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UDC 534.232

Thermooptic Generation of Sound by Semicoherent Light Pulse

18620062a Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33 No 5, Sep-Oct 87 (manuscript received 9 Sep 86) pp 785-791

[Article by V. A. Aleshkevich, V. Ya. Gayvoronskiy, and A. N. Matveyev, Chair of Physics, Moscow State University imeni M.V. Lomonosov]

[Abstract] With excitation of a sound pulse by a strong laser pulse described by a nonhomogeneous wave equation for pressure perturbation, in the linear approximation, the effect of laser semicoherence on the average space-time distribution and the fluctuations of sound pressure is analyzed on the basis of the space-time correlation function. In determining the latter the statistics of optic-to-acoustic energy conversion by the thermooptic mechanism in a radiation-absorbing medium which fills a half-space with a free or rigid boundary are taken into account. Calculations, carried out using the similitude parameters relating duration of a light pulse and the characteristic time of sound pulse propagation, have yielded sound radiation energy-density patterns for cylindrical and spherical optic-to-acoustic conversion spaces together with the kinetics of sound pressure fluctuations in a geometrically simpler plane-parallel optic-to-acoustic conversion space and the dependence of the fluctuation dispersion on the degree of temporal noncoherence of light. Figures 4; references 9: 8 Russian, 1 Western.

2415/08309

UDC 534.24

Decay Law for Noncoherent Acoustic Field in Ocean With Rough Surface

18620062b Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33 No 5, Sep-Oct 87 (manuscript received 18 Nov 86) pp 814-820

[Article by A. V. Belousov and Yu. P. Lysanov, Institute of Acoustics imeni N.N. Andreyev, USSR Academy of Sciences]

[Abstract] Propagation of the noncoherent component of an acoustic field, from an isotropic monochromatic point source immediately below a turbulent ocean surface through an oceanic channel underneath that surface, is treated as a problem of field decay in accordance with the radiation transfer theory. The channel is characterized by a depthwise increasing velocity of sound, the latter ceasing to increase at the lower channel boundary and either remaining constant or decreasing depthwise below it. The ocean bed is assumed to be perfectly absorbing so that no energy enters the channel from below. An integral equation is derived for the intensity of noncoherent sound as a function of the horizontal distance from the source to a point at which sound will be picked up after reflection and sliding. This equation includes two terms accounting for coherent reflection with attendant energy transfer from the coherent field component to the noncoherent one, the corresponding reflection coefficient being either measurable experimentally or calculable approximately from the solution to the problem of single scattering. The scattering coefficient is calculated on the assumption of a random surface turbulance with a zero mean deviation from the quiescent sea level, a smaller than unity Rayleigh parameter, and a Gaussian correlation coefficient. Figures 3; references 11: 8 Russian, 3 Western.

2415/08309

UDC 551.463.2

Statistical Characteristics of Sound Scattering in Ocean

18620062c Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33 No 5, Sep-Oct 87 (manuscript received 18 Dec 86) pp 927-929

[Article by V. A. Mozgovoy, Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences]

[Abstract] For an experimental study of bulk sound scattering in the ocean, measurements by the tonal pulse method with bathymetric sound equipment were made in summer 1983 in the Pacific Ocean, within the northeastern section of its tropical zone, during the sixth voyage of the Scientific Research Ship "Academician Mstislav Keldysh."; The measuring apparatus included an annular piezoceramic transmitter and a spherical piezoceramic receiver. Tone pulses containing packets of 10 waves each were transmitted at a repetition rate of 1 Hz, tests being performed with 2.2, 4, 8, 16 kHz wave packets. The transmitter-receiver set was placed horizontally inside and outside various sound-scattering layers, and 300-400 signals were recorded at each location at each of the four frequencies. The data have been processed on a ship computer, with the scattering volume treated as an expanding spherical layer, for a determination of vertical scattering profiles and scattering distribution statistics. Figures 4; references 6: all Russian.

2415/08309

UDC 535.241

Characteristics of Surface Acoustic Wave Excited by Moving Laser Beam

18620060b Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33 No 6, Nov-Dec 87 (manuscript received 17 Feb 87) pp 1035-1040

[Article by Ye. V. Danshchikov, V. A. Dymshakov, A. M. Dykhne, F. V. Lebedev, and B. P. Rysev]

[Abstract] An experimental study of surface acoustic waves excited on solid materials by a laser beam scanning the solid surface was made, with measurement of

the wave parameters by the absolute method while the laser beam was moved over the surface at the velocity of that wave. A copper plate with dull surface finish and a 0.10-0.20 absorption coefficient was treated by a GOS-1001 Nd-laser operating in the free-emission mode, its active element having been placed in an unstable cavity with beveled ends. The light spot was moved over the surface by means of a rotating plane mirror with high precision, the travel distance being regulated by means of slidable mirrors and not exceeding 75 mm. The radiation energy and power were regulated by regulation of the pumping energy. The intensity distribution over the spot, a 0.1 mm wide and 10 mm long tranverse strip was regulated by rotation of a focusing lens, the intensity peak reaching 2 MW/cm^2. The results revealed a surface deformation under such a wave including negative displacement, evidently owing to diffraction. A theoretical analysis of this phenomenon with the aid of Fourier and Laplace transformations confirms its occurrence, specifically when light spot and surface acoustic wave travel at the same velocity. Figures 5; references 7: all Russian.

2415/08309

UDC 537.23

Acoustic Effect of Fine Structure of Sound Velocity Field in Ocean
18620060c Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33 No 6, Nov-Dec 87 (manuscript received 24 Feb 87) pp 1079-1082

[Article by Yu. P. Lysanov and A. M. Plotkin, Institute of Acoustics imeni N.N. Andreyev, USSR Academy of Sciences]

[Abstract] The fine structure of the sound velocity field and its effect on the convergence zones during ocean sensing are analyzed on the basis of numerical calculations made by the ray method of geometrical acoustics and the wave method of physical acoustics. Perturbations of the velocity profile above the underwater acoustic channel were simulated by a multistep structure consisting of typically eight 25-100 m thick layers with relatively small velocity gradients separated by 3-10 m thick interlayers with 1.5-20 times larger velocity gradients, the velocity profile remaining unperturbed below that channel. The results, which reveal shifting of the first convergence zone in one direction only with a maximum shift of approximately 400 m at a 200 m depth, are interpreted in terms of constructive interference. The fine structure of the sound velocity field, accordingly, widens a convergence zone by shifting its front boundary toward the sound source and its rear boundary farther away. Figures 5; references 7: 6 Russian, 1 Western (in Russian translation).

2415/08309

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Generation of Sound in Solid Body by Moving Radiative Thermoacoustic Pulse Source
18620060d Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33 No 6, Nov-Dec 87 (manuscript received 16 Jun 87) pp 1083-1090

[Article by L. M. Lyamshev and B. I. Chelnokov, Institute of Acoustics imeni N.N. Andreyev, USSR Academy of Sciences]

[Abstract] Generation of sound in an isotropic and homogeneous solid body of arbitrary shape by normally incident thermoacoustic pulses of arbitrary duration from a radiative source moving above the solid surface is analyzed, assuming a Gaussian radiation beam and an exponential decrease of radiation absorption along the path. The equations for both scalar and vector displacement potentials in the acoustic field generated by penetrating thermal radiation are solved, with the aid of Fourier transforms, first for uniform linear motion of the radiation source above the radiation spot on the solid surface, then also for periodic oscillatory motion and uniform circular motion of both. The radiation intensity is in each case either held constant or quasi-monochromatically modulated at an acoustic frequency within the pulse, the modulation period being much shorter than the pulse duration and than the oscillation period or the circulation period in the respective two cases. Modulation is found not to change the characteristics of the acoustic field in Cerenkov directions. References 5: all Russian.

2415/08309

UDC 551.463

Frequency Spectrum of Probing Acoustic Signals Scattered by Sea Ripple
18620060a Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33 No 6, Nov-Dec 87 (manuscript received 4 Oct 86) pp 1024-1030

[Article by N. S. Gorskaya and M. A. Rayevskiy, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] The frequency spectrum of the acoustic field recorded in an oceanic waveguide upon scattering of a monochromatic sound wave by an anisotropically turbulent sea surface is analyzed, for a determination of its dependence on the waveguide profile as well as on the mode of signal transmission and reception. The monochromatic acoustic point source is assumed to remain stationary within the waveguide, the latter being partly or completely open above. Calculations are based on resolution of the acoustic field into normal waveguide modes, assuming a quiescent upper waveguide boundary

and a Rayleigh parameter less than unity. These calculations have yielded not only the frequency spectrum of signals picked up at various depths and vertical profiles of the acoustic velocity as well as the mode transformation coefficient but also the dependence of the spectrum asymmetry factor on the angle between the direction of wave propagation and the direction of ripple propagation. Reception of acoustic signals above an oceanic shelf is considered as a special case. The results indicate that oceanic ripples can be diagnosed by acoustic probing. Figures 4; references 10: all Russian.

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UDC 534.231.1:551.463

Ambient Noise Field in Randomly Nonhomogenous Ocean

18620060f Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33 No 6, Nov-Dec 87 (manuscript received 14 Jan 87) pp 1105-1111

[Article by A. A. Moiseyev, Institute of Oceanology imeni N.N. Andreyev, USSR Academy of Sciences]

[Abstract] The ambient noise field in a horizontally nonhomogeneous ocean, with random fluctuations of the refractive index representing a random distribution of large-scale three-dimensional inhomogeneities produced by internal waves, is analyzed on the basis of wave theory in the Markov approximation. The space coherence function is determined accordingly for any spectral component of the noise field. The ocean is treated as a largely laminar, medium of constant depth and the noise field is assumed to satisfy the Helmholtz equation. Analytical calculations indicate that randon ocean inhomogeneities distort the ambient noise field only when they significantly alter the quiescent modal distribution of the noise energy. This is confirmed by numerical calculations pertaining to a noise field which delta-correlated sources on the surface produce in an ocean with a canonical vertical sound velocity profile and with an internal Garret-Manck wave field which causes fluctuations of the refractive index. Figures 4; references 11: 9 Russian, 2 Western (1 in Russian translation).

2415/08309

UDC 551.463.2

Variability of Characteristics of Oceanic Sound-Scattering Layers

18620060e Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33 No 6, Nov-Dec 87 (manuscript received 6 Jan 87) pp 1101-1104

[Article by V. A. Mozgovoy, Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences]

[Abstract] For an experimental study of oceanic sound-scattering layers, measurements by the tonal pulse method with bathymetric sound equipment were made in spring 1986 on the Indian Ocean within its central region, during the eleventh voyage of the Scientific Research Ship "Academician Mstislav Keldysh." The underwater probing apparatus, a hermetic container with an annular piezoceramic transmitter and a spherical piezoceramic receiver, was dropped to various levels within and beyond sound-scattering layers. Tone pulses containing packets of 10 waves each were transmitted at a repetition rate of 1 Hz, tests being performed with 4, 5, 8, 10 kHz wave packets and 120-400 signals being recorded at each location at each of the four frequencies. The data have been processed on a ship computer, with the scattering volume treated as a spherical layer of a 15-80 m radius and correspondingly 10^4-10^5 m^3 large. This procedure, intermediate between those followed in local probing and in remote sensing, has yielded information about the space-time variability of characteristics of sound-scattering layers, specifically diurnal variations of vertical layer "thickness" and geographical location in terms of latitudinal and longitudinal coordinates. Figures 2; tables 1; references 14: 5 Russian, 9 Western.

2415/08309

Argon-Xenon Electroionization Power Laser With 25-50 gmrad Beam Divergence

18620042a Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 9, Sep 87 (manuscript received 14 Jul 86) pp 1739-1747

[Article by N. G. Basov, V. V. Baranov, V. A. Danilychev, A. Yu. Dudin, D. A. Zayarnyy, D. G. Merkulov, A. V. Romanov, L. V. Semenova, N. N. Ustinovskiy, I. V. Kholin, and A. Yu. Chugunov, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] The feasibility of a nondivergent high-intensity beam from an Ar-Xe laser emitting radiation at the 1.73 um wavelength with either electron-beam or electric-discharge pumping is evaluated on the basis of an experiment and theoretical analysis. The radiation distribution in the near field and in the far field is calculated for an estimate of the minimum attainable beam divergence. The experiment was performed in the TANDEM facility with the active medium, an Ar:Xe = 80:1 mixture under a pressure of 4 atm, occupying a volume of 10 dm^3 and delivering an energy of 8 J/dm^3. The length of the cavity was held constant at approximately 6 m, while its magnification M = F/f (F - focal length of concave mirror, f - focal length of convex mirror) was varied from 2 to 6. With electron-beam pumping from an Arkadyev-Marx generator, beam energy up to 350 keV and cross-section 10x100 mm^2, a laser beam with a divergence as small as 25 gmrad was obtained at half the maximum output energy level. With electric-discharge pumping, a laser beam was obtained with a divergence of 50 gmrad at maximum output energy level and with approximately diffractional divergence of 30 gmrad at maximum output energy level. The maximum efficiency of this laser was 3.2 percent. Figures 7; references 10: 6 Russian, 4 Western (1 in Russian translation).

