov]

[Abstract] Derivatives of 9,10 bis (phenylethynyl) anthracenes (BPEA) represent an interesting group of compounds for which there would appear to be no steric hindrances to the formation of eximers. They characteristically have an extended conjugate, all elements of which can be in a coplanar location, due to the lack of steric hindrances. This is manifested spectrally as strong bathochromic shift in the long-wave bands of absorption and a significant increase in intensity of absorption. The effectiveness of concentration inhibition of fluorescence of these compounds confirms the lack of steric hindrances. It is found that when homogeneous eximers are formed, typical strong reductions in probability of transition with radiation are observed with significantly lower changes in probability of nonradiative transition. A reduction in quantum yield of fluorescence with increasing concentration is characteristic of all phenylethynyl anthracenes, particularly 2-ethyl-BPEA, which is soluble in toluene. Figures 2, references 15: 13 Russian, 2 Western.

6508/12379  
CSO: 1862/289

## SPECIFICS OF SENSITIZATION OF YTTERBIUM-ERBIUM GLASSES WITH CHROMIUM IONS IN AMPLIFICATION MODE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian, Vol 61, No 1, Jul 86 (manuscript received 27 Jan 86) pp 95-102

[Article by I.G. Kuchma, Yu.K. Fedorov and V.A. Fromzev]

[Abstract] An experimental study is presented of the effectiveness of processes of sensitization of Yb-Er glasses with  $\text{Cr}^{3+}$  ions in the amplification mode and conditions are determined under which this sensitization occurs most successfully. Experiments were performed on phosphate glass activated with  $\text{Yb}^{3+}$  and  $\text{Er}^{3+}$  ions, as well as glass coactivated with  $\text{Cr}^{3+}$  ions. The specimens studied had identical concentrations of  $\text{Yb}^{3+}$  and  $\text{Er}^{3+}$  ions, differing only in the presence or absence of the  $\text{Cr}^{3+}$  ions. Estimates of the effectiveness of the transfer of energy at high levels of excitation, of the greatest interest for lasers and amplifiers, were made by analyzing experimental data on the gain achieved in the  ${}^4\text{I}_{13/2} \rightarrow {}^4\text{I}_{15/2} \text{Er}^{3+}$  ions under various lamp pumping conditions at various ratios of concentrations of the activators. The experiments revealed a complex picture of the influence of the chromium ions on the energy mode of amplification under these conditions. The influence varied from sensitization to damping of the  $\text{Yb}^{3+}$  and  $\text{Er}^{3+}$  ions, depending both on the concentration of the  $\text{Er}^{3+}$  and  $\text{Cr}^{3+}$  ions and on pumping conditions. The best conditions for sensitization are: high concentration of  $\text{Er}^{3+}$  ions, about  $3-5 \cdot 10^{19} \text{cm}^{-3}$ , low concentrations of  $\text{Cr}^{3+}$  ions,  $1-3 \cdot 10^{19} \text{cm}^{-3}$ , and relatively short pumping pulses,  $0.5-1.0 \cdot 10^{-3} \text{s}$ . Figures 5, references 7: 5 Russian, 2 Western.

6508/12379  
CSO: 1862/289

UDC 621.373.8

INVESTIGATION OF PASSIVE-SHUTTER RUBY LASER BASED ON LiF CRYSTAL WITH  $\text{F}_2^+$  COLOR CENTERS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian, Vol 44, No 6, Jun 86, (manuscript received 20 Feb 85) pp 932-935

[Article by N.A. Asayenko, N.A. Ivanov, A.S. Kovalchuk, M.M. Loyko, V.A. Chepurnoy, and A.P. Shkadarevich]

[Abstract] The characteristics of a ruby laser with a passive LiF shutter are investigated in detail.  $\text{F}_2^+$  color centers were obtained by irradiating LiF

crystals with gamma radiation from a  $^{60}\text{Co}$  source. Stable color centers were achieved by using crystals doped with OH. The passive shutter employed was a 20x20x9 mm parallelepiped. The initial transmission of the crystal at 694 nm was 41%, and the initial coefficient of absorption was  $0.9\text{ cm}^{-1}$ . The time and energy characteristics of the pulses generated were investigated. The sums of the Einstein coefficients of the direct and inverse transitions were found, along with the transverse absorption cross-section of the active centers. The ratio of the absorption cross-section of the active centers of the gate to the amplification cross-section of the ruby is approximately  $10^3$ . The characteristics of single pulses obtained by using the LiF crystal and a solution of 4.11-diphenylbisanthene in toluol indicated that the parameters of the pulses are similar. The studies indicate that LiF crystals with  $\text{F}_2^+$  color centers are promising for Q-switching ruby lasers. Figures 2, references 8: 6 Russian, 2 Western.

6900/12379  
CSO: 1862/264

UDC 537.22

#### MECHANISM OF ELECTRIZATION OF LiF SINGLE CRYSTAL DURING CLEAVAGE

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 28, No 7, Jul 86 (manuscript received 22 Jul 85, in final version 3 Dec 85) pp 2177-2180

[Article by S.G. Boyev and T.V. Fursa, Tomsk Polytechnic Institute]

[Abstract] Electrization during cleavage of grade-I LiF single crystals was studied in an experiment with undoped 2-9 mm thick specimens not wider and longer than five times the thickness. They were bombarded with  $(1.0-3.2) \cdot 10^{-13}$  J mono-energetic electrons at current densities of  $5 \cdot 10^{-6} - 5 \cdot 10^{-3}$  A/m<sup>2</sup>, or with  $(1.5-2.4) \cdot 10^{-12}$  J monoenergetic protons at current densities of  $1 \cdot 10^{-5} - 5 \cdot 10^{-4}$  A/m<sup>2</sup>, or with positrons (mean energy  $4.8 \cdot 10^{-14}$  J, maximum energy  $8.7 \cdot 10^{-14}$  J) from a 5 mCu radioactive  $^{22}\text{Na}$  source. The pattern of charge distribution between fresh and old surface during each successive cleavage into two, minutes or days or years after bombardment, is explained by concurrent buildup of a volume charge and a relaxation polarization. This mechanism is confirmed by measurements with a dynamic double capacitor and of the thermal-stimulation current. Figures 3; references 9: all Russian.

2415/12379  
CSO: 1862/278

## NUCLEAR AND ELECTRODYNAMIC EFFECTS IN SPECTRA OF Li-LIKE IONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50,  
No 7, Jul 86 pp 1349-1355

[Article by A.L. Gogava, L.N. Ivanov, and Ye.P. Ivanova, Institute of  
Spectroscopy, USSR Academy of Sciences]

[Abstract] A method of calculating the spectral and energy characteristics of multielectron atoms and ions taking into account radiative and nuclear effects is being developed, for selective action on atoms with the aid of fine isotopic and isomeric effects. Conventional analytical and numerical methods are based largely on series expansion of the physical parameter  $1/Z, \alpha Z, ZR/\alpha$  ( $Z$ - charge of nucleus,  $R$ - radius of nucleus,  $\alpha$ -fine-structure constant), any of these expansions being inevitably incorrect in some specific case. A method is therefore proposed which avoids these expansions, an economical method which correctly accounts for radiative effects and nuclear effects in the spectra with interference of interelectron correlation effects and nuclear effects as the key factor. The method is applied to calculation of all  $nlj$ -states with  $n=2-4$  of Li-like ions with  $Z=20-92$ , including relativistic one-electron effects in the Hartree-Fock-Dirac approximation, magnetic interelectron effects in the lowest order with respect to  $\alpha^2$ , the polarization part of the Lamb shift in the Uehling-Serber approximation, and the energy part of the Lamb shift "exactly" as for H-like ions with point nuclei. First an Li-like ion in the  $1s^2nlj$ -state is treated as a one-electron system. Then exchange and correlational interaction of an  $nlj$ -electron with the nuclear core is treated according to the theory of perturbations. Corrections for an extended nucleus in terms of its radius and for radiative effects in terms of their wave number to the energy of states and transitions are calculated, whereupon the problem is reduced to a single system of ordinary differential equations. The procedure and numerical results are demonstrated on  $3lj$ -states and  $4lj$ -states, on the  $2s_{1/2}-2p_{1/2}$  transition and the  $2s_{1/2}-2p_{3/2}$  transition. Figures 1; tables 4; references 11: 5 Russian, 6 Western.

2415/12379

CSO: 1862/275

ENERGY SPECTRA OF DISCHARGED ATOMS AND RESULTING FORMATION OF DEFECTS WITH  
EVENTUAL BREAKDOWN OF MATERIALS UNDER BOMBARDMENT BY PULSED FLUXES OF FAST  
NEUTRONS

Tomsk FIZIKA in Russian Vol 29, No 6, Jun 86 (manuscript received 5 Dec 84,  
after completion 6 Mar 85) pp 104-106

[Article by O.B. Alekseyevskiy, R.G. Ziyakayev, and V.V. Mameyev, Scientific  
Research Institute of Nuclear Physics, Tomsk Polytechnic Institute imeni S.M.  
Kirov]

[Abstract] The energy spectra of atoms originally knocked out from an  $Al_2O_3$   
crystal by 14 MeV neutrons and the number of resulting elementary defects as  
well as the energy absorbed in the process have been calculated theoretically,  
considering both elastic and inelastic scattering of fast neutrons by nuclei.  
The energy spectra were calculated in the nonrelativistic approximation, in the  
laboratory system of coordinates. From the mean energy in these spectra was  
determined the energy given up by neutrons in the crystal, assuming a crystal  
thickness much smaller than the maximum length of path of recoiling nuclei.  
Brittle fracture of such a crystal was found to be caused by the thermal shock  
resulting from bombardment by a neutron flux of  $(1.8-2.7) \cdot 10^{23}$  n/(cm<sup>2</sup>.s)  
intensity within a pulse of 60 ns duration. Such calculations are helpful in  
estimating the radiation resistance of materials used in thermonuclear reactor  
equipment and analyzing the mechanism of their interaction with fast neutrons  
from knockout of atoms through breakdown. Figures 1; references 10:  
4 Russian, 6 Western (1 in Russian translation).

2415/12379  
CSO: 1862/285

MICROWAVE LIGHT MODULATORS WITH SPACED CRYSTALS

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: SERIYA TEKHNICHESKIKH NAUK in  
Russian Vol 39, No 3, May-Jun 86 (manuscript received 10 Jul 84) pp 24-27

[Article by K.S. Gyunashyan, V.A. Papyan, and M.K. Sagatelyan, Yerevan  
Polytechnic Institute imeni Karl Marx]

[Abstract] A biaxial microwave light modulator has been developed for optical  
high-precision range meters Mekometr MYe-3000 and DVSD-1200, its reference  
prototype version consisting of a resonator loaded with a crystal-capacitor.  
An analysis of the electric field distribution around the crystal mount in the  
resonator cavity indicates the possibility of mounting in the cavity two  
identical crystals spaced symmetrically with respect to the cavity center so

far apart as to facilitate matching the receiver-transmitter optics with the modulator. The correct location of the crystals corresponds to the first two maxima of the Bessel function describing the radial distribution of the electric field. Two 30 mm long crystals only  $8 \times 8 \text{ mm}^2$  in cross-section replace a single 35 mm long crystal with a larger  $10 \times 10 \text{ mm}^2$  cross-section. A coaxial  $E_{10}$ -mode modulator and a biaxial  $E_{20}$ -mode modulator are possible, depending on how the effect of the metal conductors on the electric field distribution is utilized. The biaxial version is preferable for optical microwave range meters and refractometers, being both simpler and more efficient because it requires fewer mirrors behind the receiver optics and smaller metal conductors inside the resonator cavity. The spacing between receiver light beam and transmitter light beam is 35 mm, the tuning range is 120 MHz, and the figure of merit of this modulator is  $1.6 \cdot 10^{-2} \text{ rad}^2/\text{W}$ . Figures 3; tables 1; references 4: all Russian.

2415/12379  
CSO: 1862/284

UDC 541.2+548.4

#### NATURE OF CONVECTIVE STATE OF CRYSTALS UNDER 'SUPERHIGH PRESSURE + SHEAR' CONDITIONS

Tomsk FIZIKA in Russian Vol 29, No 6, Jun 86 (manuscript received 18 Jan 85)  
pp 34-40

[Article by A.I. Olemskoy, I.I. Naumov, and V.Ye. Panin, Institute of Strength Physics and Materials Science, Siberian Department, USSR Academy of Sciences, Tomsk branch]

[Abstract] The behavior of a crystal under superhigh pressure is considered, the thesis being developed that superhigh pressure as a source of energy causes a kinetic transformation which results in transition of macroscopically many atoms from a weakly excited state with predominantly vibrational motion and thus localized atoms to a strongly excited state with motion above the Peierls relief and thus dislocated ones. The crystal thus passes from a diffusional state to a convective one, the latter being characterized by anomalous behavior under superhigh pressure plus shear. The thesis is defended by an analysis of the nonequilibrium state under shearing stresses, with the thermodynamic potential under such a load always higher when it corresponds to any other than optimum values and thus also to initial values of the compounds of the plastic strain tensor. Optimum values are reached when the mass has been distributed over macroscopic distances of the order of 1 cm and this, with a diffusion coefficient of the order of  $10^{-12} \text{ cm}^2/\text{s}$ , requires a geological time of  $10^{12} \text{ s}$  or approximately 30,000 years. During initial elastic deformation already, therefore, full equilibrium cannot possibly be reached in a practical experiment. Transition to convective flow, even with macroscopically many atoms strongly excited, is possible only with coherent relaxation of the

remaining weakly excited ones. The degree of population inversion from weakly to strongly excited atoms must accordingly be included in the quantitative analysis of convective flow so that the kinetics of this population inversion as well as of stress and strain, as functions of time, can be determined from the corresponding system of three nonlinear first-order differential equations. Figures 3; references 11: 10 Russian, 1 Western (in Russian translation).

2415/12379  
CSO: 1862/285

#### NEGATIVE DYNAMIC RESISTANCE IN SEMICONDUCTOR STRUCTURES EXPOSED TO OPTICAL RADIATION

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 12, No 19, 12 Oct 86 (manuscript received 23 Feb 86) pp 1179-1182

[Article by Yu.D. Bilenko, V.L. Vidro, and B.M. Gorbovitskiy]

[Abstract] The possibility of attaining a negative dynamic resistance in semiconductor structures with nonuniform electric field distribution on the basis of the Keldysh-Frantz effect is examined, theoretically, GaAs serving as an example of such a material with straight energy bands. Its illumination by light with a quantum energy slightly below the intrinsic absorption band generates electron-hole pairs with a narrow region of peak electric field intensity. A voltage  $V=V_0+V_1 \sin \omega t$  applied to the structure modulates the optically generated charge carrier distribution in space, owing to the field dependence of the optical absorption coefficient. The current-voltage characteristic, with the phase shift between current voltage such as necessary for the dynamic resistance at frequency  $\omega$  be negative, is determined from the equations of continuity for electrons and holes and the circuital equation for the current. The analysis is based on usual assumptions for IMPATT devices, namely a photogeneration region so narrow as to have a zero net charge density. The sign of the resistance is found to alternate depending on the carrier transit angle. Figures 2; references 2: 1 Russian, 1 Western.

2415/12379  
CSO: 1862/41

PHOTOLUMINESCENCE SPECTRA OF Nd-DOPED  $\text{TlGaS}_2$  AND  $\text{TlGaSe}_2$  SINGLE CRYSTALS

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 7, No 3, May-Jun 86 (manuscript received 5 May 84) pp 103-107

[Article by R.A. Aliyev, G.D. Guseynov, V.F. Zolin, V.M. Markushev, M.N. Popova, and R.M. Sardarly, Institute of Physics, AzSSR Academy of Sciences, Institute of Radio Engineering and Electronics and Institute of Spectroscopy, USSR Academy of Sciences]

[Abstract] A photoluminescence study of Nd-doped crystals of two ternary chalcogenide compounds,  $\text{TlGaS}_2$  and  $\text{TlGaSe}_2$ , was made for the purpose of establishing their spatial symmetry group. Single crystals of these compounds were grown by the Bridgman method, while 0.1-0.5% Nd salt ( $\text{Nd}_2\text{S}_3$ ,  $\text{Nd}_3\text{Se}_3$ ) or metallic Nd was added. The resulting Nd impurity concentration in the crystals was nonuniform, according to x-ray spectral analysis, but nowhere exceeded 0.025%. Photoluminescence of Nd was excited within the 0.5-1.2  $\mu\text{m}$  wavelength range by radiation from a tunable dye laser (rhodamine 6G) with an MDR-23 monochromator. An analysis of the spectra, with valences of the elements in this system taken into consideration, indicates that Nd replaces Ga in these binary chalcogenides. From these spectra can be determined the locations of lower Stark components of several metastable states. The narrow phonon spectrum makes these chalcogenides suitable as infrared luminophores, after the doping technology has been improved and refined. Figures 3; tables 1; references 10: 4 Russian, 6 Western.

2415/12379

CSO: 1862/48

## NONISOTHERMAL INSTABILITY OF HIGH-VELOCITY FLOW OF ELASTOPLASTIC BODIES

Novosibirsk ZHURNAL PRIKLADNOY MEKhanIKI I TEKHNIChESKOY FIZIKI in Russian  
No 3, May-Jun 86 (manuscript received 18 Jan 85) pp 133-138

[Article by V.M. Volchkov, A.A. Kozlov, and P.V. Kuzin, Volgograd]

[Abstract] Nonisothermal instability of one-dimensional flow is analyzed for elastoplastic bodies, using the equations of one-dimensional flow and heat conduction for a Maxwell or elastoviscous medium and solving these equations for the appropriate boundary conditions. This system of three equations has been nondimensionalized by introduction of the Biot number as well as the ratio of characteristic heat transfer time to characteristic wave propagation time (elastic waves), the ratio of characteristic heat transfer time to characteristic relaxation time (elastic relaxation), and the ratio of characteristic heat transfer time to characteristic heat release time. It has been solved by the Runge-Kutta numerical method. Inasmuch as the stability limit does not depend significantly on the ratio of characteristic heat transfer time to characteristic wave propagation time within the  $N_{Bi}=0.01-16$  range of the Biot number, it is permissible to omit the equation containing this ratio and solve the system of the remaining two equations with this ratio thus assumed to be zero. This has been done by the Galerkin method with use of the QR algorithm, for small perturbations. For an analysis of the nonsteady flow after loss of stability, the complete system of nonlinear equations has been solved by the method of finite differences on the basis of integral relations. Such a solution with the Biot number  $N_{Bi}=1$  and the ratio of characteristic heat transfer time to characteristic wave propagation time  $A=1$  has yielded corresponding two stability regions with a stationary "focus" and a stationary "node" respectively. Figures 5; references 10: 8 Russian, 2 Western (1 in Russian translation).

2415/12379

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INSTABILITY OF FLOW ORIGINATING IN A SYMMETRICAL COLLISION OF THE JETS OF A PERFECT FLUID

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 22, No 3, May-Jun 86  
(manuscript received 5 Jun 84; after completion 23 Jul 85) pp 103-109

[Article by A.V. Utkin and A.N. Dremin, Chernogolovka]

[Abstract] A hydrodynamic approach is used to investigate the stability of two-dimensional flows originating in a symmetrical collision of jets of a perfect incompressible fluid. In this investigation, the disturbed flow as well as the original is considered to be a potential. It is shown that the jet configuration is unstable in relation to the symmetrical perturbations and the stable relatively antisymmetric perturbations. Conclusions are made on this basis with respect to the vortex nature of the waves, observed at the boundary of the junction of metallic plates during a high-speed slanting collision. Figures 3; references 15: 9 Russian, 6 non-Russian.

6415/12379

CSO: 1862/245

LASER-INDUCED GENERATION OF SUBNANOSECOND SOUND PULSES IN FLUIDS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 1(7), Jul 86 (manuscript received 9 Dec 85) pp 114-121

[Article by K.L. Vodoplyanov, L.A. Kulevskiy, V.G. Mikhalevich, and A.M. Rodin, Institute of General Physics, USSR Academy of Sciences]

[Abstract] Direct generation of strong subnanosecond sound pulses in fluids with an OH-group in the molecule by means of ultrashort laser pulses was studied in an experiment with a  $Y_3Al_5O_{12}:Er^{3+}$  laser (wavelength  $\lambda = 2.94 \mu m$ ). This laser, with active mode locking by means of synchronous electrooptic intracavity modulation, emitted  $TEM_{00}$ -mode pulse trains of approximately 50 at a repetition rate of 1 Hz. Single pulses of up to 60 mJ energy were extracted by means of an electrooptic shutter and transmitted to a 10 m thick layer of fluid between two quartz plates. Sound pulses were detected by a high-speed piezoelectric transducer with a sensitivity of  $2 \cdot 10^{-7}$  V/Pa, either in direct contact with the fluid for optimum matching of acoustic impedances or directly behind the back plate. The radius of the laser spot on the target surface was varied over the 0.04-0.5 mm range, as an additional means of regulating the radiation intensity. Sound pulses of 0.75 ns duration and up to 20 kbar pressure were recorded in water with an attenuation coefficient of  $10^2 \text{ cm}^{-1}$ , weaker pulses in glycerin, ethyl alcohol, and ethylene glycol, as the laser

radiation intensity increased to  $10^{10}$  W/cm<sup>2</sup>. Beyond that level the amplitude of sound pressure pulses ceased to increase proportionally reached saturation. An analysis of the results indicates that thermalization of excited states in molecules of these fluids occurs within a time shorter than 1 ns, considering that valence vibrations of molecules are exothermic and add heat to the fluid while sound is generated by thermal expansion of the fluid. The phenomenon of light-to-sound conversion as a shock wave process is also analyzed theoretically, using the Grueneisen coefficient and the empirical Tette equation of state. The authors thank L.M. Dorozhkin for producing the wideband piezoelectric transducers. Figures 3; references 14: 9 Russian, 5 Western.