2415/9604

Efficient Intracavity Second-Harmonic Generation in Miniature Solid-State Lasers With Semiconductor Pumping

18620042b Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 9, Sep 87 (manuscript received 11 Jul 86) pp 1748-1753

[Article by S. A. Baryshev, S. A. Belozerov, V. I. Bilak, A. A. Ioltukhovskiy, I. I. Kuratev, A. V. Semenenko, and Yu. V. Tsvetkov]

[Abstract] Second-harmonic generation by intracavity frequency doubling is analyzed on the basis of experimental data and their theoretical interpretation, a continuous-wave YAG:Nd^{3+} or LNP solid-state laser serving as primary source transversely pumped by spontaneously light-emitting diodes or longitudinally pumped by an injection laser. An experiment was performed with a milliwatt YAG:Nd^{3+} laser transversely pumped by a linear array of mesa diodes and with a $Ba_2NaNb_5O_{15}$ crystal as frequency-doubling nonlinear element. Maximum efficiency of second-harmonic generation was found to be attainable with single-mode emission of linearly polarized radiation by the main laser. Continuous-wave emission at wavelengths gl_1 = 1.06 gmm or gl'_1 = 1.32 gmm was obtained with the output power reaching 120 mW and 100 mW respectively, in cavities formed by spherical mirrors with radii r_1 = 1.5 m or r'_1 = 1 m respectively and the exit mirror having a transmission coefficient T_1 = 0.7 or T'_1 = 0.3 respectively. Maximum second-harmonic output power, at wavelengths gl_2 = 0.53 gmm or gl'_2 = 0.66 gmm, was obtained in a 12 cm long cavity formed by two spherical mirrors with radii r_o = 18 cm and r_e = 150 cm. For a theoretical interpretation of the data, resonant absorption of fundamental radiation by Nd^{3+} ions is taken into account in the expression for second-harmonic output power. The results reveal that longitudinal pumping by an injection laser is much more efficient than transverse pumping by light-emitting diodes, with the main laser typically operating in the TEM_{00}-mode. An analysis of the data and further estimates indicate the possibilities of designing such a source of green coherent light in miniature size for maximum efficiency and long life. Figures 5; references 15: 8 Russian, 7 Western.

2415/9604

Visible and Near-Infrared Chemical Exchange Lasers Operating at the Electron Transitions in Halogen and Interhalogen Molecules

18620042c Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 9, Sep 87 (manuscript received 30 Oct 86) pp 1754-1771

[Article by N. G. Basov, V. F. Gavrikov, and V. A. Shcheglov, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] The feasibility of visible and near-infrared lasers activated by the EE-exchange mechanism in halogen molecules (F_2,$C1_2$,Br_2,I_2) and in interhalogen molecules (C1F,C1Br,CI,BrF,BrI,FI) with involvement of metastable donor radicals forming during fast chemical reactions is analyzed on the basis of relevant molecular properties and process characteristics. To the list of most suitable donor molecules, those of A^VB^I compounds (A = N,P,As,Sb,Bi and B = H,D,F,C1,Br,I), are PbO and O_2 molecules. The list of 10 chemical reactions includes one of the NF_2 radical with an alkali metal (Li,Na,K,Rb,Cs). The laser performance characteristics, specifically gain and maximum attainable efficiency, are estimated on the basis of reaction thermodynamics and kinetics, spectroscopic considerations, and threshold inverse-population density. As two examples of such lasers are proposed a (NF-I_2)-laser on the I_2(B [leads to] X) transition and a (NF-IF)-laser on the B^3II_0+ [leads to] X^1gS^+ transition, both pulsed lasers in the visible range. The authors thank V. S. Zuyev, L. D. Mikheyev, P. G. Kryukov, M. P. Frolov, and N. N. Yuryshev for interest and valuable comments. Figures 2; tables 13; references 42: 7 Russian, 35 Western.

2415/9604

New Class of Chemical Lasers Operating At Electron Transitions With Chain Excitation Mechanism

18620042d Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 9, Sep 87 (manuscript received 30 Oct 86) pp 1772-1785

[Article by N. G. Basov, V. F. Gavrikov, S. A. Pozdneyev, and V. A. Shcheglov, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] A new class of chemical lasers operating at the electron transitions of atoms or molecules is proposed, electron states being excited by chain-reaction oxidation in the presence of a catalyst:

$K(K^*) + P - O \xrightarrow{k1}$ [leads to] $KO(KO^*) + P + E_1(E_1^*)$
$KO(KO^*) + F \xrightarrow{k2}$ [leads to] $K^*(K) + F - O + E_2(E_2^*)$
$P - O + F \xrightarrow{k3}$ [leads to] $P + F - O + E_3$

Here O denotes an O,S,Se,Te or F,Cl,Br,I atom or radical, F denotes a fuel atom or molecule, P - O denotes an oxidizer molecule or radical, F - O denotes the end product, E_1,E_2,E_3 denotes released energy, and * denotes electron excitation. Four possible schemes of chain reaction are considered: 1) lasing directly at the transitions of intermediate products (K,KO), 2) lasing by electrons in acceptor excitable in a quasi-resonant exchange process, 3) selective "chemical lamp" for optical pumping of solid, liquid, or gaseous medium by spontaneous radiation from K* or KO*, 4) chemical excimer laser on the basis of recombination reaction $K^*(KO^*) + X + Y$ [leads to] $KX^*(KOX^*) + Y$ (X denoting an atom of noble gas). Available fuels and catalysts are evaluated for suitability, catalysts being classified into a) elements in groups I, III, VII with equal spins in ground state and in lower excited electron states, b) elements in groups II, V with different spins in ground state and in lower excited electron states, c) elements in groups IV, VI with different levels of lower excited electron states in which the spin is either the same as or different than the spin in the ground state. Basic performance characteristics of the corresponding four devices, gain and emission power density, are estimated on the basis of theoretical relations and specific numerical data. Tables 6; references 24: 11 Russian, 13 Western.

2415/9604

Collisional Quenching of Levels in Laser With Nuclear Pumping in Cd Vapor

18620047 Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 13 No 18, 26 Sep 87 (manuscript received 6 Jun 86, in final version 28 Nov 86) pp 1139-1143

[Article by A. I. Miskevich, Moscow Institute of Engineering Physics]

[Abstract] Additional quenching of both $5d^2D_{5/2,3/2}$ and $6p^2P^0_{3/2,1/2}$ laser levels in a Cd II ion by collisions with He atoms was discovered in an experiment with nuclear pumping of a He-Cd mixture under pressures not lower than 0.5 at abs, these levels being quenched at rates comparable with or higher than the rates of spontaneous transitions. The inversion for $4f^2F^0_{7/2,5/2}$—$5d^2D_{5/2,3/2}$ transitions and the gain increased as a result, while the inversion for $6p^2P^0_{3/2,1/2}$—$6s^2S_{1/2}$ Cd II transitions decreased and the threshold neutron flux density increased. A likely mechanism of such quenching is the reaction $(Cd^+)^* + He + e \xrightarrow{k12}$/[forms and is formed from]$_{k21}$ $He^m + Cd + gDE$ (* denoting an excited state, ^{m} denoting a metastable state, $gDE = E_1 - E_2$ energy difference between Cd II ion and He* atom), a He-Cd active medium with nuclear pumping constituting a recombination-nonequilibrium plasma with Cd^+,Cd_2^+,He^+,He_2^+ content. An analysis of both the forward quenching reaction and the reverse Penning reaction on the basis of available thermodynamic and kinetic data yields a close agreement with experimental data when this collisional quenching effect is taken into account. Figures 1; references 8: 4 Russian, 4 Western.

2415/9604

Laser-Fluorescent Detection of Sparse Atoms of Metals in Graphite Cuvette

18620054a Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 47 No 4, Oct 87 (manuscript received 30 Oct 86) pp 563-568

[Article by N. V. Bodrov, T. Ye. Dobrova, A. M. Nemets, S. V. Oshemkov, and A. A. Petrov]

[Abstract] An experimental study was made concerning detection of sparse atoms of metals in a graphite cuvette by laser-induced fluorescence, a graphite cuvette being eminently suitable for electrothermal atomizers but the conventional atomic-absorption method not being sufficiently sensitive to very low atom concentrations. Dye lasers operating in the pulsed emission mode, pumped by an N_2-laser or with second-harmonic radiation from a YAG:Nd^{3+} laser and tuned to the absorption line of a given metallic element by means of an appropriate monochromator were used as the excitation sources. Concentrations of Pb atoms and of Cr atoms were measured in this way, the cuvette being lined with Ta foil for measurement of the Cr atom concentration. Since the concentration of metal vapor and thus also the intensity of its fluorescence depend not only on the power density of incident laser radiation but also on the temperature of the cuvette, that temperature was held constant within one degree centigrade and the laser power was held constant within the linear range below saturation so as to maximize the signal-to-noise ratio. The detection threshold of this method was found to be 10^4-10^5 atoms/cm^3 and thus 4-6 orders of magnitude lower than that of the atomic-absorption method based on determining the temperature dependence of saturated-vapor pressure. Figures 4; references 13: 12 Russian, 1 Western.

2415/9604

Dye-Activated Epoxy-Polymer Lasers

18620054b Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 47 No 4, Oct 87 (manuscript received 5 Dec 86) pp 569-573

[Article by T. B. Bermas, Yu. S. Zaytsev, Yu. V. Kostenich, M. K. Paktar, Yu. M. Paramonov, A. N. Rubinov, A. Yu. Smirnov, and T. Sh. Efendiyev]

[Abstract] New tunable solid-state laser media are reported, an epoxy-polymer compound with various activator dyes (rhodamine 6G, rhodamine C, oxazine 17) dissolved in the compound at temperatures of 60-90 degrees centigrade prior to hardening of the compound at temperatures of 100-140 degrees centigrade. Their luminescence spectra and emission characteristics, inside a nonselective cavity and inside a distributed-feedback laser laser cavity, were measured and compared with those of a similarly activated epoxy-oligomer compound and those of the same dyes in ethanol solution. The results indicate high efficiency and quantum yield, 50-67 nm wide tuning bands within the 554-672 nm range of wavelengths depending on the activator dye, as well as high stability of refractive index and emission wavelength during temperature changes. The authors thank A.G. Morozov and V.Ye. Polyakov for assistance. Figures 2; tables 1; references 8: all Russian.

2415/9604

Measurement of Efficiency of Nuclear-to-Luminous Energy Conversion in Xe Plus Hg and Kr Plus Hg Mixtures

18620054c Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 47 No 4, Oct 87 (manuscript received 3 Jul 86) pp 652-656

[Article by G. A. Batyrbekov, E. G. Batyrbekov, A. B. Tleuzhanov, and M. U. Khasenov]

[Abstract] In a study of laser media such as gaeous Xe plus Hg or Kr plus Hg mixtures with nuclear pumping, the ratio of luminous output power to nuclear input power was measured for emission at the Hg triplet line. The mixtures were pumped with alpha particles from ^{210}Po sources, 18 of them with a total activity of $1.8 \cdot 10^{10}$ Bk inside a chamber with walls of stainless steel. The efficiency of energy conversion had been found to depend on the input power but not on the kind of ionizing particles. Emission spectra were recorded through an SPM-2 monochromator with a quartz prism and an FEU-106 photomultiplier-counter. The conversion efficiency was determined on the basis of comparison with calculated efficiency of luminescence of an Ar plus N_2 mixture in its emission bands as reference. Figures 1; references 17: 13 Russian, 4 Western.

2415/9604

Automatic Tunable LiF Crystal Laser 'Malsan-201' With Radiatively Induced Color Centers

18620054d Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 47 No 4, Oct 87 (manuscript received 27 Feb 87) pp 682-685

[Article by T. T. Basiyev, F. V. Karpushko, S. M. Kulashchik, S. B. Mirov, V. P. Morozov, V. S. Motkin, N. A. Saskevich, and G. V. Sinitsyn, Institute of Physics, BSSR Academy of Sciences, Minsk, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] The automatic laser "MALSAN-201" is a tunable LiF crystal laser, one with F_2 [leads to] F_2^+ color centers induced by second-harmonic (530 nm wavelength) radiation and one with F_2^- color centers induced by fundamental (1060 nm wavelength) radiation from a pumping laser. The active elements, LiF crystals cut along their crystallographic axes, are respectively 90 mm and 40 mm long. Synchronous emission is possible with independent tuning within the two bands. The emission efficiency is maximized by means of additional focusing with interchangeable prism telescopes. Other accessories include a KDP crystal converting the frequency for second-harmonic emission, a Fabry-Perot interferometer inside the cavity for narrowing the emission spectra and narrowing the emission lines, an integrated He-Ne laser with a set of diaphragms for automatic or manual alignment and stability monitoring, also a DVK-2 interactive control computer with a CAMAC crate. The laser performance characteristics are: tuning range 840-1100 nm with F_2^+-centers (second harmonic 420-550 nm) and 1090-1240 nm with F_2^--centers (second harmonic 545-620 nm), maximum efficiency 15 percent with 25 MW pumping power at the 1060 nm wavelength, and pulse duration 5-30 ns with repetition rate of 12.5 Hz. This laser is the first of its kind operating at room temperature. Further improvements under consideration are replacement of the KDP crystals with KTP crystals or with frequency conversion by stimulated Raman scattering in $Ba(NO_3)_2$ or $KGd(WO_4)_2$ crystals for higher efficiency and wider tuning range of second-harmonic emission, also replacement of the DVK-2 computer with an integrated minicomputer. Figures 2; tables 1; references 4: all Russian.