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CSO: 1862/286

LASERS

ANOMALOUS NARROWING OF EMISSION LINE OF SEMICONDUCTOR LASER WITH COMPOUND RESONATOR

Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 12, No 13, 12 Jul 86 (manuscript received 10 Feb 86) pp 776-780

[Article by R.A. Suris and A.A. Tager, Institute of Radio Engineering and Electronics, USSR Academy of Sciences]

[Abstract] Processes governing the emission linewidth of a semiconductor laser are analyzed, considering not only fluctuation of the charge carrier concentration caused by amplitudinal noise and resulting in additional phase noise with attendant undesirable widening of the emission line in a simple two-mirror Fabry-Perot resonator with negligible inverse-law frequency dependence of the noise amplitude but also "internal" phase-amplitude-concentration-phase feedback which stabilizes the frequency and can possibly narrow the emission line. The balance between these two competing effects is evaluated on the basis of the equation for the "slowly" varying complex field amplitude and a  $\delta$ -correlated Gaussian force which generates spontaneous noise in a resonator weakly coupled to a semiconductor laser, one with an external dispersive mirror. One term in this equation accounts for the effect of such a mirror in the form of an integral and one term accounts for net amplification or attenuation. The resultant line width is calculated as a function of noise factors, widening of the emission line being found to be avoidable by use of a selective mirror for stabilizing the frequency and thus minimizing the linewidth factor with some sacrifice of raising the threshold. Figures 2; references 3: 1 Russian, 2 Western.

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CSO: 1862/270

NONLINEAR CONVERSION OF CONTINUOUS RADIATION BY STIMULATED-SCATTERING WAVEGUIDE LASERS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 4(10), Oct 86 (manuscript received 6 Mar 86) pp 1249-1261

[Article by Ye.M. Dianov, A.N. Pilipetskiy, A.M. Prokhorov, and V.N. Serkin, Institute of General Physics, USSR Academy of Sciences]

[Abstract] A method is proposed for nonlinear conversion of continuous radiation into a periodic sequence of strong pulses, by a stimulated-scattering laser in a fiber-optic waveguide. The theoretical development of this method is based on numerical solution of the corresponding system of nonlinear partial differential equations which describe the dynamics of radiation emission by such a laser, with a noise field already present and a short triggering pulse within the Stokes region of the noise spectrum available. Continuous radiation is assumed to be pumping the laser, led in through the resonator cavity so as to excite waves propagating in one direction only. Under consideration is both stimulated Mandel'shtam-Brillouin (SMBS) and Raman (SRS) scattering, only excitation of the first Stokes component in each case being considered as a practical matter. Interaction of the radiation field with intrinsic oscillations of the scattering medium, hypersonic and molecular ones, is described by a system of partial differential equations for slowly varying amplitudes of the pumping radiation wave and the first Stokes component. This system of equations is solved for appropriate boundary conditions in the resonator cavity, assuming that at time  $t=0$  a rectangular pumping pulse of infinitely long duration appears at the cavity entrance. Resulting evolution of a single Stokes component and nonlinear dynamics of subsequent radiation emission by the laser are analyzed semiquantitatively for an SMBS laser, then for a compound SMBS + SRS laser with compression of Stokes pulses from the SMBS stage to the SRS stage. The practicality of such an intracavity conversion of continuous radiation to pulsed radiation should become evident when applied to infrared radiation of a continuous-wave  $\text{CO}_2$ -laser. The performance of such a radiation converter will depend on the ratio of SMBS and SRS gain increments as well as on the delay in excitation of a hypersonic wave in the scattering medium. Figures 6; references 12: 8 Russian, 4 Western.

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CSO: 1862/53

## CHANGE IN CHEMICAL COMPOSITION OF ACTIVE MEDIUM OF CO-LASER DURING PERIODIC-PULSE ELECTRICAL DISCHARGE PUMPING

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 56, No 8, Aug 86  
(manuscript received 29 Jul 85) pp 1573-1579

[Article by N.G. Basov, A.I. Kipshakbayev, I.B. Kovsh, and V.I. Panteleyev,  
Institute of Physics imeni P.N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] Technological suitability of CO-lasers with periodic-pulse electrical discharge pumping is examined from the standpoint of emission suitability, the latter depending essentially on chemical stability of the active medium during excitation. In order to establish the degree of this stability, on the basis of CO<sub>2</sub>-impurity concentration buildup, it has been necessary to determine the rates and the energy characteristics of 14 most probable plasmochemical two-particle or three-particle reactions, first in pure CO and then in CO:N<sub>2</sub> mixtures with a usually not appreciable buildup of NO and NO<sub>2</sub> concentrations. Calculations based on numerical solution of the corresponding equations of reaction kinetics by the Runge-Kutta method on a BESM-6 high-speed computer for [CO] = const (t) = 0.5 Amaga and in CO:N<sub>2</sub> mixtures [N] = 0,5 Amaga at a temperature of 300 K ( $E_e = 100$  keV,  $j_e = 10$  mA/cm<sup>2</sup>, pumping pulse duration 50 us) as well as experiments with ELIT-1B commercial electron accelerator ( $E_e = 500$  keV,  $j_e = 2.5$  A/cm<sup>2</sup>, pumping pulse duration 2.5 us, pulse repetition rate 1 Hz) reveal that the only stable products of such reactions are C and CO<sub>2</sub>, both produced by the radiation mechanism. Periodic-pulse pumping is therefore preferable to continuous-wave pumping, on account of much weaker plasmochemical processes in the parelectrode regions and a less severe problem of CO<sub>2</sub> removal. The authors thank A.A. Sedov for performing mass-spectrometric analysis gases and V.V. Kurenkov for assistance in experiments. Figure 6; references 19: 15 Russian, 4 Western.

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## GENERATION OF STRONG TUNABLE ULTRASHORT LIGHT PULSES IN QUASI-WAVELENGTH THIN-FILM LASER WITH DISTRIBUTED FEEDBACK

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: FIZIKA in Russian Vol 21,  
No 2, Mar-Apr (manuscript received 27 Jul 84) pp 80-83

[Article by A.V. Karmenyan, T.E. Meliksetyan, and K.M. Pokhsraryan, Scientific  
Research Institute of Physics of Condensed Media, Yerevan State University]

[Abstract] Use of dye lasers without resonators, quasi-waveguide thin-film lasers or lasers with distributed feedback, is proposed for generating

ultrashort light pulses tunable over the luminescence spectrum. The pumping radiation pulses not only excite molecules of the active medium but also provide the necessary feedback. The feasibility of generating picosecond light pulses in a quasi-waveguide thin-film active medium with distributed feedback has been established both theoretically and experimentally. A film of dye solution not thicker than  $10\ \mu\text{m}$  and having a refractive index  $n_2$  is placed between two passive solid dielectrics with refractive indexes  $n_1, n_3$  such that  $n_1 > n_2 < n_3$ . Interference of two pumping beams results in periodic modulation of the film structure and thus produces distributed feedback, emission then being obtained at a wavelength according to the Bragg criterion. The experiment was performed with a solution of rhodamine 6G in ethyl alcohol,  $10^{-3}$  mole/dm<sup>3</sup>, between two prisms. As pumping source was used a YAG:Nd<sup>3+</sup> laser with passive mode locking which generated trains of 5-7 ultrashort pulses at a repetition rate of 1 Hz, at the fundamental radiation wavelength of  $1.06\ \mu\text{m}$ , pulses of 35 mJ energy and 38 ps duration within a beam 4 mm in diameter with a 1 mrad divergence angle. One such pulse was extracted by means of a Pockels shutter and amplified. Second-harmonic pulses were produced by means of frequency doubling with a 15 mm long KDP crystal. The dye laser generated pulses of 4 mJ energy, their duration not having been measured but estimated to be half the duration of the pumping pulses. Such pulses were generated at wavelengths covering the luminescence bands of rhodamine 6G, with a spectral line width of 0.6 Å. Figures 3; references 9: 7 Russian, 2 Western.

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CSO: 1862/290

## MEASUREMENTS FOR DETERMINING DURATION OF NUCLEAR REACTIONS WITH HEAVY IONS

Moscow FIZIKA ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA in Russian Vol 17, No 4, Jul-Aug 86 pp 753-788

[Article by S.A. Karamyan, Joint Institute of Nuclear Research, Dubna]

[Abstract] Measuring the duration of nuclear reactions, most of them lasting  $10^{-22}$ - $10^{-14}$  s, requires special methods and instruments. One such method is based on the shadow effect and applies to heavy ions moving through single crystals. The minima on the shadows of two identical differently oriented crystallographic axes are recorded as an ion beam passes through such a target at a different angle to each axis. This method has been studied at the Joint Institute of Nuclear Research since 1970. It is also useful for determining the buildup of defects in a single crystal caused by scattering of ions, such as  $^{14}\text{N}$ ,  $^{16}\text{O}$ ,  $^{20}\text{Ne}$ ,  $^{22}\text{Ne}$ ,  $^{22}\text{Ne}$ ,  $^{31}\text{P}$ ,  $^{40}\text{Ar}$  ions with energy of 0.6-8 MeV/nucleon by GaP, Ge, W,  $\text{UO}_2$  single crystals. The duration of a fission reaction can be measured by this method, formation of fission fragments being treated as an evolutionary process in which time delay caused by finiteness of the reaction rate converts into displacement along a normal to an atomic nucleus in the crystal and becomes measurable owing to the fact that the intensity of the shadow effect is determined by this displacement. Relations have been established for conversion of measurable quantities into duration of a reaction so that practical determinations of the reaction time could be made for fission of W and Ta nuclei by  $^{16}\text{O}$  or other heavy ions as well as of  $^{235}\text{U}$  and  $^{238}\text{U}$  nuclei by  $^3\text{He}$  or  $^4\text{He}$  ions. A description of nuclear reactions with heavy ions, in terms of duration and neutron spectra as well as nucleus temperature and its asymptotic rise with increasing excitation energy, was also obtained on the basis of lifetime statistics of an excited compound nucleus. The duration of such reactions, especially short ones lasting less than  $10^{-18}$  s, can be and has been determined from the angular distribution of the reaction products. Experiments were performed recently, moreover, for determining the lifetime of several dinuclear (quasi-molecular) systems from positron spectra and products of inelastic interaction,  $\delta$ -electron spectra and inelastic nuclear interaction, angular distribution of fragments, angular distribution of fission products, excited energy levels, angular distribution of nuclei, resonances of the excitation function, or angular distribution of elastic scattering. Figures 19; tables 2; references 102: 32 Russian, 70 Western (2 in Russian translation).