2415/9604

Acoustooptic Q-Switching of (Gd-Sc-Ga):Cr:Nd Garnet Laser Pumped at High Energy Level

18620052 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 296 No 2, 1987 (manuscript received 16 Jun 86) pp 335-337

[Article by Ye. V. Zharikov, Yu. D. Zavartsev, M. Yu. Nikolskiy, Academician A. M. Prokhorov, P. A. Studenikin, A. F. Umyskov, and I. A. Shcherbakov, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] An experimental study of a (Gd-Sc-Ga):Cr^{3+}:Nd^{3+} garnet laser pumped by an INP-6-90

xenon lamp was made, for a determination of its performance characteristics in the free-emission mode and in the Q-switching mode. The active element, a cylindrical crystal 8 mm in diameter and 100 mm long, was placed inside a 260 mm long cavity between a spherical high-reflectance mirror and a plane variable-transmittance exit mirror. High-energy pumping pulses of 150 microsecond duration, whether single or in trains with up to 10 kHz repetition rate, generated emission pulses of 1 J energy (differential efficiency 5.4 percent, transmission coefficient of exit mirror T = 0.7). Lengthening their duration to 1.5 millisecond raised the emission threshold to 95 J (differential efficiency 7 percent, transmission coefficient of exit mirror T = 0.9), while raising their energy to 400 J raised the energy of emission pulses to 20 J. With an MZ-301 acoustooptic Q-switch, in a 350 mm long cavity, the emission pulse energy did not decrease as the modulation frequency was varied over the 0-250 kHz range. Figures 3; references 4: all Russian.

2425/9604

Luminous Heating and Detonation in Metal Capillaries

18620064 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 297 No 5, 1987 (manuscript received 29 Oct 86) pp 1119-1122

[Article by V. V. Kondrashov, K. A. Krivoruchko, V. P. Reshetin, and R. I. Soloukhin, corresponding member, USSR Academy of Sciences]

[Abstract] The main problem in laser-beam cutting and welding of metals, namely attainment of sufficiently deep beam penetration, is analyzed with the aid of gasdynamic theory and numerical simulation of processes occurring in a metal capillary through which a thin laser beam propagates. Since laser radiation and gaseous plasma interact here quite differently than upon incidence of a wide beam on a plane target, the simulation is based on another physical model: luminous heating and detonation by CO_2-laser radiation pulses of microsecond duration at the bottom of a narrow cavity, where they vaporize the metal and ionize the vapor into a gaseous plasma which will fill the cavity and become opaque while the pressure drops. Propagation of coherent light is described in the parabolic approximation, allowing for absorption of light by the walls. The applicable gasdynamic equations are solved by the method of large particles, assuming diffusional transfer of intrinsic radiation in quanta of two energy bands. This analysis reveals two kinds of subsonic heat waves, first one without any pressure gradients behind the shock front under pressure above 0.1 atm and then a luminous detonation wave with rarefaction behind the plasma front under pressure lower than 0.1 atm. The authors thank S.A. Zhdanek, L.A. Bolshov, D.D. Malyuta, and A.Yu. Sebrant for helpful discussions. Figures 1; references 10: 9 Russian, 1 Western.

2415/9604

Tunable Pulsed Dye Laser With Low Level of Wideband Background Superluminescence

18620059a Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 10, Oct 87 (manuscript received 13 Feb 87) pp 1987-1989

[Article by T. V. Plakhotnik and A. M. Pyndyk, Institute of Spectroscopy, USSR Academy of Sciences, Troitsk (Moscow Oblast)]

[Abstract] A tunable pulsed dye laser set has been built with ethanol solution of rhodamine 6G as active medium and with negligible wideband background superluminescence. The laser oscillator is pumped transversely by pulses of 2 mJ energy and 2.8 MW peak power from a YAG laser at 532 nm, a diffraction grating with 1200 lines/mm serving as dispersive element in the second order and a 13-stage prism telescope increasing the angular dispersion. Wideband background superluminescence is reduced to 5.10^{-4} percent level by special design of the cavity. With an appropriate configuration of plane opaque mirrors, it is broken up into three compartments for the laser oscillator and two successive laser amplifier stages respectively. The common exit mirror for the oscillator and the first amplifier is a semitransparent one. The laser set is tunable over the 560-620 nm range of wavelengths, with a minimum contrast of 1000 throughout. With the efficiency of the oscillator not higher than 0.1 percent but the efficiency of the amplifiers high, an overall efficiency of 20 percent was achieved without minimization of inherently high losses in a multipath rather than straight cavity. Figures 1; references 6: 4 Russian, 2 Western.

2415/9604

Zeeman Laser With Switching of Emission Frequency for Recording Atmospheric Pollutants

18620059b Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 10, Oct 87 (manuscript received 26 Mar 87) pp 1992-1994

[Article by G. I. Kozin, V. V. Petrov, and Ye. D. Protsenko, Moscow Institute of Engineering Physics]

[Abstract] An experimental study of a He-Ne Zeeman laser with periodic switching from one signa component of the active medium to another in a magnetic field was made, for possible use of such a laser for air spectroscopy. Inside the cavity between two spherical mirrors, before the He-Ne tube inside a solenoid there is a polarization selector which consists of a YAG crystal inside a solenoid acting as a Faraday element rotatable through a 45 deg angle each way between a polarization plate and quarter-wavelength plate parallel to the latter. Emission occurs only at one of the two sigma components depending on the direction in which the Faraday element has been rotated, and a reversal results in switching of the emission frequency. Tests were performed with a He-Ne laser emitting radiation at 339.22 nm for neon and with methane, using its P(7) nu_3 line in

the E-band. Switching was done at a frequency of 137 Hz. The power balance of laser emission remained stable within 10^{-2} percent for one hour, the relative unbalance increasing proportionally with the partial pressure of methane in air. This demonstrates the suitability of such a laser for differential air pollution spectroscopy. Figures 2; references 5: 3 Russian, 2 Western.

2425/9604

Hybrid Reactor Based on Laser Fusion

18620059c Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 10, Oct 87 (manuscript received 21 Oct 86) pp 1068-1081

[Article by N. G. Basov, N. I. Belousov, P. A. Grishunin, Yu. K. Kalmykov, I. G. Lebo, V. B. Rozanov, G. V. Sklizkov, V. I. Subbotin, K. I. Finkelshteyn, V. V. Kharitonov, and K. B. Sherstnev, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] The concept of a hybrid inertial fusion reactor operating with laser fusion and producing plutonium for a nuclear power plant as well as electric energy has been developed on the basis of comprehensive comparative physical performance and engineering design analysis of key reactor components. The blanket material should be metallic uranium, less radioactive upon neutron bombardment and therefore more economical than thorium, with a graphite moderator and a liquid-Li lining, between two walls of stainless steel with a layer of 30 percent W + 70 percent Pb on the inside surface of the inner one. The target inside the reactor chamber should be a cryogenic one, most simply deuterium-tritium ice lining the inside of a spherical Be or preferably polymer shell and yielding a gain of close to 100. Most suitable for this application are a CO_2-laser (1060 nm wavelength) or a KrF-laser (248 nm wavelength), with mirrors rather than lenses used for focusing: metallic Al or Mo mirrors with a CO_2-laser (infrared) or multilayer dielectric Al_2O_3, MgF_2 or HfO_2, fused-quartz mirrors with a KrF-laser (ultraviolet). Target acceleration by conventional methods, mechanically, pneumatically, or electrostatically to necessary high velocities will be adequate, as long as uniform irradiation of the target surface is maintained by not allowing excursion of the target center beyond the focal spot. Existing energy conversion systems for operation of steam turbines should be optimized for such a hybrid reactor so as to ensure the best possible tradeoff between cost and efficiency. While metallic uranium with its excellent neutron-physical characteristics is compatible with coolants operating at low temperatures of only 300-400 deg C in plants with only 30-35 percent reactor net efficiency, raising the efficiency to 40-50 percent by operating the coolants at higher temperatures of 600-1000 deg C requires use of other fuel materials such as UC, UO_2, or U_3Si in the blanket. The authors thank V.V. Orlov and G.Ye. Shatalov for helpful critique of proposed blanket designs and of plant cost analysis. Figures 4; tables 3; references 18: 13 Russian, 5 Western (1 in Russian translation).

2415/9604

Effect of Atmospheric Induced-Temperature Fluctuations on Characteristics of Laser Radiation

18620059d Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 10, Oct 87 (manuscript received 24 Jul 86) pp 2098-2107

[Article by V. A. Banakh and I. N. Smalikho, Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] Propagation of continuous-wave laser radiation with thermal self-action through a turbulent atmosphere is described by a parabolic equation and analyzed accordingly, for a determination of its second-order cross-coherence function. Calculations taking into account not only the average profile of the induced temperature but also its fluctuations caused by large-scale random atmospheric inhomogeneities yield a closed equation for this function, which is subsequently solved in the nonaberrational approximation and assuming negligible heat absorption. Finiteness of both space and time correlation scales characterizing wind velocity fluctuations is also taken into account. The results indicate that, as the laser power is increased, first thermal defocusing lengthens the coherence radius but then fluctuations of the induced temperature inhibit its further lengthening and even shorten it further. Numerical estimates have been made on this basis pertaining to the dependence of the coherence radius on the initial coherence and on the length of the propagation path. Figures 6; references 20: 19 Russian, 1 Western (in Russian translation).

2415/9604

Nonequilibrium Processes in Laser Macrokinetics

18620061 Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 12, Dec 87 pp 58-72

[Article by F. V. Bunkin, corresponding member, USSR Academy of Sciences, N. A. Kirichenko, candidate of physico-mathematical sciences, and B.S. Lukyanchuk, candidate of physico-mathematical sciences]

[Abstract] While most mechanisms by which laser radiation can trigger chemical reactions were extensively studied prior to 1977, insufficient attention was paid during that early stage of research to the possibly most trivial, thermal mechanism, and this despite its many promising applications in heat treatment of materials. The few studies that were made dealt with laser-stimulated homogeneous and heterogeneous chemical reactions, revealing that thermochemical laser action is definitely not an isothermal one. Theoretical and

experimental research during the subsequent second stage in the 1977-80 period was much more concerned with that mechanism, from the standpoint of laser macrokinetics and thermodynamics involving infrared radiation as well as heat from visible lasers. This research has yielded a sufficiently large base for focusing on laser macrokinetics in the subsequent third stage from 1981 on. Key factors in laser macrokinetics are selective feedback and nonlinear energy dissipation during laser action on materials, possibly useful for purposes of control, feedback resulting in any of three modes of oscillations: kinetic ones within chemical reaction channels, thermokinetic ones between chemical and thermal degrees of freedom, and trivial relaxation oscillations where either threshold conditions exist or the rate of reaction is higher than that of material intake. The main object of research in laser macrokinetics has been finding new types of selective feedback, lumped or distributed, and new heating modes with more intricate temperature-time characteristics. Practical applications include thermolithography, high-temperature synthesis of compounds in gaseous phase and of ultrafine-disperse refractory powder alloys, case hardening of metals by formation of carbide surface layers, and thermochemical microelectronic durable data recording. Most problems here relate to nonlinear distributed systems, dealing with transition from point systems whose performance parameters are functions of coordinates to distributed ones whose performance parameters are not and in which a solitary active medium has been replaced by an equivalent array of interacting ones. Typical examples of this are found in heat treatment of oxidizing metals in air with a CO_2-laser. Heating of Ti targets by a continuous-wave CO_2-laser was found to cause ignition of the metal and its subsequent combustion at an eventually steady rate, while fast focusing was found to cause randomized combustion of the metal with irregular temperature oscillations. Experiments performed with other metals and numerical calculations based on mathematical models indicate that effects of sublimation and oxidation combine here. They also reveal a doubling of the spatial period caused by nonuniformity of the radiation field within a part of its dynamic range. Another example are helical or even more exotic structures on the surface of V_2O_3 crystals and then melts produced by action of a CO_2-laser on V in an oxidizing-reducing medium. Studies of laser action on gases such as SF_6+ CF_3I and SF_6+ air mixtures have revealed periodic excursions of the radiation-absorbing component from under the laser beam with attendant quasi-periodic power fluctuations. Generally, from the technical standpoint phenomena associated with space-time ordering in chemically active media in a laser radiation field are of interest, and from the mathematical standpoint phenomena associated with self-adaptation in nonlinear media are of interest. Figures 7; references 8: all Russian.