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CSO: 1862/272

## ANISOTROPY OF ELASTIC NEUTRON SCATTERING AND PROPERTIES OF NUCLEI

Moscow FIZIKA ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA in Russian Vol 17, No 4, Jul-Aug 86 pp 713-752

[Article by G.S. Samosvat, Joint Institute of Nuclear Research, Dubna]

[Abstract] Research done on elastic scattering of low-energy ( $<0.5$  MeV) neutrons is reviewed, data on scattering of such neutrons being much more scarce than data on scattering of high-energy neutrons. The three reasons for it are lower intensity and narrower energy distribution of weaker neutron sources, appreciable but not easily and quite unambiguously determinable scattering through a compound nucleus, and a less intricate and thus less informative angle dependence of the differential cross-section for scattering. However, there were determined the orbital moments and the spins of scattering resonances at various angles for  $^{24}\text{Mg}$ ,  $^{28}\text{Si}$ ,  $^{32}\text{S}$ ,  $^{40}\text{Ca}$ ,  $^{56}\text{Fe}$ ,  $^{206}\text{Pb}$ ,  $^{207}\text{Pb}$  nuclei. Observations were made yielding new evidence about neutron resonances at light nuclei, s-resonances and d-resonances identified as isobar-analog states, about spin dependence of the neutron force function for heavy nuclei, about mixtures of spin channels and the ratio of their contributions to two-channel p-resonances at  $^{19}\text{F}$ ,  $^{35}\text{Cl}$ ,  $^{89}\text{Y}$ ,  $^{93}\text{Nb}$ ,  $^{117}\text{Sn}$  nuclei, one-pion exchange interaction having been detected in these resonances but found not to be a governing factor. Measurements at the Joint Institute of Nuclear Research were made in the IBR-30 research reactor by the time-of-flight method with the aid of a MERA-60-30 computer. Scattering radii and neutron force functions were determined, various methods of calculation including statistical ones having been developed for this purpose, using the neutron scattering pattern within energy ranges covering many resonances. There have also been obtained systematic data on potential scattering of 400 keV neutrons by nuclei within the  $A=50-130$  range and on its interference with elastic scattering. The author thanks all colleagues-coauthors for many years of fruitful collaboration, V.G. Nikolenko and A.B. Popov especially for reading this manuscript and for valuable comments. Figures 16; tables 4; references 65: 28 Russian, 37 Western (2 in Russian translation).

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SOLUTION OF BOUNDARY-VALUE PROBLEM FOR FLUCTUATION SPECTROSCOPY

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 4, Jul-Aug 86 (manuscript received 29 Mar 84, after revision 26 Mar 86) pp 51-53

[Article by M.M. Aripov, T. Turlibekov, and R.A. Yusupov, Tashkent State University imeni V.I. Lenin]

[Abstract] The parameters of a composite line in a Raman scattering spectrum are calculated more accurately than by applying the method of least squares to each component line, after "separation" of overlapping bands, namely by reducing this problem of spectroscopy to a boundary-value problem for the corresponding second-order ordinary differential equation known to have a unique solution. The method was applied to the doublet line in the Raman scattering spectrum of barite ( $955 \text{ cm}^{-1}$  band) and the results found to agree closely with readings of a DFS-12 spectrometer at a temperature of 493 K. Figures 1; references 4: all Russian.

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CSO: 1862/66

COULOMB WIDENING OF NONLINEAR RESONANCES IN OPTICAL SPECTRA OF IONS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 4(10), Oct 86 (manuscript received 31 Mar 86) pp 1270-1279

[Article by S.A. Babin, V.I. Donin, and D.A. Shapiro, Institute of Automation and Electrometry, Siberian Department, USSR Academy of Sciences]

[Abstract] A theory of Coulomb widening of nonlinear ion resonances in a strong light field is constructed on the basis of the equation of quantum kinetics for the Wigner density matrix in the impact approximation, including a collision term which account for interaction of resonant ions with electrons as well as for relaxation processes. A supportive experiment was performed with

an Ar-laser, for a determination of the Lamb dip widening and its dependence on the concentrations of charged particles. The active medium was contained in a high-current discharge tube 70 cm long and 7 mm in diameter. The resonator was formed by a Littrow prism and a spherical mirror with a 10 cm radius. The discharge tube inside the resonator cavity was followed by a diaphragm for extraction of the fundamental transverse mode, a tiltable quartz plate for insertion of additional losses, and an only selectively transparent absorbing Au-film for frequency selection. A pair of 45° plane opaque mirrors outside the resonator cavity facilitated measurements, with one photoreceiver directly behind the first mirror transmitting not more than 0.5% of the incident light and another photoreceiver behind a Fabry-Perot interferometer on a 10 cm base recording most of the light reflected by the second mirror. Measurements were made at two Ar<sup>II</sup>-lines, the only 260 MHz wide 5017 Å line and the approximately 460 MHz wide 4880 Å line. The power of single-frequency emission was measured as a function of the discharge voltage and as a function of the frequency deviation from the Bohr frequency of m n transition. Its dependence on that frequency deviation was found to be asymmetric with the resonance line approximately 150 MHz wide and thus much wider than the 75 MHz mode separation. Spontaneous emission and the form of its line were recorded with a Fabry-Perot interferometer on a 1 cm base and an MDR-2 monochromator extracting either one of the two Ar<sup>II</sup>-lines. Temperature and drift velocity of ions were also measured, by the conventional Doppler method. The experimental data are evaluated, assuming equal ion and electron concentrations on the basis of measurements with the discharge current varied over the 100-180 A range under a constant pressure of 0.18 torr and with the pressure then raised at a constant discharge current of 180 A. Other than Coulomb widening of the Lamb dip, particularly inelastic scattering of excited ion states by atoms and electrons, is estimated theoretically and quenching of laser levels in Ar<sup>II</sup> by collisions with atoms is found to be negligible mainly on account of the low atom concentration in an Ar<sup>+</sup>-laser medium. Much more significant are Stark widening and quenching of ion states by electrons. The authors thank S.G. Rautian and G.I. Smirno for helpful discussion of the results, T.T. Timofeyev for assisting in performance of the experiment, and A.V. Rodishevskiy for assistance in computer processing of the data. Figures 6; references 31: 20 Russian, 11 Western (1 in Russian translation).

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UDC 535.36:523.035

#### CALCULATION OF RADIANT FLUXES IN NONCONCAVE SCATTERING BODIES

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 30, No 7, Jul 86 (manuscript received 3 Jun 85) pp 609-612

[Article by N.N. Rogovtsov, Belorussian Polytechnic Institute]

[Abstract] As a contribution to the theory of radiation transfer, asymptotic inequalities and exact relations are established for calculation of radiant

fluxes across boundary or internal surfaces of bodies. They are inferred from the invariance principle and applied specifically to nonconcave bodies such as plane-parallel layers, spheres, and cylinders confined by Lambertian subjacent surfaces with uniform albedo. The invariance principle is formulated with respect to total radiant flux or integral luminance for a body of arbitrary shape, assuming that its boundary surface may be a subjacent one but there is no subjacent surface inside it. For simplicity, the body is considered to be optically symmetric with respect to its geometric center. The two extreme cases are a homogeneous body without subjacent surface but containing radiation sources only and a body immersed together with its radiation sources in a homogeneous boundless medium. Article was presented by Academician (BSSR Academy of Sciences) B.I. Stepanov. References 8: all Russian.

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UDC 551.463.5

#### POWER OF LIGHT SIGNAL REFLECTED BY OBJECT IN SCATTERING MEDIUM

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 30, No 7, Jul 86 (manuscript received 23 Sep 85) pp 601-604

[Article by A.I. Kolesnik and A.P. Ivanov, corresponding member, BSSR Academy of Sciences, Institute of Physics, BSSR Academy of Sciences]

[Abstract] Reflection of a thin light beam from a point source by an object of finite dimensions in a scattering medium is considered, and expressions are derived for the power of light reflected by that object into a photoreceiver with small aperture. The object is assumed to be far from the source so that all points of the photoreceiver entrance pupil become equivalent. The source axis and the photoreceiver axis are assumed to intersect on the reflecting surface. The power and the radiation pattern of the source are given. The object is assumed to be a plane circular shield with the same reflection coefficient over the entire surface and scattering light in accordance with Lambert's law. The blurring function is defined as Green's function for a unidirectionally light emitting point source of unit power in the diffuse-light approximation. Additivity of dispersions and multiplicativity of zeroth-order moments of both source and photoreceiver radiation patterns are used in the convolution integral for the product of two Gauss functions. As a result is obtained a simple expression for the signal power at the photoreceiver aperture as a function of the shield radius and the object-to-source distance, both multiplied by the absorption coefficient of the turbid medium. This expression simplifies further when both dispersions are equal and for very small shields with the signal power proportional to the shield surface area or for very large shields with the signal power independent of the shield radius. Figures 1; tables 1; references 4: all Russian.

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FREQUENCY CHARACTERISTICS OF DUAL-MODE CO<sub>2</sub> LASER WITH PHASE-ANISOTROPIC CAVITY

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 44, No 6, Jun 86  
(manuscript received 24 Sep 84) pp 942-947

[Article by V.M. Yermachenko, V.N. Petrovskiy, Ye.D. Protsenko, A.N. Ruruin,  
and R.A. Shananin]

[Abstract] The frequency characteristics (intermode beating, liner and nonlinear frequency shifts of the generated modes) of a CO<sub>2</sub> laser generating two orthogonally polarized modes at a separate vibration-rotation transition are investigated. The radiation of a CO<sub>2</sub> laser was passed through a polarization filter to a cooled high-speed Cd-Hg-Te photodiode. The beat signal was amplified and fed to a frequency deviation meter to determine the change in frequency of intermode beats as a function of the detuning of the modes from the symmetrical position on the contour of the amplification line, and to a spectrum analyzer to measure the absolute value of the frequency of the generated modes as a function of various laser parameters. The intermode beat frequency as a function of the mode detuning was described by a bell curve. The investigations revealed the basic behavioral principles of the frequency characteristics of a two mode CO<sub>2</sub> laser, and their distinguishing features in comparison with the corresponding values in He-Ne lasers. Figures 4, references 7: 6 Russian, 1 Western.

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CSO: 1862/264

OPTICAL FIELDS WITHIN CORUNDUM PARTICLES IN SPECTRAL RADIATION BAND OF CO<sub>2</sub> LASER

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 44, No 6, Jun 86  
(manuscript received 8 Feb 85) pp 948-953

[Article by N.N. Belov]

[Abstract] This study analyzes the optical field within corundum particles in the wavelength region of CO<sub>2</sub> lasers (the IR region of the spectrum). The real and imaginary parts of the index of refraction are determined by using phonon models for the region of anomalous light dispersion. It is found that, by using corundum particles and a tunable CO<sub>2</sub> laser, it is possible to vary the intensity and position of the maximum heat release in the particles, achieving uniform heat release within the particles ( $\lambda=9.6-9.8 \mu\text{m}$ ) or predominant heating

of the illuminated ( $\lambda=10.0-11.2 \mu\text{m}$ ) or shadowed ( $\lambda=9.1-9.5 \mu\text{m}$ ) hemispheres of the particle, demonstrating the possibility of changing the value and location of the specific absorption maximum. Figures 4, tables 1, references 11: 9 Russian, 2 Western.

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PICOSECOND TRANSIENT DYNAMICS OF OPTICAL TRANSMISSION DURING BREAKDOWN OF THIN ALUMINUM COATINGS BY ULTRASHORT LIGHT PULSES

Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 12, No 14, 26 Jul 86 (manuscript received 29 Apr 86) pp 853-858

[Article by A.F. Dite and A.I. Filin, Institute of Solid-State Physics, USSR Academy of Sciences]

[Abstract] An experiment with optical breakdown of thin aluminum films was made, for a study of the transient dynamics of optical transmission. Aluminum films  $180 \pm 30 \text{ \AA}$  thick and  $370 \pm 30 \text{ \AA}$  thick with an initial transmission coefficient  $T=0.24$  at the  $\lambda=1.054 \mu\text{m}$  wavelength were deposited on substrates of K8 glass. They were irradiated with light monopulses of  $\tau = 13 \text{ ps}$  duration and  $1 \text{ mJ}$  energy from a glass(phosphate):Nd laser, with an intensity of the order of  $10^{11} \text{ W/cm}^2$  and a repetition rate of  $1 \text{ Hz}$ . Measurements were made by the method of pumping and nondestructive probing, over target spots  $200 \mu\text{m}$  and  $100 \mu\text{m}$  in diameter respectively. They have revealed a dependence of the transmission coefficient on the delay time with two time constants characterizing a quasi-exponential increase of transmission with time: one of the order of the laser pulse duration and not dependent on the film thickness, one much longer and dependent on the film thickness. With the transmission coefficient building up to  $0.9$  ( $180 \text{ \AA}$  film) or  $0.7$  ( $370 \text{ \AA}$  film), an interpretation of the data on the basis of aluminum breakdown with attendant plasma formation, expansion, and dispersal under laser radiation suggests no strong absorption of light by a subcritical plasma owing to ion-acoustic turbulence. The authors thank S.I. Anisimov for discussion and valuable comments. Figures 2; references 8: 3 Russian, 5 Western.

2415/12379  
CSO: 1862/283

PLASMA PHYSICS

SELF-EXCITATION OF BALLOONING TEARING MODES AND NATURE OF ANOMALY IN TOROIDAL MAGNETIC PLASMA CONFINEMENT

Moscow PISMA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 44, No 9, 10 Nov 86 (manuscript received 9 Sep 86) pp 424-426

[Article by L.Ye. Zakharov, Institute of Atomic Energy imeni I.V. Kurchatov, and K. Reidel, New York State University]

[Abstract] In a toroidally confined high-temperature plasma, where the condition  $B \nabla p = 0$  is nearly satisfied, MHD tearing perturbations are shown to be always unstable and the resulting split of rational magnetic surfaces is considered to be responsible for the transport anomaly in such a toroidal system. This is demonstrated theoretically on self-excitation of ballooning tearing modes with high wave numbers  $m, n \gg 1$ , in accordance with the simplest model of a tokamak configuration and the theory of imminent equilibrium. Figures 2; references 2: 1 Russian, 1 Western.

2415/12379  
CSO: 1862/60

INTERACTION OF  $\beta$ -ELECTRON IN FINAL STATE WITH BOUND ELECTRON AND ASSOCIATED PHENOMENA

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 4(10), Oct 86 (manuscript received 19 Mar 86) pp 1160-1171

[Article by Ye.G. Drukarev and M.I. Strikman, Leningrad Institute of Nuclear Physics imeni B.P. Konstantinov, USSR Academy of Sciences]

[Abstract] Interaction of a  $\beta$ -electron in the final state and a bound electron of the atomic shell is analyzed, for an evaluation of its role in and effect on decay phenomena. Equations describing this interaction are derived in the quadratic approximation with respect to the Coulomb interaction parameter. Necessary fundamental relations for the energy distribution of  $\beta$ -electrons and the total probability of  $\alpha$ -decay are established, with the effect of interaction in the final state taken into account in the nonvanishing

approximation. A matter of particular interest is  $\alpha$ -decay of tritium, the traditional vehicle for search of the neutrino mass. Theoretical and experimental data on the heavy neutrino and on the probabilities of transitions of bound electrons into specific states of the  ${}^3\text{He}$  atom are used for an evaluation of interaction in the final state. Corrections are accordingly made accounting for its contribution to the probabilities of superallowed  $0^+ \rightarrow 0^+$  transitions useful for calculating the weak constant  $G_V$ , this being an exceptional case where the contribution of interaction in the final state is explicitly measurable (not so where other heavy nuclei are involved and the contribution of interaction in the final state can only be estimated as a very large one). Also theoretical and experimental data on the lifetime of bound states during tritium, meson, muon, and pion decay are refined by correcting for the effect of interaction in the final state. The authors thank V.G. Gorshkov, A.A. Klochikhin, V.A. Koptev, A.N. Moskalev, and L.L. Frankfurt for valuable discussions. Figures 4; tables 2; references 24: 8 Russian, 16 Western (2 in Russian translation).

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CSO: 1862/53

UDC 539.163

#### PROCESSES ACCOMPANYING $\beta$ -DECAY OF NUCLEI WITH NUMEROUS EXCESS NEUTRONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50, No 5, May 86 pp 834-846

[Article by Yu.S. Lyutostanskiy, Moscow Engineering Physics Institute]

[Abstract] This study investigates  $\beta$ -delayed processes using a uniform approach based on the description of the  $\beta$ -decay power function  $S_\beta(E)$  within the framework of the microscopic theory. Possible  $\beta$ -delayed processes are described. The  $\beta$ -decay power function, on which the theoretical description of  $\beta$ -delayed processes is based, is analyzed. The emission of delayed neutrons is explained. The emission of charged particles and fission during  $\beta^-$  decay is described. The role of  $\beta$ -delayed processes in astrophysics is discussed. Figures 9, references 45: 23 Russian, 22 Western.

6900/12379  
CSO: 1862/260

## MECHANISM OF f-DECAY AND SPONTANEOUS EMISSION OF FRAGMENTS BY HEAVY NUCLEI

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50,  
No 5, May 86 pp 1016-1020

[Article by V.A. Rubchenya, V.P. Eismont, and S.G. Yavshits]

[Abstract] This study investigates a new type of radioactive decay of heavy nuclei--spontaneous fragment emission, termed f-decay, which is viewed as a process that combines features of  $\alpha$ -decay and nuclear fission. The mechanism underlying f-decay is mainly associated with corrective nuclear movements of small amplitude, so that the probability of f-decay is governed by the probability of occurrence of a configuration of the original nucleus that corresponds to the formation of a fragment and residual nucleus, and the permeability of a potential barrier. A fragment is found to be formed for a particular oscillation amplitude that then tunnels through the potential barrier. The results of calculating the probability of f-decay with the formation of a magic Pb nucleus in the finite state for a nucleus from Ra to Cf indicate that f-decay of heavy nuclei should be sought further in the region of nuclei lighter than Pu. Figures 5, tables 1, references 12: 5 Russian, 7 Western.

6900/12379  
CSO: 1862/260

## PLASMA DIAGNOSIS DURING LASER-INDUCED FUSION ON BASIS OF PRODUCTS OF SECONDARY THERMONUCLEAR REACTIONS

Moscow FIZIKA PLAZMY in Russian Vol 12, No 8, Aug 86 (manuscript received  
7 Mar 85) pp 916-926

[Article by N.G. Basov, O.B. Vygovskiy, S.Yu. Gus'kov, D.V. Il'in, A.A. Levkovskiy, V.B. Rozanov, and V.Ye. Sherman, Institute of Physics imeni P.N. Lebedev, USSR Academy of Sciences]

[Abstract] Plasma diagnosis during laser-induced fusion on the basis of secondary particles leaving the target is considered, especially in the case of a small  $\rho R$  product ( $R$ - radius of target,  $\rho$ - density of target material) and correspondingly negligible retardation of charged particles in the plasma. The ratio of secondary yield to primary yield  $N_2/N_1 = f(\rho)$  for homogeneous constant-mass targets, a function of the target material density, is then the reference quantity. The problem is to determine how this ratio for any given

target material depends on the plasma density and temperature as well as on such influencing factors as retardation of primary particles with attendant change in cross-sections for secondary reactions, degeneracy of the electron gas, and various edge effects. Such a determination is made theoretically for a deuterium target, preferable to a deuterium-tritium target for diagnostic purposes so that the plasma compression hydrodynamics will not depend on the target composition. Calculations are based on numerical solution, by the Monte Carlo method, of the equation of kinetics for thermonuclear particles in a confined plasma. They cover energy lost on retardation of charged plasma particles by Coulomb interaction with free charged particles, cross-sections for  $\text{He}^3(\text{D},\text{p})\text{He}^4$  and  $\text{He}^3(\text{D},\text{n})\text{He}^4$  reactions, and yield of secondary particles from a homogeneous target. Ratios  $N_{p2}/N_{n1}$  or  $N_{n2}/N_{n1}$  of secondary nucleons (protons or neutrons) to primary neutrons and ratio  $N_{p2}/N_{n2}$  of secondary protons to secondary neutrons are then considered for plasma diagnosis, their usefulness depending on their respective criticality ranges. Figures 4; references 21: 17 Russian, 4 Western.