2415/9604

Generation of Subpicosecond Light Pulses in Linear Single-Jet Dye Laser

18620043 Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 13 No 17, 12 Sep 87 (manuscript received 16 Jan 87, in final version 18 Jun 87) pp 1038-1040

[Article by V. L. Bogdanov, B. V. Bondarev, G. D. Rodionov, and V. B. Sorokin, Novosibirsk State University imeni Lenin Komsomol]

[Abstract] Ultrashort light pulses were experimentally generated in a continuous-wave dye laser of simple single-jet configuration with synchronous pumping by an Ar-laser. The active medium was a mixture of rhodamine 6G and DODKI dye, such a laser emitting red light with maximum intensity at the gl_1 = 610 nm wavelength and yellow-green light with maximum intensity at the gl_2 = 570 nm wavelength. Addition of rhodamine 4s perchlorate stabilized the emission of ultrashort pulses, evidently by shifting the maximum-amplification line into the red region toward the maximum-absorption line of DODKI and suppressing emission of yellow-green light. Accordingly, stable emission of pulses as short as 150 fs was attained with maximum intensity at the gl = 613 nm wavelength upon addition of $2 \cdot 10^{-3}$ mol./dm^3 rhodamine 4s perchlorate. Pumping was done by an Ar-laser with mode locking by means of an acoustooptic modulator, its pulses having an average power of 400-500 mW and a frequency instability not greater than 10^{-5} percent. The duration of emission pulses was measured by the method of second-harmonic generation using a KDP crystal. Duration of the pulses as well as emission power and radiation spectrum width were regulated by varying the concentrations of dyes in the mixture. The authors thank S.O. Zontsov and A.V. Karablev for constructing the necessary electronics, and A.A. Apolonskiy for discussions. References 5: 3 Russian, 2 Western.

2415/9604

Emission Spectrum of XeF-Laser Within 350 nm Waveband

18620162 Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 46 No 1, Jan 87 (manuscript received 27 Aug 85) pp 130-132

[Article by I. S. Gorban, N. G. Zubrilin, N. V. Uvarova, M. P. Chernomorets, V. A. Shevchenko, and S. V. Yurchik]

[Abstract] Luminescence of an XeF molecule within the 350 nm waveband was produced in an experiment by electric-discharge pumping of an NF_3:Xe:He = 1:4:40 mixture under a pressure of 0.5 atm. Varying the pressure of the buffer gas revealed a correlation between the intensity of emission lines within this band and within the range of large angular momentum for the 0-2 transition. Calculation of the Fortrat diagram for 1-3 (B—X) and 3-3 (C—X) transitions on the basis of available data pertaining to an "averaged" $^{131.3}Xe^{19}F$ isotope molecule

also yielded four lines in the emission spectrum, corresponding to frequencies gs_1 = 28,565.7 cm^{-1}, gs_2 = 28,543.2 cm^{-1}, gs_3 = 28,522.5 cm^{-1}, gs_4 = 28,500.1 cm^{-1} and attributable to rotations at branches R^j, R^e, P^f, P^e respectively. The corresponding values of the quantum number of the total angular momentum for the upper level and those of the Franck-Condon coefficients indicate, accordingly, that the transitions with these frequencies terminate at extremely high rotational levels of the X-state near the "rotational barrier." They also indicate the possibility of still discrete final states at frequencies gs_1, gs_2 and of states already above the continuous part of the spectrum at frequencies gs_3, gs_4. The marked difference of intensity confirms that B—X transition is the principal contributor to the ultraviolet spectrum of an XeF-laser, while interaction of B and C states can only shift the frequencies with attendant local redistribution of intensity. The authors thank V.V. Khofak for assistance in computations. Figures 2; references 7: all Western (1 in Russian translation).

2415/9604

Generation of RF Currents By Biharmonic Laser Action on Metal Target

18620164 Moscow FIZIKA PLAZMY in Russian
Vol 13 No 3, Mar 87 (manuscript received 16 Dec 85, after revision 9 Apr 86) pp 336-341

[Article by A. A. Antipov, A. Z. Grasyuk, L. L. Losev, A. P. Lutsenko, and Ye. A. Meshalkin, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] An experimental study of laser action on a metal target was made, its purpose being to determine the feasibility of generating RF currents in such a target. Radiation of a two-frequency Nd-laser at the gl = 1.06 gmm wavelength was focused by a lens first onto the surface of a brass target inside an air chamber with dielectric walls and pressure regulation. A power density of 10^9-10^{10} W/cm^2 and thus optical breakdown of air at atmospheric pressure near the target were reached, while metal plasma was produced at the surface and a double electric layer was formed here with subsequent polarization of the plasma and electrization of the metal to the floating potential upon absorption of the laser radiation. The intensity of laser radiation was modulated harmonically, the electron temperature varying correspondingly but the ion temperature not varying as fast and determined by the average laser radiation intensity. Conversion of the single-frequency laser to a biharmonic one was achieved with the aid of stimulated Mandelshtam-Brillouin scattering in two different media, SF_6 and CH_4, which shifted the radiation frequency and modulated the radiation intensity at a frequency of 573 MHz. Such a radiation focused by a lens with 40 cm focal length on a 240 mm long copper tube 5 mm in diameter constituting an electric dipole with a natural frequency of 600 MHz generated a current of this frequency in the latter. An amplifier inductively coupled to the tube, with a gain of 3 dB and a bandwidth of 30 MHz, boosted the current signal for recording on an oscillograph and analysis. The amplitude of this current was found to increase with increasing laser pulse energy and to decrease with increasing gas pressure around the target. Using a lens with longer focus (80 cm) raised the laser pulse energy necessary for generating this high-frequency current, while using a lens with shorter focus (20 cm) did not lower that energy. Single-frequency laser pulses of 50 ns duration did not generate an alternating current in dipole tube. Generation of a high-frequency current does, accordingly, require modulation of the potential difference across the double electric layer at the plasma boundary, at the difference frequency of two light waves. The authors thank Yu.V. Afanasyev for discussing the results. Figures 6; references 15: 13 Russian, 2 Western.

2415/9604

Efficacy and Quality of Phase Conjugation by Confluent Four-Wave Mixing

18620165 Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 51 No 2, Feb 87 pp 347-357

[Article by Yu. A. Arutyunov, V. V. Zherdiyenko, and A. I. Zhizhnyak, Institute of Physics, UkSSR Academy of Sciences]

[Abstract] Phase conjugation by confluent four-wave mixing is considered for laser beams, both efficacy of the nonlinear medium and quality of the reversal depending on the characteristics of the medium as well as on those of the interacting beams. For the purpose of design and performance analysis, this dependence is evaluated theoretically in the approximation of two given pump waves and a weak signal wave. The mathematical model is constructed for long pulses of the incident laser radiation and corresponding transient thermal response of the nonlinear medium behind a semitransparent mirror. The corresponding system of four integrodifferential equations in the slow amplitude approximation has been solved by numerical methods, an analytical solution not being feasible except in the extreme case of a very weak signal wave. The results of calculations indicate that an inert medium with diffusional loss of nonlinear changes in the refractive index should perform adequately, with the space distribution of interacting laser beams and the ratio of their intensities matching different lengths of relaxation time for induced small-scale and large-scale optical inhomogeneities in the medium. Figures 6; references 12: 9 Russian, 3 Western (1 in Russian translation).

2415/9604

Quasi-Continuous Generator of Picosecond Light Pulses With YAG:Nd^{3+} Laser and Frequency Doubling by $KTiOPO_4$ Crystal

18620165 Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 51 No 2, Feb 87 pp 259-260

[Article by D. N. Dovchenko, V. A. Dyakov, V. I. Kuznetsov, V. I. Pryalkin, and A. V. Simonov, Moscow State University imeni M. V. Lomonosov]

[Abstract] A quasi-continuous generator of picosecond light pulses at 1.064 gmm or 0.532 gmm wavelength has been developed, built, and tested. The light source is a YAG:Nd^{3+} laser under continuous pumping which operates either continuously with mode locking or with simultaneous mode locking and Q-switching by means of an acoustooptic modulator, emitting pulses at repetition rates of 1-3 kHz. For efficient frequency doubling of the laser radiation, an 8 mm long KTP crystal with a 4x5 mm^2 aperture is placed between two condensing lenses outside the cavity behind the 84 percent-reflection movable plane exit mirror. The other mirror is a 99 percent-reflection concave spherical one. The modulator is built on a 25 mm high quartz monoblock, draws a microwave power of 30-40 W, and has an 80-85 percent Bragg diffraction efficiency. With pumping pulses of 150 ns duration, the generator delivers an average power of 1.9 W in pulses of 47 ns duration when operating at the gl = 1.064 gmm wavelength and 1.1 W in pulses of 33 ns duration when operating at the gl = 0.532 gmm wavelength. Figures 1; references 2: Russian.

2415/9604

Some Problems of Phase Conjugation in Laser Systems

18620165 Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 51 No 2, Feb 87 pp 330-339

[Article by V. V. Lyubimov, A. A. Mak, and V. Ye. Yashin]

[Abstract] Several problems of phase conjugation in laser systems are analyzed and methods of solving them are described, particularly problems and solutions applicable to glass:Nd^{3+} lasers and phase conjugation by the mechanism of stimulated Mandelshtam-Brillouin scattering. The first problem is accurate correction of smooth phase distortions such as spherical aberration in the wavefront. This is attainable by use of an auxiliary optical element which corrects the index profile typically to a parabolic one and compensates birefringence, residual nonreversed wavefront being best minimized by means of "noise" producing regular phase transparencies such as optical screens. The second problem is phase conjugation at energy levels high above the threshold of stimulated Mandelshtam-Brillouin scattering, which requires shielding against various parasitic nonlinear effects. A successful remedy is splitting the reflection process into two stages, namely first generating a small signal at the Stokes frequency and then amplifying it in the strong pump. The third problem is phasing several laser beams and synthesis of apertures, laser crystal being generally very small because of technological limitations. Most helpful here is automatic phasing during simultaneous stimulated Mandelshtam-Brillouin scattering of several laser beams on a common hypersonic hologram, which does not require phase tracking but requires that the attendant frequency shift not result in an excessively large difference between optical paths in the channels and that the laser beams mix within the interaction space. The latter requirement is satisfied by simultaneous appropriate focusing of several laser beams. Figures 12; references 24: 23 Russian, 1 Western (in Russian translation).

2415/9604

Spatial Structure of Stokes Fields Reflected by Stimulated Mandelshtam-Brillouin Scattering in Lightguide

18620165 Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian
Vol 51 No 2, Feb 87 pp 289-298

[Article by I. Yu. Anikeyev, D. A. Glazkov, A. A. Gordeyev, I. G. Zubarev, A. B. Mironov, and S.I. Mikhaylov]

[Abstract] Amplification and reflection of a Stokes wave in the field of a non-uniform pump wave by stimulated Mandelshtam-Brillouin scattering in a light guide with square cross-section are analyzed theoretically in the approximation of a given pump field and a parabolic equation for the signal field, assuming that the amplitude of each varies slowly and their interaction is monochromatic. The corresponding system of two differential equations with periodically varying coefficients is, by expansion into a transverse Fourier series, reduced to one with constant coefficients. Subsequent incorrect but adequate replacement of the sum with an appropriate integral yields the longitudinal profile of the Stokes wave increment, to which a correction over the correlation length can be added, and the transverse profile of the scattered field in the far region. In an experiment radiation of a single-mode YAG:Nd^{3+} laser (gl = 1.064 gmm wavelength) was amplified by stimulated Mandelshtam-Brillouin scattering in a cell with $TiCl_4$ and from here was passed through a Fresnel rhomb and a Glan prism, for polarization decoupling, into an interferometer with a Mandelshtam-Brillouin mirror. The pumping radiation was split by a semitransparent mirror into two beams, which were reflected by a perfect mirror each onto a common phase plate and from here passed through a biconvex lens in a 1:1 ratio into a light guide containing CS_2. The backscattered Stokes radiation was, after interference on the semitransparent mirror, recorded in two calorimeters: in one after passage through another Fresnel rhomb and a polaroid for polarization decoupling, in the other after passage through a

set of compensating filters to balance the energy loss. The total energy of radiation reflected by the CS_2 cell was, after passage through the same biconvex lens, measured with a third calorimeter. The results of this experiment confirm, within close accuracy, the theoretically calculated energy-gain characteristic of a Stoke wave and radiation pattern of a pump wave in such a system. Figures 6; references 9: all Russian.

2415/9604

Media Suitable for Phase Conjugation of CO_2-Laser Radiation

18620165 Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 51 No 2, Feb 87 pp 280-288

[Article by N. G. Basov, V. I. Kovalev, and F. S. Fayzullov, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] Phase conjugation of infrared radiation by four-wave mixing has been found to be achievable in media with cubical nonlinear susceptibility, where the power reflection coefficient for the signal wave has a quadratic dependence on the susceptibility and an exponential dependence on the total absorption coefficient. Materials with the highest nonlinear susceptibility for most efficient phase conjugation of middle-infrared radiation, including radiation at gl = 10.6 gmm are known to be semiconductors: Ge, InAs, InSb, HgCdTe, also $Hg_{1-x}Cd_xTe$ with x = 0.20-0.23, each characterized by a peculiar nonlinearity mechanism and the maximum four-wave reflection coefficient attainable with each depending also on the product of two constant coefficients which represent respectively the linear and nonlinear components of absorption. These materials were studied experimentally at various temperatures from 77 K to 300 K, with various concentrations of free electrons. Other promising materials are NaCl:SF_6, $K_2S_2O_8$ crystals, semiconductors Si and GaAs, liquids CCl_4, $CHCl_3$, $(C_2H_5)_2O$, $(CH_3)_2CO$, CS_2, and gases BCl_3, CF_2Cl_2, SF_6, NH_3, inverted CO_2. For phase conjugation by stimulated Mandelshtam-Brillouin scattering, not requiring exact opposition of the reference waves and thus preferable to four-wave mixing, Ge, GaAs, As_2S_3, As_2Se_3, $As_{12}Se_{55}Ge_{33}$, CsBr, CsI, $C_2S_2O_8$, liquid I_2, liquid N_2, and gaseous Xe are suitable. Tables 5; references 40: 23 Russian, 17 Western (2 in Russian translation).