2415/12379

CSO: 1862/287

QUASI-EQUILIBRIUM MODEL OF KINETICS OF COUPLED MODES IN CO<sub>2</sub> MOLECULES

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian  
No 3, May-Jun 86 (manuscript received 15 Mar 85) pp 16-22

[Article by R.Sh. Islamov, Moscow]

[Abstract] A quasi-equilibrium model is proposed for describing the kinetics of CO<sub>2</sub> molecules, without the restrictive assumption of a quasi-steady ascending quantum flux. This model covers vibrational kinetics, involving VV-exchange and VT-relaxation between multiplets as well as the attendant redistribution of molecules. It also accounts for possible pumping by external sources. Assuming a Boltzmann population distribution within multiplets and a translational temperature of the CO<sub>2</sub> gas, the problem of relaxation and coupled modes reduces to equations of an equivalent anharmonic oscillator with levels corresponding to multiplets of CO<sub>2</sub> molecules and with a temperature-dependent anharmonicity constant. On the basis of this model has been evaluated the evolution, in time, of the distribution function of mean multiplet level populations characterizing coupled modes in CO<sub>2</sub>. Quantitative data based on calculation of kinetic coefficients and electron energy balance in mixtures of vibrationally excited CO<sub>2</sub> with inert gases such as Ar (CO<sub>2</sub>:Ar= 1:9) are compared with data on such mixtures where some of the inert gas has been replaced by water vapor. Figures 3; references 12: 8 Russian, 4 Western.

2415/12379

CSO: 1862/269

ACCELERATION OF PARTICLES RIDING ON STRONG POTENTIAL WAVE WITH BENT FRONT IN  
MAGNETIC FIELD

Moscow PISMA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian  
Vol 44, No 9, 10 Nov 86 (manuscript received 21 Aug 86) pp 421-423

[Article by S.V. Bulanov and A.S. Sakharov, Institute of General Physics, USSR  
Academy of Sciences]

[Abstract] Acceleration of a particle riding on a strong potential wave in a  
magnetic field parallel to the wavefront is analyzed, this principle being  
applicable to a surfotron-accelerator with a strong laser or maser radiation  
field, the wavefront being not plane but a surface of revolution and the  
magnetic lines of force being correspondingly curved. The conditions for  
maintaining such a particle at the wavefront are established on the basis of  
the Lagrangian for motion on a surface and losses limiting the acceleration are  
estimated. As a specific example is considered acceleration of an  
ultrarelativistic particle riding on the front of a cylindrical wave. The  
authors thank G.A. Askaryan, G.M. Batanov, and L.M. Kovrizhnykh for discussion.  
References 8: 6 Russian, 2 Western.

2415/12379  
CSO: 1862/60

UDC 539.107.3

USE OF HOLOGRAPHY IN TRACK DETECTORS WITH HIGH SPATIAL RESOLUTION

Moscow FIZIKA ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA in Russian Vol 17, No 3,  
May-Jun 86 pp 546-601

[Article by E. Bartke and I.Ts. Ivanov, Joint Institute of Nuclear Research,  
Dubna]

[Abstract] Holographic recording of tracks of particles in bubble chambers and  
in streamer chambers with high spatial resolution is considered, particularly  
laser holography, the feasibility of which being determined by the intensity  
and the coherence of light as well as on the hologram requirements. These  
requirements are defined in terms of space resolution, information load  
capacity, and also diffraction efficiency. The physical processes on which  
detection of tracks depends are initiation and growth of vapor bubbles in a  
bubble chamber, stagnation of o-electrons and release of their energy being the  
most likely mechanism here, or formation of optical inhomogeneities after  
buildup of electron avalanches in a streamer chamber. Formation of a streamer  
channel in the latter case is pressure dependent and influenced by impurities  
such as methane, xenon, water vapor, and also depends on the laser parameters.

These are length of pumping period, which must yield laser emission pulses of duration shorter than the time delay in the streamer chamber and with a repetition rate equal to the frequency of streamer pulses, and wavelength of the laser light. On the basis of these physical relations and conditions have been established the technical requirements for track detection, namely kind of laser medium and components of the holographic data extraction system including all necessary optics, whether a bubble chamber or a streamer chamber operating by the focused-images method, by the dark-field method, or by the bright-field method, and for stereoscopic recording of tracks with either a plane or a spherical reflector. Into consideration must be taken the effect of turbulence in the chamber on the resolution, contrast being possibly lost even though visibility may be retained. Bubble chambers so far developed and successfully used with laser recording of tracks include the Freon bubble chamber at the Leningrad Institute of Nuclear Physics for tracking 100 MeV  $\gamma$ -quanta from the electron synchrotron at the Institute of Engineering Physics (USSR Academy of Sciences) and several CERN bubble chambers (BIBC Freon bubble chamber, HOBC precision bubble chamber with heavy fluid, LEBC, HOLEBC, RCBC hydrogen bubble chambers, BEBC bubble chamber with ruby laser). Only one streamer chamber, SKALAR (Streamer Chamber with Laser Recording of Tracks) was used in a physical experiment with a particle accelerator and a high-pressure streamer chamber has been developed by CERN. Equipment for three-dimensional processing of holograms, for example the HOLMES system developed and built by CERN, involves a gas laser (Ar, He-Ne), light beam shaping optics, an xy-stage, a z-stage, three fixed mirrors, two lenses, two light beam splitters, two television cameras, and one anamorphic television camera. Figures 38; tables 6; references 104: 45 Russian, 64 Western (4 in Russian translation).

2415/12379

CSO: 1862/273

UDC 533.92:621.039.61

#### ION ENERGY SPECTRA PRODUCED BY LASER TREATMENT OF MOLYBDENUM WITH IMPURITY

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 4, Jul-Aug 86 (manuscript received 17 Apr 85) pp 82-83

[Article by M.R. Bedilov and T.G. Tsoy, Institute of Nuclear Physics, UzSSR Academy of Sciences]

[Abstract] An experimental study was made concerning laser treatment of molybdenum with impurities, elements lighter than molybdenum, found in the commercial metal. Specimens of commercial Mo, and for reference of pure Mo, were treated with a Nd-laser at a power density of  $10^{11}$  W/cm<sup>2</sup>. Measurement of the ion energy spectra was made with a time-of-flight mass-spectrometer connected to an electrostatic energy analyzer. The energy spectrum of ions in pure Mo was found to be approximately 1.8 keV wide and up to 1.5 times wider than that of ions in commercial Mo, with the ion charge number ranging from

1 to 8 in pure Mo and only from 1 to 5 in commercial Mo. The results indicate that the number and the energy of Mo ions are higher in pure Mo, even though their velocity may be lower than in commercial Mo. Figures 2; references 3: all Russian.

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CSO: 1862/66

UDC 535.21:539.198

#### SELF-ALIGNMENT OF MOLECULAR BEAM

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 60, No 6, Jun 86 (manuscript received 20 Dec 85) pp 1103-1106

[Article by M.P. Chayka]

[Abstract] In the Weber-Bylicki-Miksch experiments performed in 1984 a beam of NO molecules was irradiated with light from a tunable laser so that the molecules became excited at a single hyperfine transition, whereupon the difference between two fluorescence intensities corresponding to two orthogonal axes of linear polarization was measured by an instrument recording  $S = (I_x - I_y) / (I_x + I_y)$  signals behind a filter stopping all scattered laser light and passing all more "reddish" light. The molecular beam was scanned by a magnetic field or by a composite magnetic and radio-frequency field, for a determination of the dependence of the signal S amplitude on the magnetic field intensity. The experiment was set up so that the size of the small excitation region was determined solely by the diameter of the laser beam and did not exceed a few millimeters, with the spectrum of the laser light much narrower than a Doppler spectrum. As the excitation power was gradually increased, both the Hanle signal and the magnetic-resonance signal eventually reversed their sign. For an interpretation of this unexpected result, all resonances occurring here are classified into soft and sharp ones. Sharp resonances include the Hanle effect and magnetic resonance at the upper level. The effective width of a soft resonance corresponds to and is the reciprocal of the time in which molecules cross the excitation regions while also interacting with the laser radiation, soft resonances therefore being associated with lower levels. While the appearance of wide signals is attributable to optical pumping and an attendant dip in the velocity distribution of molecules in a noncollimated beam, the sign reversal characterizing sharp resonances is attributable to collisions which involve molecules inside the gun before their exit and beam formation. The mechanism of sign reversal is further interpreted in terms of beam alignment by the laser field, alignment of the excited state or transfer of alignment from the lower state to the upper one. A quantitative analysis of both competing processes on the basis of the two easily evaluated extreme cases of weak and strong pumping explains the sign reversal of narrow resonance signals as a consequence of alignment, alignment of the upper state being inversible only with a positive alignment of the lower state during

excitation. Calculations made for a transition (1-line in W-B-M experiment) with lower level and upper level having quantum numbers of the angular momentum respectively  $F= 7/2$  and  $F= 5/2$  confirm the validity of this model. Figures 2; tables 1; references 4: 2 Russian, 2 Western.

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CSO: 1862/267

UDC 539.194

#### EVIDENCE OF CORIOLIS INTERACTION IN INFRARED SPECTRUM OF MOLECULES DISSOLVED IN LIQUID ARGON

Leningrad OPTIKA I SPECTROSKOPIYA in Russian Vol 60, No 6, Jun 86 (manuscript received 4 Nov 85) pp 1165-1170

[Article by T.D. Kolomiytsova, S.M. Melikova, and D.N. Shchepkin]

[Abstract] The infrared absorption spectra of  $CF_4$  molecules in the gaseous phase at two temperatures (296 K, 120 K) and in the liquid phase (dissolved in liquid Ar at 90 K) were measured, for the purpose of tracking the  $\nu_1 + \nu_2$  forbidden-transition band induced by Coriolis interaction in the gaseous phase with free rotation and vanishing upon transition to the rotational diffusion limit in the liquid phase. Here the Coriolis interaction involves mixing of the  $\nu_1 + \nu_2$  (E) state eigenfunction with the  $\nu_3$  ( $F_2$ ) source and probably also the  $\nu_1 + \nu_4$  source eigenfunction. The infrared spectra of  $CF_3Cl$  molecules were similarly measured, in the gaseous phase at two temperatures (296 K, 176 K) with Ar as buffer, gas under respective partial pressures  $p(CF_3Cl)= 340$  torrs and  $p(Ar)= 3$  atom as well as in the liquid phase (dissolved in liquid argon at 90 K), for the purpose of tracking two forbidden-transition bands  $\nu_4 + \nu_5$  and  $3\nu_4$  induced by Coriolis interaction and vanishing without this interaction. The two molecules represent opposite extreme situations, namely weak Coriolis interaction ( $CF_4$ ) and strong Coriolis interaction with almost complete overlap of bands ( $CF_3Cl$ ). The authors thank N.N. Filippov for discussion of the results. Figures 3; tables 2; references 8: 7 Russian, 1 Western.

2415/12379  
CSO: 1862/267

## KINETIC REGULARITIES OF LASER PYROLYSIS OF EPOXIDE RESIN

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 22, No 3, May-Jun 86  
(manuscript received 19 Dec 84; after completion, 23 May 85) pp 88-91

[Article by S.G. Bychkov, A.V. Desyatkov, A.A. Biketov, and G.I. Ksandonulo,  
Alma-Ata]

[Abstract] Laser pyrolysis of EKhd epoxide resin solidified by Diamet-X, the traditional connection for a whole series of composite materials, was investigated. The radiation source was a LG-43 continuous CO<sub>2</sub> laser with a radiation wavelength of 10.6 micrometers. The tests were conducted in an argon atmosphere. The installation which made it possible to record directly the speed of formation of gaseous products and to select tests for subsequent chromatographic analysis is illustrated and explained. The LG-43 laser used made it possible to obtain a density of the radiation intensity up to  $q = 50 \text{ W/cm}^2$  with a  $0.13 \text{ cm}^2$  beam diameter. An IMO-2-2 calorimetric meter was used to measure  $q$ . Figures 3; references 5: 4 Russian, 1 non-Russian.

6415/12379

CSO: 1862/245

## NONLINEAR ELECTROMAGNETIC EXCITATION OF ULTRASOUND IN METALS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 91,  
No 1(7), Jul 86 (manuscript received 24 Dec 85) pp 202-212

[Article by A.N. Vasilyev, M.A. Gulyanskiy, and M.I. Kazanov, Moscow State  
University imeni M.V. Lomonosov]

[Abstract] Excitation of ultrasonic waves in a metal upon impingement of electromagnetic waves on its surface with attendant corresponding energy conversion by the deformation mechanism with an anomalous skin effect is considered, such an excitation by the induction mechanism with a normal skin effect having been considered in an earlier study (USPEKHY FIZICHESKIKH NAUK Vol 141, 1983, p 431). A theory is constructed for contactless excitation of double-frequency ultrasound by an electromagnetic wave impinging normally on the boundary of an isotropic metal half-space, without a constant magnetic field present and in the  $\omega\tau \ll 1$  approximation ( $\tau$  - electron relaxation time,  $\omega$  - frequency of electromagnetic wave). Calculations are based on isotropic dispersion and specular reflection of conduction electrons with a  $\tau$ -approximation of the collision integral. The principal source of nonlinearity is the  $\chi \propto EH$  nonequilibrium term added to the electron distribution function, representing interaction of the alternating magnetic

field and the current it induces in the skin layer. The excitation problem is solved by the Fourier method. Transition from normal to anomalous skin effect is found to increase the amplitude of an excited double-frequency ultrasonic wave, proportionally to  $(1/\delta_a)^2$  ( $l$  - mean-free-path length,  $\delta$  - depth of skin layer), until  $\omega_c \tau \omega_a l$  ( $\omega_c$  - cyclotron frequency of electrons). Experimental verification of the theory is and outlined. Figures 2; references 19: 13 Russian, 6 Western.

2415/12379  
CSO: 1862/286

#### DYNAMICS OF AND RADIATION EMISSION FROM PARTICLES TRAPPED BY POTENTIAL WAVE IN MAGNETIC FIELD

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 1(7), Jul 86 (manuscript received 2 Jan 86) pp 98-105

[Article by G.M. Zaslavskiy, S.S. Moiseyev, and A.A. Chernikov, Institute of Space Research, USSR Academy of Sciences]

[Abstract] A new phenomenon of radiation emission by electrons riding on a potential wave during their acceleration in a transverse magnetic field is analyzed, calculations being based on the canonical equations of motion of an electron and the Hamiltonian of its entrapment interaction with a traveling potential wave under conditions of adiabaticity. First is considered spontaneous emission of radiation by a relativistic electron moving with the wave front along a curvilinear trajectory and oscillating transversely. Both intensity and frequency of radiation emission in this case can be calculated, the frequency found to be higher than the bounce frequency when the velocity of the electron becomes ultrarelativistic. Next comes induced or stimulated emission of coherent radiation at high current density with not any more negligible interelectron photon interaction. Acceleration of trapped electrons to a relativistic velocity is in this case found to result in radiation emission at a frequency much higher than their oscillation frequency. The authors thank R.Z. Sagdeyev for attentiveness and helpful discussions. References 8: 5 Russian, 3 Western (2 in Russian translation).

2415/12379  
CSO: 1862/286

## NEW KIND OF HIGH-Q OSCILLATIONS IN OPEN WAVEGUIDE RESONATOR

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 12, No 14,  
26 Jul 86 (manuscript received 2 Apr 86) pp 876-879

[Article by A.A. Kirilenko and S.L. Senkevich, Institute of Radio Engineering and Electronics, UkSSR Academy of Sciences, Kharkov]

[Abstract] An analysis of multimodal waveguide resonators and their natural complex frequencies has revealed unique oscillations with high Q and low diffraction loss. As an example are considered  $H_{m0p}$ -modes in a rectangular resonator between two semiinfinite waveguides. Their unique characteristics are demonstrated by determining the values of the complex parameter  $k' + jk'' = \omega b \sqrt{\epsilon \mu}$ , the normalized frequency, which yield nonzero solutions to the homogeneous Helmholtz equation for Dirichlet conditions at the walls of the resonator and both waveguides, disregarding ohmic losses. Calculations reveal that within the  $315^\circ \leq \arg k \leq 360^\circ$  range, which corresponds to oscillations decaying in time, superhigh-Q oscillations can exist in a symmetric resonator owing to mutual compensation of radiation losses associated with a high-Q mode ( $H_{20p}$ ) and a low-Q mode ( $H_{10q}$ ) under conditions of longitudinal resonance. Figures 2; references 4: all Russian.

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CSO: 1862/283

UDC 536.521.384

## SURFACE TEMPERATURE OF CARBON PARTICLES IN A POWERFUL LASER RADIATION FIELD

Moscow TEПЛОФИЗИКА VYSOKIKH TEMPERATUR in Russian Vol 24, No 5, Sep-Oct 86  
(manuscript received 21 May 84) pp 1004-1007

[Article by V.I. Bukatyy, I.A. Sutorikhin and A.M. Shayduk, Altay State University]

[Abstract] The temperature of individual carbon particles in a field of continuous laser radiation at wavelength 1.06  $\mu\text{m}$  was measured under normal atmospheric conditions and at reduced oxygen concentration. Each carbon particle was placed on the end of a quartz filament 15-20  $\mu\text{m}$  in diameter. Laser radiation was focused by a 6 cm lens and directed onto the top of the carbon particle (side opposite filament). Temperature changes were recorded by the color method, allowing simpler implementation of high speed recording than the brightness method. Granulated particles of type PM-100 carbon black and particles of Ekibastuz coal were studied. Temperatures of over 350 particles were measured. Curves illustrate the variation in particle temperature as a function of time for various radiation intensities and particle diameters. The results of the experiments show that when the content of oxygen in the cuvette

results of the experiments show that when the content of oxygen in the cuvette is decreased below the normal atmospheric content, the temperature rise time remains practically constant. However, the temperature fall time from the maximum to the minimum value increases. With oxygen concentration less than 1%, the particle temperature reaches its maximum and remains practically unchanged over a period of 5 seconds. The experimental estimate of the thermal effect of combustion agrees well with the results of computations using the theoretical model selected. Figures 3, references 11: Russian.

6508/12379  
CSO: 1862/43

UDC 537.591.15

#### ČERENKOV RADIATION FROM EXTENSIVE AIR SHOWERS AND STUDY OF SUPERHIGH-ENERGY COSMIC RAYS

Tomsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: FIZIKA in Russian Vol 29, No 9, Sep 86 pp 24-32

[Article by Yu.A. Fomin and G.B. Khristiansen, Scientific Research Institute of Nuclear Physics, Moscow State University imeni M.V. Lomonosov]

[Abstract] Čerenkov radiation from extensive air showers precipitated in the atmosphere by cosmic rays with  $10^{15}$  eV or higher energy has been shown, on the basis of the Franck-Tamm relation and the mean-value theorem, to yield information not only about the total number of particles up to some depth but also about their differential number at various depths. Here the methodology of obtaining in this way information about superhigh-energy cosmic rays is examined, first by analysis of Čerenkov pulse evolution at various distances from the shower axis and then by analysis of experimental data already available. Measurements with Čerenkov radiation detectors having a sufficiently large bandwidth and also a sufficiently large geometrical factor, to ensure a high signal-to-noise ratio and to minimize pulse distortion, have yielded the dependence of the depth of a shower peak on the energy of shower seeding particles, the cross-section for inelastic interaction of such particles and  $N^{14}$  nuclei, cascade profiles of extensive air showers, and the integral primary spectrum of cosmic rays. More precise study of this spectrum is still necessary, especially within the not yet explored  $3 \cdot 10^{16}$ - $3 \cdot 10^{17}$  eV range.

2415/12379  
CSO: 1862/42

'MARIYA' EXPERIMENT ON BOARD OF 'SALYUT-7'-'SOYUZ T-13'-'KOSMOS-1669' ORBITAL COMPLEX FOR STUDY OF ELECTRON-POSITRON COMPONENT IN COSMIC RAYS

Tomsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: FIZIKA in Russian Vol 69, No 9, Sep 83 pp 19-24

[Article by S.A. Voronov, A.M. Gal'per, M.V. Guzenko, V.G. Kirillov-Ugryumov, S.V. Kollashov, A.V. Popov, and V.Yu. Chesnokov, Moscow Institute of Engineering Physics]

[Abstract] A study of the high-energy component in cosmic rays within the region of Brazilian geomagnetic anomaly, originally discovered through a "Yelena-F" telescope during the 1979-80 experiment on board of the "Salyut-6"- "Soyuz"- "Progress" orbital complex, was undertaken on board of the "Salyut-7"- "Soyuz T-13"- "Kosmos-1669" orbital complex. This experiment included measurements with a "Mariya" magnetic scintillation spectrometer. The instrument consists of two scintillation counters, a magnet which generates a field of approximately 4 kOe intensity for deflection of incoming charged particles, and a third scintillation counter for recording them. Each counter is split into 2 cm wide separate strips perpendicularly to the magnetic lines of force, each strip being scanned by a photomultiplier for measurement of the deflection angles within 2° accuracy. The spectrometer logic circuitry consists of a signal shaper-discriminator, a single-hit sampler and pulse generator, and array of pulse shapers with tracking thresholds, a prioritizing discriminator, and a coincidence circuit. Upon forward passage of a relativistic particle through the three counters, the coincidence circuit generates an output signal which triggers an arithmetic unit followed by a temporary storage with 42 bytes capacity. A telemetering channel transmits data to the peripheral memory of a computer on earth. The physical characteristics of this spectrometer have been calculated on a computer by the Monte Carlo method and confirmed by calibration against the electron accelerator at the Institute of Physics (USSR Academy of Sciences). The instrument was installed on board of the orbital complex so as to record particles of the earth's radiation belt trapped in the magnetic field. The results of the experiment indicate that electrons trapped by the earth's magnetic field have been generated by a not yet known mechanism, possibly during their acceleration through the magnetosphere. The authors thank V.A. Dzhaniybekov and V.P. Savinykh for active participation in the experiment, also V.B. Zotov and N.I. Shvets for assistance in preparation of the experiment. Figures 6; tables 1; references 9: 8 Russian, 1 Western (in Russian translation).