2415/9604

Measuring Duration of Ultrashort Pulses by Means of Asynchronous Noncollinear Generation of Harmonics

18620165 Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 51 No 2, Feb 87 pp 261-263

[Article by A. G. Akmanov, A. M. Valshin, L. S. Telegin, and B. G. Shakirov, Bashkir State University imeni 40th Anniversary of October Revolution]

[Abstract] The method of asynchronous noncollinear generation of harmonics for determining the duration and the shape of single ultrashort pulses was tested experimentally on picosecond radiation pulses from a HAG:Nd^{3+} laser with self-locking of modes. Trains of pulses with not more than 15 percent variance were extracted by means of a passive shutter, an isobutanol solution of 3274 dye pumped through the cavity before the 100 percent-R mirror. Second and third harmonics were generated by means of a nonlinear-optics correlator. The latter consisted of a KDP frequency-doubler crystal, a pair of adjacent filters, one extracting second-harmonic radiation and one behind a delay line extracting fundamental radiation, a $LiIO_3$ mixer crystal behind a roof prism (total internal reflection) combining both radiations into third-harmonic one, and another filter this radiation to a photographic film. The spatial distribution of radiation thus recorded corresponded to microdensitograms of the intensity correlation function, indicating the same spatial distribution of radiation energy as recorded upon synchronous generation of harmonics but with the energy of harmonics reduced by three orders of magnitude. In this way pulse durations of 35[plus or minus]3 ps at the half-amplitude level were determined. The method is applicable to pulses of ultraviolet and infrared radiation, also with appropriate conversion factors to Gaussian pulses. Figures 2; references 5: 3 Russian, 2 Western.

2415/9604

Light-Induced Heating of Active Medium in Pulsed CO_2-Laser

18600000k Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62 No 1, Jan 87 (manuscript received 8 Jul 86) pp 136-139

[Article by M. S. Yuryev]

[Abstract] The dynamics of a pulsed CO_2-laser and particularly self-action of its radiation in its active medium are analyzed, induced heating of the active medium tending to degrade its optical characteristics and to widen the space spectrum of radiation emission. Calculations for such a laser operating in the "long pulse" mode with pulses of duration longer than 10 gms are made on the basis of a laser model with two vibrational modes, an asymmetric one and a depleted symmetric deformation mode with VT-relaxation. The system of three equations of three-quantum decay kinetics involving both modes yields the heating dynamics and the dependence of the transient characteristics on the intensity of stimulated radiation emission, considering that the active medium is generally a CO_2:N_2:He mixture. The system of equations is solved for the extreme cases of very short transient periods and very long transient periods corresponding to a weak field with a linear intensity dependence of heating. Figures 1; references 7: 5 Russian, 2 Western.

2415/9604

Spectroscopy of Intermolecular Repulsion and Attraction in Relaxing Liquid Systems

18600001 Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62 No 1, Jan 87 (manuscript received 18 Jun 85) pp 68-74

[Article by A. N. Perov]

[Abstract] A method of spectroscopy is proposed for determining the intermolecular forces of repulsion and van der Waals attraction in simple organic liquids, these forces causing a solvation shift of electronic absorption and luminescence bands. A solvate is considered consisting of an activator molecule capable of electronic transition from ground state to excited state and k identical molecules forming a solvate shell around it. A structural and energy analysis of such a system yields data not only pertaining to intermolecular interaction during an absorption—emission cycle but also indicating the mechanism of intramolecular and intermolecular relaxation with attendant restructurization of the solvate. The results of such a spectroscopy are demonstrated on "compound" relaxation with 0'—0" transition of states in an anthracene-propanol solvate, on the basis of known experimental data including measurements at temperatures of 113-360 K. The author thanks N.G. Bakhshiyev for attentiveness. Tables 1; references 24: 17 Russian, 7 Western.

2415/9604

Reconstruction of Wavefront From Intensity Distribution

18620000d Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62 No 5, May 87 (manuscript received 29 Oct 85) pp 1105-1108

[Article by V. V. Aristov, A. I. Yerko, Ch. V. Kopetskiy, S. M. Kuznetsov, and N. G. Ushakov]

[Abstract] The "phase" problem of reconstructing the wavefront from the intensity distribution is analyzed for uniqueness and correctness of the solution, considering that differesnt wave functions in the plane of an object can yield the same intensity distribution of the recording plane and that, therefore, reconstruction from the absolute value of the squared wave function is not feasible. Two reconstruction theorems pertaining to Fourier transforms are rigorously proved for non-negative real functions bounded and thus integrable in accordance with the Kramer condition as well as finite and thus fast decaying at infinity, one theorem for asymmetric functions and one theorem for centrisymmetric functions. It is demonstrated that the "phase" problem is inapplicable even for symmetric finite and bounded functions. The necessary conditions are established accordingly for uniqueness and accuracy, not counting shift and reflection relative to the origin of coordinates. While a two-dimensional space has been considered here, the conclusions apply also to a one-dimensional space and a three-dimensional space as well as to any nonphysical n-dimensional one. References 8: 6 Russian, 2 ?.

Models of Gd-Impurity Centers in Laminate GaSe

18620000d Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29 No 1, Jan 87 (manuscript received 28 Apr 86) pp 28-32

[Article by A. A. Klimov, V. G. Grachev, S. S. Ishchenko, Z. D. Kovalyuk, S. M. Okulov, and V. V. Teslenko, Institute of Semiconductors, UkSSR Academy of Sciences, Kiev]

[Abstract] An experimental study of laminate gy-GaSe crystals doped with Gd^{3+} was made, using for the first time the two methods of electron-paramagnetic resonance (EPR) and electron-nuclear double resonance (ENDR). Measurements were made with an EPR-12 spectrometer and an ENDR superheterodyne spectrometer over the 4.2-77 K temperature range. The second method was useful for analysis of paramagnetic centers and their environment. Six kinds of such centers were detected: two containing Gd^{3+} ions only (vGd^{3+}v, wGd^{3+}w), three containing also ^{7}Li nuclei ($Li^{+}/_{w}Gd^{3+}$w, $Li^{+}/_{v}Gd^{3+}$v, $Li^{+}/_{w}Gd^{3+}$v), and one containing also ^{23}Na nuclei ($Na^{+}/_{w}Gd^{3+}$w). The ENDR frequency of these nuclei did not change upon rotation of the magnetic field in a plane perpendicular to the C-axis, indicating their location on the axis of symmetry. Since no neutral Li and Na atoms were revealed by EPR, these two metals must exist in GaSe as ions. Six corresponding models of Gd^{3+}-centers in a GaSe crystal have been constructed and their parameters calculated on the basis of the experimental data and their description with a spin-Hamiltonian. Figures 3; tables 3; references 6: all Russian.

Interaction of Serumal Albumin and Water With Various pH Levels According to Rayleigh Scattering Data

18620000d Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA ASTRONOMIYA in Russian Vol 28 No 2, Mar-Apr 87 (manuscript received 29 Dec 85, after revision 11 Sep 86) pp 59-63

[Article by G. P. Petrova, Yu. M. Petrusevich, I. I. Shirkova, and O. P. Revokatov, Department of Molecular Physics and Physical Measurements]

[Abstract] An experimental study of albumin macromolecules in water was made, for the purpose of determining the dependence of their interaction with water and their polarization characteristics on their total surface charge. Measurements were made by Rayleigh scattering of light, with minimum possible impurity salt content in the water, and the data were evaluated according to the theory of nonideal solutions. For the measurements, "Serva" albumin was dissolved in water in concentrations of 0.1 percent, 0.33 percent, and 1 percent so as to maintain the D [is much greater than] d condition and the hydrogen ion concentration was varied over the 0.0001-0.0005 mol./dm^3 range. As light source and for photoelectric recording of scattered light was used a He-Ne laser (gl = 632 nm wavelength). For the calculations, the osmotic pressure was represented by a virial power series in the albumin concentration $cHK/R_{90}o = 1/M + 2cB + \ldots$ ($R_{90}o$- scattering coefficient, M- molecular weight of solute, c- concentration of solute, $H = 2\text{-}^{2}n^{2}/_{0}(dn/dc)^{2}/(gl_{0}{}^{2}N_{A})$, n_0- refractive index of solvent, n- refractive index of solution, gl_0- wavelength of incident light, N_A- Avogadro's number, K- coefficient accounting for anisotropy of a macromolecule in terms of depolarization). These calculations, assuming an ellipsoidal albumin macromolecule, have yielded a parabolic dependence of the virial coefficient B, of the depolarization coefficient, of the mean electronic polarizability, and of the polarizability tensor components ga_2,ga_1 ($ga_1 = ga_2 = ga_1$, $ga_3 = ga_2$) on the pH factor characterizing the total surface charge on a macromolecule. The mean polarizability and the optical anisotropy of an albumin macromolecule have been found each to be minimum at the point where its total surface charge is zero, the tensor of electronic polarizability thus becoming more symmetric as that charge increases. Figures 3; references 7: 4 Russian, 3 Western (1 in Russian translation).

Effect of Ultrasonic Perturbation of Host Crystal on Spectrum of Molecular Impurity Center

18620000d Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29 No 1, Jan 87 (manuscript received 10 Dec 85, in final version 23 Jun 86) pp 92-97

[Article by V. L. Popkov, A. P. Ryabov, and V. M. Burlakov, Institute of Spectroscopy, USSR Academy of Sciences, Troitsk (Moscow Oblast)]

[Abstract] The effect of periodic uniaxial deformation of a $K_{0.95}Rb_{0.05}Cl$ crystal on the inhomogeneously-broad-

ened spectral line gq [similar to] 631 cm^{-1} of a molecular NCO^- impurity center in it is analyzed on the basis of experimental data and their theoretical interpretation, such a generally weak effect being detectable with the aid of an AVIKS automatic high-resolution spectrophotometer. Deformation is assumed to alter the local characteristics of impurity-crystal interaction, while strong ultrasonic excitation is known to produce dislocations in the crystal. Measurements were made at temperatures of 180 K and 10 K, at which the spectral gap was 0.12 cm^{-1} and 0.05 cm^{-1} wide respectively. Periodic deformation was produced by means of a piezoceramic transducer with ultrasonic excitation, of lower power off-resonance and higher power at resonance. The optical density spectra were subsequently resolved into component contours by the least squares method and with three contours of the $A[1+ C(gDgq)^2 + E(gDgq)^4]^{-1}$ form approximating a spectrum, one of them the background interference. Calculations for the crystal-transducer system vibrating at resonance or off resonance yield the absorption spectra in each case. When at resonance, crystal and transducer remain in contact all the time. Above or below resonance the crystal breaks away at some instant of time and rejoins the transducer at a later instant of time during a cycle, the free crystal moving without velocity or phase discontinuities. This study has revealed that the frequency shift of intramolecular impurity vibrations in the host crystal is proportional to the uniaxial strain of the crystal, with an anomalous intensity peak within the inhomogeneously broadened spectral band, that resulting defects in the crystal hardly influence the parameters of this spectral band, and that the post-deformation trend of optical properties of such a crystal with impurity depends on the deformation power. The authors thank Ye.A. Vinogradov and G.N. Zhizhin for support and attentiveness. Figures 3; tables 1; references 8: 5 Russian, 3 Western.

Role of Speckles in Real-Time Recording and Processing of Optical Signals in Photorefractive Crystals

18620000d Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62 No 5, May 87 (manuscript received 18 Jul 86) pp 1098-1104

[Article by A. A. Berezhnoy and A. A. Buzhinskiy]

[Abstract] An experimental study of real-time recording of optical signals modulated by the speckle pattern of laser radiation was made, with a $Bi_4(SiO_4)_3$ photorefractive crystal instead of less suitable photographic film. Recording was done by the double-exposure method in a transverse electric field, such an electric field ensuring efficacious recording of optical signals modulated in space with a high frequency. The crystal faces perpendicular to the 110 direction were polished and the electric field was applied in this direction so as to ensure optimum conditions for the Pockels effect, while the modulated optical signal was projected onto the polished crystal faces between the two electrodes. A speckle pattern was produced by passage of radiation from a He-Cd laser (gl = 0.44 gmm wavelength) through translucent glass, the size of spots in the speckle pattern depending on the roughness of the glass surface as well as on the aperture of the objective lens and spots of the size corresponding to a space frequency [equivalent to] = 5 mm^{-1} being most densely distributed. The speckle pattern was exposed continuously, with a constant electric field applied to the crystal, and was read in coherent radiation from a He-Ne laser (gl = 0.63 gmm wavelength). An analysis of recorded Fourier spectra of the speckle pattern produced with and without simultaneous recording of a harmonic optical signal, analysis of recording and erasure kinetics, and analysis of double-exposure recording with attendant formation of interference fringes in a photorefractive crystal confirm that a transverse geometry of the external electric field enhances the resolution and double exposure facilitates real-time recording with the contrast between interference fringes first fast peaking and slowly fading. Figures 4; references 3: all Russian.