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THEORETICAL PHYSICS

RESEARCH ON MECHANISM OF QUARK-DIQUARK FRAGMENTATION IN  $pp$ -INTERACTIONS AT 360 GeV

Moscow PISMA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 44, No 9, 10 Nov 86 (manuscript received 16 Sep 86) pp 411-415

[Article by I.V. Gorelov and L.A. Tikhonova, Moscow State University (USSR), A.V. Batumin, G.V. Zholobov, and E.P. Kistenev, Institute of High-Energy Physics, Serpukhov (USSR), J.K. Maran, L. Montanet, H. Neuhofer, and D.B. Singh, CERN, Geneva (Switzerland), B. Buschbeck, J. Grubeck, H. Dibon, M. Markitan and P. Port, Institute of High-Energy Physics, Vienna (Austria), B. Enn and P. Girtler, Institute of Experimental Physics, Innsbruck (Austria), D.L. Baillie and F. Harquette, Research Department, State University, Mons (Belgium), T. Gemesi, S. Krasnovsky, and H. Pinter, Institute of Physics Research, Budapest (Hungary), A. Gurtu, P.K. Malhatra, and K. Sudhakar, Institute of Basic Research, Bombay (India), G.M. Koli and I.S. Mitra, University of Punjab, Chandigarh (India), C. Caso, S. Scuarchia, and U. Trevisan, University of Genoa and Research Institute of Nuclear Physics (Italy), I. Iga, T. Tsurugai, T. Hirous, and T. Emura, Metropolitan University of Tokyo (Japan), R. Hamattsu, University of Agronomy and Technology, Tokyo (Japan), T. Kobayashi, Chuo University, Tokyo (Japan), I. Shiba, University of Hiroshima (Japan), F.D. Dugas-Hedo, T. Rodrigo, and A. Ferrando, Department of Nuclear Energy, University of Madrid (Spain)]

[Abstract] A quark-parton model is constructed to describe soft scattering in the process of which one of the dressed quarks (diquarks) "i" escapes from an a-proton and forms a c-hadron, assuming that the distribution of quarks and diquarks in the nucleon (proton) obeys the Regge duality theory. Data from the CERN NA23 experiment with a fast-cycling bubble chamber and a European hybrid spectrometer have been utilized for evaluating the inclusive characteristics of charged-hadron  $h^\pm$  formation as well as of  $\pi^0$ ,  $K^0$  meson formation and of  $\Lambda$ ,  $\bar{\Lambda}$  hyperon formation during  $pp$ -interactions at 360 GeV/s. The total cross-sections for their formation predicted theoretically on the basis of this model are comparable with the experimentally determined ones, approaching a close agreement, which confirms the substantial role of diquark structures in such a process and especially in formation of baryons. Both the Field-Feynman model and the LUND model of hadron formation were used in the analysis. Figures 2; references 26: all Western.

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## LIFETIME HIERARCHY OF CHARMED AND BEAUTIFUL HADRONS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 91, No 4(10), Oct 86 (manuscript received 16 Apr 86) pp 1180-1193

[Article by M.B. Voloshin and M.A. Shifman, Institute of Theoretical and Experimental Physics]

[Abstract] Theoretical and experimental data on decays of charmed hadrons are analyzed, for a determination of preasymptotic effects, considering not only the  $\Lambda_c^-$ -baryon as well as the D-meson and the F-meson but especially also three weakly decaying other charmed baryons consisting of one heavy quark and two light (up, down, strange) ones. After the fundamental concepts and postulates pertaining to decays of these particles have been formulated, the effective Lagrangian for the decay width of those charmed hadrons is constructed and then "hybrid" logarithmically renormalized in the low-energy domain. Next is established the decay width hierarchy of charmed hadrons and data on decays of beautiful hadrons are refined by correcting for preasymptotic effects. The authors thank A.M. Badalyan for making numerical calculations based on the potential model, also Ya.I. Azimov, M.V. Danilov, V.A. Khoze, and N.G. Ural'tsev for helpful discussions. Figures 7; References 32: 7 Russian, 25 Western.

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UDC 539.126

## LOW-ENERGY PHYSICS OF MESONS ACCORDING TO SUPERCONDUCTIVITY-TYPE QUARK MODEL

Moscow FIZIKA ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA in Russian Vol 17, No 3, May-Jun 86 pp 433-471

[Article by M.K. Volkov, Joint Institute of Nuclear Research]

[Abstract] Construction of phenomenological meson Lagrangians on the basis of 4-quark interaction according to a superconductivity-type model is outlined, these Lagrangians describing the low-energy physics of mesons more accurately than the quantum chromodynamics. One method of their construction involves the MIT-bag according to T. Goldman and R.W. Haymaker, but takes also into account spontaneous breaking up of chiral symmetry. With the effective 4-quark interaction have been constructed Lagrangians for scalar and pseudoscalar nonets of the  $\sigma$ -model and have been calculated the masses of these nonets, breaking of chiral symmetry transforming light current quarks into heavy constituent quarks. It has also been applied to s-quarks, to vector and axial-vector mesons, to electromagnetic interactions, and to vectorial dominance. Low-energy processes thus describable include  $\pi \rightarrow A_1$  transitions of d-quarks,

$\omega \rightarrow 2\pi$  decay, strong and electromagnetic or radiative decays of mesons,  $\pi\pi$ -scattering, and  $\pi K$ -scattering. Parameters of  $\pi$ -mesons and  $K$ -mesons determined both theoretically and experimentally include their electromagnetic radii, electric polarizability, and magnetic polarizability. The agreement is close, but the model is still quite incomplete and in need of refinement. Figures 10; tables 7; references 59: 28 Russian, 31 Western (2 in Russian translation).

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LIBERATION REACTIONS OF NUCLEONS AND CLUSTERS BY INTERMEDIATE-ENERGY PHOTONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian, Vol 50, No 5, May 86 pp 916-922

[Article by V.I. Ostroumov, I.I. Loshchakov, and A.I. Vdovin]

[Abstract] This study analyzes the results of investigations of liberation reactions of nucleons ( $p$ ,  $pN$ ) and clusters ( $p$ ,  $pX$ ) from light nuclei  $A=6-16$  caused by protons with energies of 30-100 MeV. The possibilities of using  $t$ -matrix approximation with distorted waves--termed the DWETA approach--for describing these reactions are analyzed. The DWETA theory describes the liberation reactions of nucleons and clusters by protons with energies smaller than 100 MeV satisfactorily. Figures 6, references 30: 14 Russian, 16 Western.

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UDC 539.171

ALLOWANCE FOR COLLECTIVE NUCLEON MOVEMENT IN DESCRIBING ELECTRON SCATTERING BY  $^{18}\text{O}$  AND  $^{18}\text{Ne}$  NUCLEI

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 50, No 5, May 86 pp 953-958

[Article by A.I. Steshenko, Institute of Theoretical Physics, Ukrainian SSR Academy of Sciences]

[Abstract] This study extends earlier work by the author on the electronic form-factors of near-magic nuclei within the framework of the minimal

approximation of the generalized hyperphoric function method for the  $^{18}\text{O}$  and  $^{18}\text{Ne}$  mirror atomic nuclei. A study is made of the scattering of electrons by those nuclei in an elastic, as well as certain inelastic channels, corresponding to nuclear transition from the fundamental state to one of the excited states of the main rotation band. Tables 2, figures 2, references 8: 6 Russian, 2 Western.

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#### SUBTHRESHOLD GENERATION OF $K^+$ -MESONS ON MULTIQUARK CLUSTERS IN NUCLEI

Moscow YADERNAYA FIZIKA in Russian Vol 44, No 2(8), Aug 86 (manuscript received 11 Sep 85) pp 517-524

[Article by B.Z. Kopelovich and F. Niedermeier, Joint Institute of Nuclear Research]

[Abstract] Generation of  $K^+$ -mesons on multiquark clusters at energy levels below the threshold is examined, with the nucleus either breaking up or not. The analysis, in the nonrelativistic approximation, is based on inelastic collision of a proton and multiquark cluster according to the model of color tubes. The probability of nucleons coming sufficiently close for formation of a multiquark cluster in heavy nuclei is determined, no data being available on light nuclei, whereupon the cross-section for generation of  $K^+$ -mesons and the attendant energy release are calculated for comparison with experimental data on C and Pb nuclei. Despite the accuracy of this analysis, it does not yet definitively explain the role of multiquark clusters in generation of  $K^+$ -mesons. The authors thank R.Kh. Kutuyev for participating in computer-aided calculations, also V. Koptev and L.I. Lapidus for helpful discussions. Figures 3; references 7: 2 Russian, 5 Western.

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#### PHOTON EMISSION BY ELECTRON IN RADIATION-DOMINATED UNIVERSE

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 29, No 9, Sep 86 (manuscript received 24 Aug 84) pp 96-100

[Article by I.L. Bukhbinder and L.I. Tsaregorodtsev, Tomsk Pedagogical Institute imeni Lenin Komsomol]

[Abstract] The process of photon emission by an electron in a curved space-time continuum with a metric corresponding to radiation domination (standard

model of the universe) is analyzed, by extension of the S-matrix theory for quantum electrodynamics in an external electromagnetic field to quantum electrodynamics in external gravitational fields. Spinor electrodynamics in such a continuum and the corresponding Lagrangians are formulated accordingly, whereupon Fock spaces of initial and final states of the fermion field are constructed with the aid of solutions to the corresponding Dirac equation. The process of photon emission by an electron in a gravitational field being a phenomenon of first order with respect to radiative interaction, the amplitude of its probability and the spectral distribution of its relative probability are calculated for the two extreme cases of soft and stiff photons. In the first case there is found to be no infrared divergence and in the second case the probability of photon emission is found to decrease fast with increasing photon energy, photon emission in a flat space being altogether precluded by laws of conservation. A special case is emission of soft photons by a nonrelativistic electron, which in the process loses much of its energy. The results indicate that the total probability of photon emission by an electron is always finite. References 17: 8 Russian, 9 Western (2 in Russian translation).

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