New Dyes for Efficient Emission of Red Radiation

18620000d Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 8, Aug 87 (manuscript received 3 Jul 86) pp 1576-1581

[Article by V. V. Maslov, M. I. Dzyubenko, S. N. Kovalenko, V. M. Nikitchenko, and A. I. Novikov, Institute of Radiophysics and Electronics, UkSSR Academy of Sciences, Kharkov]

[Abstract] Two new synthetic dyes have been developed for efficient emission of red radiation covering the gl_3 = 610-660 nm band, with optical pumping, each a derivative of benzopyran with a benzimidazole cycle added by condensation. Their performance was evaluated experimentally with benzene, acetonitrile, methanol, ethanol, also ethanol solutions of 0.15-450 mol./dm^3 HCl as solvents. Their absorption spectra and fluorescence spectra were measured in a Hitachi 356 and Hitachi MRF-4 spectrophotometer respectively. Their fluorescence quantum yield was measured by the method of absorption equalization with an ethanol solution of rhodamine 6G having a fluorescence quantum yield of 0.95[plus or minus]0.01 as reference. For measurement of the laser characteristics, a dye solution was optically pumped with radiation from two parallel INP2-7/120 flashlamps, in 2 gms wide pulses with a 0.8 gms rise time, while being continuously circulated by a centrifugal pump through a 142 mm long quartz tube with a 3.5 mm inside diameter and a 2.25 mm wall thickness inside a cavity between a dielectric plane 99 percent-reflectance mirror and a plane-parallel plate of K8 quartz glass. For measurement of the spectral characteristics of emission in the laser mode, a dye solution was poured into a 15 mm high cylindrical cup 10 mm in diameter inside the same cavity as before and transversely pumped with monochromatic radiation of gl_p = 520 nm wavelength, in 1 gms wide pulses of up to 150 mJ energy, from a similar laser with an ethanol solution of 2-iminocoumarin as active medium. Emission spectra were recorded in a

UF-90 camera through an objective with 1.2 m focal length and a diffraction grating with 1200 lines/mm, while the emission energy was measured with an IMO-2M instrument. For a theoretical evaluation of the data and performance analysis of these dyes, the electronic structure of excited states in their molecules was calculated by the method of molecular fragments with linear combination of atomic orbits in the Pariser-Parr-Popl semiempirical gp-electron approximation. The results indicate that ethanol solutions of both dyes make much more efficient and photostable laser than conventional rhodamine B and 101 xanten dyes emitting radiation at the same 610-660 nm wavelength. They therefore provide an excellent replacement of the latter in tunable lasers to fill the gap between the emission bands of rhodamine 6G and oxazine 17. The authors thank A.I. Rybachenko for assistance in measurement of fluorescence spectra. Figures 4; tables 1; references 11: 7 Russian, 4 Western.

High-Power Parametric Generator of Subnanosecond Light Pulses Pumped By Laser With S-M-B-S Compressor

18620000d Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 8, Aug 87 (manuscript received 7 Aug 86) pp 1658-1660

[Article by V. V. Krushas, A. S. Piskaraskas, V. I. Smilgyavichyus, and G. P. Shlekis, Vilnyus State University imeni V. Kapsukas]

[Abstract] A high-power optical parametric oscillator is described which generates subnanosecond light pulses, when pumped preferably by a YAG:Nd^{3+} laser with Q-switching and with pulse compression through stimulated Mandelstam-Brillouin scattering. The advantages of such a pump are that it delivers pulses of nominally 1 ns duration at a high repetition rate with an up to 80 percent efficiency and that control of focusing into the Mandelstam-Brillouin cell facilitates smooth regulation of the pump pulse duration. The performance of such a pump laser was evaluated experimentally in a test stand including a YAG:Nd^{3+} master laser with passive Q-switching by color centers in a LiF:F_2^- crystal, an S-M-B-S compressor in the form of a cell containing CCl_4, and two YAG:Nd^{3+} amplifier stages, the latter followed by a KDP frequency-converter crystal as second-harmonic generator. The parametric optical oscillator, a superluminescent one consisting of two KDP crystals respectively 4 cm and 6 cm long, was pumped with second-harmonic radiation from the YAG:Nd^{3+} lasers through a filter and then a cylindrical lens. Radiation pulses from this oscillator were passed through another filter to a DFS-8 spectrograph, and IMO-2N energy meter, and an AGAT-SF-1 photochronograph. The oscillator was found to generate pulses of as low as 450 ps duration with a power density of 9 GW/cm^2 at the maximum attainable efficiency of 27 percent or, in the linear interaction mode, pulses of as low as 200 ps duration with a power density of 2 GW/cm^2 at an efficiency of 5 percent. Still shorter pulses can be generated by KDP crystals as well as by DKDP, CDA, KTR, or other crystals, upon further compression of the pump pulses. Figures 3; references 7: all Russian.

Electrostrictive and Thermal Excitation of Hypersonic Vibrations in Liquid By Near-Counterpropagating Picosecond Radiation Pulses From a YAG:Nd^{3+} Laser

18620000d Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14 No 8, Aug 87 (manuscript received 5 Dec 86) pp 1666-1668

[Article by A. S. Dementyev and A. V. Mikhaylov, Institute of Physics, LiSSR Academy of Sciences, Vilnyus]

[Abstract] A theoretical analysis of the dynamics of decaying elastic vibrations excited in a liquid medium by pulses of interfering laser beams through a nonlinear mechanism is followed by a description of an experiment with acetone in a 2 mm thick glass cup and a YAG:Nd^{3+} laser emitting pulses of 15-20 mJ energy and 30 ps duration, in a conventional arrangement for degenerate four-wave interaction. The laser beam was split into two exciting beams of equal intensity for passage through the liquid in near-counterpropagating directions, with a 172° angle between them, and a reading beam with a delay line formed by three right prisms in its path. The total energy of all incident pulses and the reflected one was measured with two FD-24K photodiodes, one on each side of a 45° beamsplitter plate. Tests were performed with analytically pure acetone and with acetone solution of 3274-u dye in various concentrations. Measurement of the reflection coefficient and its oscillatory variation in time has revealed electrostrictive excitation of hypersonic vibrations in pure acetone and a gradual transition to thermal excitation as the absorption coefficient is increased by addition of dye. Figures 2; references 12: 4 Russian, 8 Western.

Optical Spectra and Spin-Lattice Relaxation of Rare-Earth Ions in KY_3F_{10} Crystal

18620000d Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 63 No 1, Jul 87 (manuscript received 19 Nov 86) pp 97-101

[Article by R. Yu. Abdulsabirov, A. V. Vinokurov, V. A. Ivanyshin, I. N. Kurkin, Ye. A. Pudovik, A. L. Stolov, and Sh. I. Yagudin]

[Abstract] Optical absorption and emission spectra of rare-earth ions from Pr^{3+} to Tm^{3+} isomorphously replacing the cation in a KY_3F_{10} crystal for high-power lasers were measured, this crystal being the only one among those with an yttrium sublattice accepting up to 10 percent of a lighter rare-earth element such as Nd without loss of optical homogeneity and transparency. Specimens of this crystal were grown by the Bridgman-Stokbarger method from a salt melt in graphite crucibles, doped with 0.1-1 atom. percent of a rare-earth fluoride

as activator. Measurements were made at two low temperatures of 77 K and 4.2 K, with a DFS-8-II diffraction spectrometer having a dispersion of 3 [Angstrom]/mm and with an MDR-2 monochromator. The number of spectral lines and their locations were found not to depend on the activator concentration, an increase of the latter causing only a broadening of the lines and a quenching of the luminescence. Compression along the C_4-axis but not along the C_3-axis was found to produce dichroism, owing to removal of orientational degeneracy, all spectra accordingly belonging to a single center of tetragonal symmetry in each case. Energy diagrams could be constructed on this basis for the odd rare earths (Nd^{3+}, Sm^{3+}, Gd^{3+}, Dy^{3+}, Er^{3+}, Yb^{3+}), indicating spin-lattice relaxation through optical vibrations and the first excited Stark level. They could not be constructed for even rare earths (Pr^{3+}, Ho^{3+}, Tm^{3+}), there being fewer lines than levels into which the final terms of each transition splits. The components of the g-tensor characterizing the ground state were determined from EPR spectra, or from Zeeman spectra of ions such as Eu^{3+} with g[perpendicular to] [less than] 0.1 and therefore not producing an EPR signal. Matrix elements $B^0/_2$, $B^0/_4$, $B^4/_4$, $B^0/_6$, $B^4/_6$ were calculated by the method of equivalent operators. The authors thank M.P. Rodionov and N.M. Khasanov for assisting with calculations. Figures 2; tables 2; references 7: 3 Russian, 4 Western.

(H+e)-Centers of Luminescence in KI and RbI Crystals

18620000d Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 63 No 1, Jul 87 (manuscript received 14 Jul 86) pp 102-109

[Article by B. Ya. Berzinya and L. E. Intenberg]

[Abstract] An experimental study of KI and RbI crystals with nonluminescent radiative hole-defect H-centers was made, for the purpose of verifying the hypothesis of electron capture by such centers and their subsequent luminescence. Crystals of these two alkali halides were specially purified, whereupon F and F' electron centers were produced in them by irradiation with light within the 3/2 ½ excitons (5.76 eV and 5.71 eV) absorption band. For stimulated luminescence, they were excited thus at a temperature of 11 K. For comparison of two spectra, one with and one without H-centers in a KI crystal, one such crystal was colored with a 5.76 eV exciton at 11 K and another one was cooled down to 11 K after having been colored with a 6.50 eV exciton at 85 K. An analysis of these difference spectra as well as of the polarization and the thermal extinction of stimulated luminescence has identified (H+e)-centers, also $(H+e)_d$-centers, as the sources of luminescence, such centers being produced by the recombination mechanism. The authors thank R.I. Gindina for synthesizing specially purified KI and RbI crystals essential for this study. Figures 4; tables 1; references 26: 6 Russian, 20 Western.

Tunnel Luminescence of $Y_3Al_5O_{12}$:Sc Crystals

18620000d Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 63 No 1, Jul 87 (manuscript received 22 Oct 86) pp 110-113

[Article by Z. A. Rachko and Ya. L. Yansons]

[Abstract] An experimental study of YAG crystals activated with Sc^{3+} ions was made, for the purpose of determining the mechanism of their luminescence and its spectral kinetics. Such crystals were excited with electrons in pulses of 300 ns duration including a fall time of 3 ns, at a repetition rate of 100 Hz. Measurements were made with a vacuum monochromator limiting the long-wave range. These measurements revealed a wide cathodoluminescence band with a half-width of approximately 0.8 eV and a peak about 4.1 eV. The temperature dependence of the luminescence intensity was measured over the 80-400 K range, the data revealing a long afterglow at 80 K and a maximum intensity about 230 K. The decay of luminescence was found to occur with the intensity decreasing as a hyperbolic function of time $I = kt^{-ga}$ at temperatures up to approximately 200 K, where ga = 0.97, and faster than that at higher temperatures. The results indicate that luminescence is caused here by tunnel recombination of donor-acceptor pairs following a Coulomb interaction, rather than by annihilation of excitons localized near Sc^{3+} ions or by intercenter transitions. Thermal ionization above 80 K indicates that one of the pair, most likely the donor, has a low ionization energy and explains the shift of the luminescence spectrum toward higher energy as well as the eventual departure from hyperbolic decay kinetics as the temperature is raised. The authors thank Ya.A. Valbis for supplying specimens and for discussing scientific aspects. Figures 3; references 7: 1 Russian, 6 Western.

Information Display by Hologram of Focused Image During Recording Through Stationary Phase-Inhomogeneous Media. Amplitude Rise in Aperture

18620000d Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 63 No 1, Jul 87 (manuscript received 2 Jun 86) pp 168-174

[Article by V. G. Sinchenko]

[Abstract] With regard to information display in optical communication systems by the holographic method with multiple recording of images corresponding to different pupil sizes on a focused-image hologram, the effect of resulting amplitude rise in the aperture is evaluated for the case of a diffraction-limited objective and a medium causing stationary phase distortions of the object beam within the pupil. The hologram is assumed to have been recorded linearly by an oblique reference beam, with negligible noise from the recording medium, and the image to be reconstructed by a plane monochromatic beam. The phase grating is assumed to be sinusoidal or

cosinusoidal. A comparison between images with amplitude linearity and images with intensity linearity, based on calculation of the corresponding line broadening functions, indicates adequacy of amplitude rise during recording of focused-image holograms successively with different sizes of the pupil or of one such hologram in the plane of the pupil with the amplitude of the incident beam changed in a number of steps equal to the number of different pupils. Figures 2; references 11: 10 Russian, 1 Western.

Effect of Thermal Vibrations of Atoms on Scattering of and Radiation Emission by Ultrarelativistic Particles in Crystals

18620000d Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 93 No 2(8), Aug 87 (manuscript received 27 Mar 86) pp 570-582

[Article by V. S. Malyshevskiy, Rostov State University, V. I. Truten and N. F. Shulga, Kharkov Institute of Engineering Physics, UkSSR Academy of Sciences]

[Abstract] The effect of thermal vibrations of lattice atoms on scattering and radiation emission by ultrarelativistic particles in a crystal is evaluated, assuming that the Born theory of coherent interactions no longer applies to such particles and lattice atoms. The spectral density of radiation emission is calculated for the case of a scattering angle smaller than the characteristic radiation emission angle, within the coherence length, radiation emission occurring with recoil and over a distance much longer than the lattice parameter ga. The stepwise change of the particle velocity upon collision with each atom is taken into account. The spectral-angular density of radiation emission is expressed in terms of the particle trajectory and is averaged over the range of atom locations during thermal vibrations. A particle moving at a low angle to one of the crystallographic axes is of special interest, because of the strong orientation dependence of its scattering and radiation emission. The mean spectral density determining the intensity of radiation emission is calculated for a particle beam passing through a crystal, passage of superbarrier electrons being characterized by a spectral density of high-frequency radiation emission independent of the transverse electron energy and passage of a positron beam along a crystallographic axis being characterized by an appreciable redistribution of particles with respect to transverse energy. In conclusion is calculated the mean-square angle of multiple scattering for a fast particle, electron or positron, in a crystal. References 30: 26 Russian, 4 Western.

2415/9604

Critical Magnetic Field Intensity and Spin-Orbit Interaction in Amorphous Superconducting $Zr_{100-x}Ni_x$ Alloys

18620000e Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29 No 1, Jan 87 (manuscript received 11 Jun 86) pp 302-305

[Article by M. P. Voronko, S. K. Tolpygo, and S. K. Yushchenko, Institute of Metal Physics, UkSSR Academy of Sciences, Kiev]

[Abstract] The spin-orbit interaction time in amorphous superconducting $Zr_{100-x}Ni_x$ alloys is determined from the temperature dependence of their upper critical magnetic field intensity H_{c2} and their magnetic-field-dependent component of electrical conductivity. It is found by a comparison of the theoretically calculated dependence, including orbital effects and the paramagnetic limit as well as the effect of electron-phonon interaction on extension of that limit, with the measured one. For four alloys of this system with a strong bond and a large $(oH_{c2}/oT)_{T0}$ slope, $Zr_{83}Ni_{17}$, $Zr_{81.5}Ni_{15.5}$, $Zr_{80}Ni_{20}$, $Zr_{75}Ni_{25}$, this time is within the 10^{-13}-10^{-12} s range. Figures 1; tables 1; references 9: 3 Russian, 6 Western.

Extraordinary Current in Superconductors With Pyroelectric Symmetry

18620000e Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29 No 1, Jan 87 (manuscript received 16 Jul 86) pp 165-169

[Article by Yu. V. Nazarov, Institute of Theoretical Physics imeni L.D. Landau, USSR Academy of Sciences, Chernogolovka (Moscow Oblast)]

[Abstract] Superconductivity of materials with pyroelectric symmetry is analyzed as a property which they acquire following a spontaneous departure from gauge invariance so that the gauge-invariant vector and scalar potentials become independent quantities. Neither symmetry nor gauge invariance preclude existence of a current j proportional to the scalar potential, calculation of the proportionality factor R requiring a model for a material without diffuse singularities and thus without an inversion center. Such a model for a crystal with central symmetry and impurity has been constructed which includes not only the Gorkov-Nambo function and the Fourier component of the impurity potential but also an anisotropic part according to the perturbation theory. This model yields R and its scale of magnitude in the quasi-classical approximation of elastic scattering by the lattice. The extraordinary current is then found from the system of three equations of nonsteady superconduction and the corresponding field equation div j= 0 with the eliminated left half, taking into account spatial dispersion of first order with respect to gradients and assuming a characteristic length of gradient-odd dispersion much smaller than that of gradient-even dispersion. Most realistic is a situation with the extracted vector parallel to the plane of contact, where the extraordinary current perpendicular to the ordinary one is compensated by an additional superconduction current. In the reverse situation a uniform electric field inducing a scalar potential proportional to the vector potential. The author thanks G. M. Eliashberg and N. B. Kopnin for helpful discussions. Figures 1; references 17: 13 Russian, 4 Western.

Polarization of Magnetic Moments of Rare-Earth (R) Ions in $RCu_3Mn_4O_{12}$ Perovskites

18620000e Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29 No 1, Jan 87 (manuscript received 7 Feb 86, in final version 26 May 86) pp 210-213

[Article by F. P. Korshikov, I. O. Troyanchuk, L. A. Bashkirov, V. B. Shipilo, and V. M. Pavlov, Institute of Solid State and Semiconductor Physics, BSSR Academy of Sciences, Minsk]

[Abstract] An experimental study of $RCu_3Mn_4O_{12}$ compounds containing rare-earth elements R= Pr,Sm,Eu,Gd,Tb,Dy,Er,Tm or Y was made, the purpose being to determine their magnetization characteristics and the magnetic moments of the R^{3+} ions. Polycrystalline specimens were produced by solid-phase reactions under pressures of 4-6 GPa at temperatures of 1450-1550 K. They were examined in a DRON-3 x-ray diffractometer with an FeK_{ga}-radiation source, all of them having been found to contain only one phase and to have a perovskitic structure with a cubic lattice. Their magnetization was measured with a vibration magnetometer in magnetic fields of up to 25 kOe intensity at temperatures covering the 4.5-450 K range, whereupon the Neel point was determined from the temperature dependence as well as thermodynamically from the Bedov coefficients. The first method yielded a Neel point of all compounds within the 410-415 K range and the second method yielded one consistently 10-15 K lower, such a narrow range despite the widely different atomic numbers of the rare-earth elements indicating a weak interaction of their ions and other ions. Assuming that this exchange interaction is determined principally by the spin moments, the temperature at which the energy of exchange interaction becomes comparable with that of thermal interaction is calculated using the Lande factor and the Boltzmann constant. At that temperature, 40 K for the Gd^{3+} ion and 10 K for the Er^{3+} ion, the magnetization of the rare-earth sublattice is found to increase most steeply. The field dependence of the magnetization reveals that the magnetic moments of heavy rare-earth ions have an L+S coupling and are oriented antiparallel to the resultant magnetic moment of Cu and Mn ions, which indicates a negative exchange interaction of rare-earth ions and d-ions. Figures 2; table 1; references 8: 1 Russian, 7 Western.

Effect of Irradiation Current-Voltage Characteristic of Small Josephson Junction in Macroscopic Quantum Tunneling Mode

18620000e Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29 No 1, Jan 87 (manuscript received 2 Dec 85, in final version 16 Jun 86) pp 56-63

[Article by R. O. Starobogatov, N. N. Trunov, and G. Yu. Yashin, All-Union Scientific Research Institute of Metrology imeni D. I. Mendeleyev, Leningrad]

[Abstract] The effect of irradiation on a Josephson junction smaller than the characteristic length is evaluated, the adiabatic approximation being valid under normal conditions but external perturbation in the vicinity of resonance producing intense transitions between Stark levels of oscillating particles. The current-voltage characteristic of such a junction is calculated, particularly the amplitudes and the widths of resulting anomalies, on the assumption that all transitions occur within the same low range of the Mathieu equation obtained from the adiabatic Hamiltonian at zero current. Attenuation, in the classical model represented by a dissipation term in the equation of motion for the varying phase, is related to the correlator of random Langevin forces representing the effect of fluctuations in accordance with the known fluctuation-dissipation theorem. The current-voltage characteristic is obtained by solving the Fokker-Planck equation and then applying Josephson's second theorem. Random current and its correlator along with external perturbation are introduced to complete the classical formulation of this problem, for the experimentally verifiable case of a small superconducting energy gap between levels in the one-band approximation. Solution of the problem on this basis yields the sought parameters of the current-voltage characteristic in dimensionless form. Its segments of negative differential resistance are found to be unstable, their instability increasing as they become wider. The authors thank V. V. Bryksin for helpful discussions. Figures 1; references 20: 10 Russian, 10 Western.

Theory of Gauge Symmetry in Superconductors

18620000e Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 93 No 2(8), Jul 87 (manuscript received 5 Jun 86) pp 583-589

[Article by V. I. Marchenko]

[Abstract] Gauge symmetry groups are established and some general properties of states departing from gauge invariance are determined for superconductors, which requires only that the arguments of the gg-function [Chi] such as the momenta of electrons characterizing the superconductor material change in a known manner upon crystallographic transformations while the structure of the space of arguments need not be precisely known. Considering that generally a crystallographic symmetry group characterizing a superconductor differs from the symmetry group which characterizes its normal state and that many magnetic superconductor materials do not satisfy the stability criterion analogous to the Lifshits criterion in the theory of phase transitions of the second kind, an analysis of all 32 crystallographic classes has yielded altogether 343 possible symmetry structures with the Cooper-pair momentum q= 0 and 276 stable ones including 32 structures characterizing ordinary superconductivity in addition to 58 nonmagnetic, 73 ferromagnetic, and 113 antiferromagnetic ones with nontrivial departure from gauge symmetry. The remaining structures with q [not equal to] 0 represent degenerate and, indeed, exotic superconductor materials. References 5: all Russian.

Temperature Dependence of Flux Creep and Critical Current in Molybdenum Sulfides

18620000e Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 93 No 2(8), Aug 87 (manuscript received 16 Jun 86) pp 590-604

[Article by A. V. Mitin, Institute of Problems in Physics, USSR Academy of Sciences]

[Abstract] In an experimental study of superconducting molybdenum-tin, molybdenum-lead, and molybdenum-copper sulfides with a "frozen" magnetic field the temperature dependence of its rate of change, known as flux creep, and of the critical current density over a temperature range extending below the superconducting transition point was measured. Specimens of these ternary compounds, ground in an agate mortar and then molded in cylindrical dies under a pressure of 10-15 kbar, were homogenized by annealing at various temperatures between 700°C and 1200°C for 24 h so as to vary their microstructure depending on that temperature. The phase composition after annealing was monitored in a "geigerflex" diffractometer with a CuK_{ga}-radiation source (wavelength gl = 1.541 [Angstrom]). The specimens were finally machined into 15-20 mm long tubes with a 5 mm outside diameter and a 1.2-1.5 mm wall thickness. The critical current density was determined from the difference between external and internal magnetic field intensities. Changes in the intensity of the internal magnetic field as a function of time, and depending on the intensity of the external magnetic field prior to its removal, were measured at constant temperatures over the 0.5-16 K range. Most measurements were made in the International Laboratory of Strong Magnetic Fields and Low Temperatures (Wroclaw/Poland). Cooling to 16-1.6 K was done with liquid or gaseous helium-4 and cooling down to 0.5 K was done by circulation of helium-3 vapor. Analysis and evaluation of the data on $Pb_{1.2}Mo_{6.4}S_8$ annealed at 1020°C, this representative compound being a superconductor of the second kind with a high critical current density and a large-Ginzburg-Landau parameter, indicate that a "frozen" magnetic field decays logarithmically within 20 s after removal of the external one and nonlogarithmically owing to relaxation during a short initial period only. Such a decay and its temperature dependence as

well as that of the critical current density cannot be explained on the basis of the activation mechanism alone but together with quantum diffusion of vortices. The author thanks N. Ye. Alekseyev and V. I. Nizhankovskiy for participation, discussion of the results, and helpful comments, also Ye. P. Khlybov for performing x-ray phase anlaysis. Figures 6; references 43: 11 Russian, 32 Western.

Anomalies of Properties of Tunnel Junctions and Josephson Junctions Near Lifshits's Electronic Topological Transition

18620000e Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 93 No 2(8), Aug 87 (manuscript received 8 Jan 87) pp 701-708

[Article by A. A. Varlamov, A. V. Pantsulaya, and M. V. Fistul, Moscow Institute of Steel and Alloys]

[Abstract] Electronic topological transition according to I. M. Lifshits in tunnel junctions and in Josephson junctions is considered, the current-voltage characteristic of the former and the critical current of the latter becoming anomalous as such a transition is approached. These anomalies are analyzed theoretically for information they yield about the anomalous density of one-particle states in a tunnel junction, when temperature spread as well as impurity spread are taken into account, and about the anomalous electron relaxation time in a Josephson junction. The analysis is based on change in the topology of the Fermi surface in real metals and alloys, a change which occurs in a wide variety of ways. Calculations are made on the basis of the corresponding equation for a symmetric tunnel junction where an electronic topological transition occurs in both electrodes simultaneously, assuming first a very low impurity concentration and then a higher one, also for an asymmetric tunnel junction where one electrode remains a plain metal while some external action induces an electronic topological transition in the other. For a Josephson S-N-S junction, a variant of a tunnel structure with a metal interlayer subject to electronic topological transition between two superconductors, the critical current density is calculated as a function of a parameter characterizing the degree of proximity of the normal metal to that transition. The authors thank A. A. Abrikosov, B. L. Altshuler, and M. I. Kaganov for interest. Figures 3; references 21: 19 Russian, 1 Polish, 1 Western.

Inhomogeneous State in Quasi-One-Dimensional Superconductors

18620000e Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 93 No 2(8), Aug 87 (manuscript received 3 Dec 86) pp 747-761

[Article by A. I. Buzdin and S. V. Polonskiy, Moscow State University imeni M. V. Lomonosov]

[Abstract] Two groups of new organic superconducting materials are characterized by an appreciable anisotropy of electronic properties, $(BEDT\text{-}TTF)_2X$ compounds being in effect two-dimensional superconductors and $(TMTSF)_2X$ compounds being in effect quasi-one-dimensional ones with the upper critical magnetic field intensity most anisotropic near the superconducting transition temperature T_c. At temperatures below the triple point $T^* = 0.56T_c$ a magnetic field induces a phase transition of the second kind which gives rise to superconductivity in the form of a Larkin-Ovchinnikov-Fulde-Ferrell inhomogeneous state with finite Cooper-pair momentum. Existence of the Larkin-Ovchinnikov-Fulde-Ferrell phase in a quasi-one-dimensional superconductor is examined, a pure such superconductor having no paramagnetic limit. The range of magnetic field intensity within which this phase exists in such a superconductor is quite broad at temperatures T [leads to] O and this phase constitutes a soliton lattice, while the field range of its existence in a three-dimensional superconductor is quite narrow and especially so in such a superconductor with extrinsic scattering. Only the presence of an impurity gives rise to a finite paramagnetic limit, as indicated on the temperature-field phase diagram constructed for a quasi-one-dimensional superconductor with non-magnetic impurity in various concentrations. This diagram with both coordinates, temperature and magnetic field intensity, normalized to the superconducting transition temperature includes also phase transition of the first kind and transition to the Bardeen-Cooper-Schrieffer homogeneous superconducting state. Complete description of the Larkin-Ovchinnikov-Fulde-Ferrell phase is facilitated by use of the Ginzburg-Landau functional, which yields here a fourth-order nonlinear partial differential equation in the superconducting order parameter with a negative coefficient in the gradient term. The authors thank L. N. Bulayevskiy and V. V. Tugushev for helpful discussion. Figures 4; references 28: 18 Russian, 10 Western (2 in Russian translation).

2415/9604

Nonuniform Superconduction in Disordered Metals

18620131a Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 92 No 2, Feb 87 (manuscript received 21 Jul 86) pp 672-687

[Article by L. N. Bulayevskiy, S. V. Panyukov, and M. V. Sadovskiy, Institute of Physics imeni P.N. Lebedev, USSR Academy of Sciences]

[Abstract] Superconduction in a disordered metal with wide statistical space fluctuations of the order parameter is analyzed, using a new parameter which characterizes the temperature range about the superconducting transition point within which these fluctuations are wide. The range of wide fluctuations is estimated with the aid of the Ginzburg-Landau functional and relative to the Ginzburg parameter characterizing strong thermodynamic fluctuations. Superconducting transition is treated according to the theory of superconducting bubbles,

assuming a Gaussian radial temperature profile. The logarithm of statistical sums is averaged explicitly by the method of replicas, using solutions uniform in space as well as solutions localized in space at discrete instants of time. The concentration and the free energy of these superconducting bubbles, also their diamagnetic susceptibility, are calculated on the basis of the model of noninteracting superconducting bubbles. Superconduction is found to occur indeed in isolated regions, in such bubbles, when the new order parameter is large. It occurs simultaneously throughout the metal volume, upon an ordinary second-order transition, when that parameter is small. The authors thank B. L. Altshuler, S. L. Ginzburg, L. P. Gorkov, I. Ya. Korenblit, A. I. Larkin, D. Ye. Khmelnitskiy, and Ye. F. Shender for helpful discussions. Figures 2; references 29: 11 Russian, 8 Western.

2415/08309

Mesoscopic Fluctuations in S-N-S Junction
18620161c Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 92 No 2, Feb 87 (manuscript received 30 Jun 86) pp 607-615

[Article by B. L. Altshuler, Leningrad Institute of Nuclear Physics imeni B. P. Konstantinov, USSR Academy of Sciences, and B. Z. Spivak, Institute of Analytical Instrument Design, Scientific-Technical Association, USSR Academy of Sciences]

[Abstract] Properties of a disordered S_1-N-S_2 (superconductor - normal metal - superconductor) junction in the form of a parallelepipedic sandwich with phase coherence are analyzed, particularly the dependence of its conductance on the phase difference $X_1 - X_2$ of order parameters at S_1-N and N-S_2 boundaries respectively as a consequence of Andreyev electron reflection by the S-edges into the N-region between them. Only mesoscopic fluctuation effects attending buildup of a random impurity potential in the N-region are considered, effects associated with interaction of electrons within the N-region being ignored. Mean-square deviations of the superconduction current and of the conductance from their respective mean magnitudes at temperatures far below the superconducting transition point are calculated, also mean-square fluctuations of the thermodynamic potential. The dependence of cooperons and diffusons on the phase differences $gf_C = X_1 - X_2 + gf_D = X_1 - X_2 - gf'$ respectively is taken into account. Fluctuations of the critical current are foundto be detrmined only by the temperature and the characteristic diffusion time for electrons through the N-region, and to be much smaller than the ratio on the difference between energy levels at S_1-N and N-S_2 boundaries respectively to the energy gap of the normal metal. The mean superconduction current is found to be suppressible in an external magnetic field as well as in a ferromagnetic material used as normal metal. An experimental verification with a Josephson junction shunting the S_1-N-S_2 junction is proposed, in addition to the current-voltage method of measuring the conductance. The authors thank D. Ye.Khmelnitskiy and B. I. Shklovskiy for valuable discussions. Figures 5; references 23: 10 Russian, 13 Western. 2415/08309

Antiferromagnetism in Organic Conductors
18620161b Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 92 No 2, Feb 87 (manuscript received 29 Aug 86) pp 756-765

[Article by A. V. Sokol, Institute of Theoretical Physics imeni L. D. Landau, USSR Academy of Sciences]

[Abstract] Antiferromagnetism of Bechgaard organic compounds is evaluated theoretically in terms of spin density waves at temperatures below the 10-14 K transition range and on the basis of experimental data pertaining to $(TMTSF)_2AsF_6$ and $(TMTTF)_2Br$ salts. The ground state and the magnetic properties, namely anisotropic magnetic susceptibility and spin-flip field intensity as well as their temperature dependence, are calculated on the basis of a Fermi surface with two open segments and using the apparatus of Green's functions with dipole-dipole interaction as principal contributor to energy of magnetic anisotropy. The frequency of antiferromagnetic resonance is calculated by analytic continuation of thermodynamic responses. Fair agreement with experimental data and their extrapolation validates the given model of a Fermi surface. The author thanks L. P. Gorkov for suggesting the topic and subsequent guidance. Figures 4; references 16: 5 Russian, 11 Western.

2415/08309

UDC 530.12:537.3

Relativistic Effects in Superconducting Ring
18620065 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 297 No 4, 1987 (manuscript received 25 Jul 86) pp 843-845

[Article by O. Yu. Dinaryev and A. B. Mosolov, All-Union Scientific Research Institute of Natural Gases, Moscow]

[Abstract] A superconducting ring in the field of a gravitational wave propagating normally to the plane of that ring is considered, and the wave function for a Cooper pair condensate in such a ring is analyzed for relativistic effects in a system of units with both the Planck constant and the speed of light set equal to 1. The analysis is based on the Ginzburg-Landau equation according to the Bardeen-Cooper-Schrieffer theory, with necessary constraints to satisfy the theory of relativity and assuming zero volume strains in the ring. As a special case a plane gravitational wave incident on a ring of superconducting wire is considered. Such a wave induces a current, some energy being dissipated typically by emission of electromagnetic waves. Article was presented by Academician L. I. Sedov on 22 July 1986. References 5: all Western (1 in Russian translation).

2415/08309

New Type of Phase Diagram With Incommensurate Phase

18620161 Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 92 No 2, Feb 87 (manuscript received 26 Mar 86) pp 580-588

[Article by D. G. Sannikov and V. A. Golovko, Institute of Crystallography, USSR Academy of Sciences]

[Abstract] Existence of an incommensurate phase on the phase transition diagram is considered, when the irreducible representation of the symmetry group of any one commensurate phase but not that of the parent phase admits the Lifshits invariant in its thermodynamic potential. This invariant derives from the gradiental invariant which is linear with respect to the derivatives but more than quadratically nonlinear with respect to components of the order parameter. The simplest such case is a three-component order parameter. Following an appropriate change of variables, variation of the thermodynamic potential with respect to the three new variables yields a phase transition diagram on which the incommensurate phase appears between two commensurate ones not related through subgroups and on which there appear correspondingly two different triple points. Figures 1; references 27: 16 Russian, 1 Czechoslovak, 1 East German, 9 Western.

2415/08309

Separation of Phases of Electron Fluid in New Superconductor Materials

18620058b Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 46 No 8, 25 Oct 87 (manuscript received17 Sep 87)pp 333-336

[Article by L. P. Gorkov and A. V. Sokol, Institute of Theoretical Physics imeni L.D. Landau, USSR Academy of Sciences]

[Abstract] Coexistence of two phases in "pure" La_2CuO_4 is proposed, a conducting one and a dielectric one, to circumvent apparent contradictions arising from experimental evidence of high-temperature superconductivity of this new material. On the one hand its tetragonal phase has been found to have a b.c.c. lattice, which corresponds to a half-full Brillouin zone, its electrical resistivity remaining very high with a weak temperature dependence above 150 K but having a narrow anomaly below that temperature. On the other hand a small addition to Sr has been found to cause a steep increase of the electrical conductivity to metallic level, without evidence of an energy gap and of a correlation with the temperature dependence of electron mobility. Theoretical analysis of lattice configuration and energy structure, considering existence of an octahedral CuO_6 coordination and cubic symmetry, may explain the appearance of small clusters in the form of "droplets" or "mist"in terms of separation of the two phases according to a percolation model. Structural transition can, meanwhile, be readily associated with third-order anharmonicity of the $E_gF_{2g}F_{2g}$ product of representations with the three-dimensional F_{2g} representation containing strain which corresponds to rotation of octahedra. The authors thank G.M. Eliashberg for many discussions. Figures 2; references 6: 3 Russian, 3 Western.

2415/08309

Self-Oscillations in Exciton-Electron System Upon Impact Ionization of Excitons

18620055b Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEKHNICHESKOY FIZIKI in Russian Vol 46 No 7, 10 Oct 87 (manuscript received 10 Aug 87) pp 284-286

[Article by B. M. Ashkinadze and A. V. Subashiyev, Institute of Engineering Physics imeni A.F. Ioffe, USSR Academy of Sciences]

[Abstract] A study was made concerning absorption of microwave radiation pulses by nonequilibrium electron-hole plasma in pure Si and Ge crystals at very low temperatures. Nonequilibrium electron-hole pairs were produced by treatment with a He-Ne laser, whereupon the crystals were exposed to radiation of 8 mm wavelength from a 100 mW source inside a waveguide containing He vapor at temperatures of 5-15 K. Most electron-hole pairs recombined into excitons, attendant emission of radiation having been recorded by a spectrometer and the width of the luminescence band indicating the temperature of the crystal. Oscillograms of transmitted microwave pulses reveal regular oscillations of the microwave conductance within each pulse when the pumping power reaches a threshold level of approximately 1 W/cm^2, their frequency increasing from 0.5 MHz to 5 MHz and their waveform changing as the pumping power is further increased. These oscillations were detected in Si crystals at temperatures of 8-15 K and in Ge crystals at temperatures of 4-8 K. They were also detected in both kinds of crystals upon excitation by radiation pulses of 4.10^{-4} s duration from a GaAs laser and placement in a constant microwave field. Such oscillations of plasma conductance and thus also of plasma density are attributable to ionization instability of excitons in a microwave field caused by heating of electrons and an increase of their concentration. This hypothesis is supported by theoretical analysis of electron and exciton kinetics, also by absence of oscillations during heating of electrons at cyclotron frequency by a constant field with a subunity product of microwave frequency times pulse relaxation time. The authors thank V.V. Belkov for assisting in the experiment. Figures 2; references 6: 4 Russian, 2 Western (1 in Russian translation).

2415/08309

Superconductivity and Magnetic Properties of Compounds of Metal Oxides With Yttrium or Lanthanides

18620057a Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian
Vol 46, 1987 pp 3-6

[Article by N. Ye. Alekseyevskiy, Ye. P. Khlybov, V. V. Yevdokimova, G. M. Kuzmicheva, A. V. Mitin, V. I. Nizhankovskiy, and A. I. Kharkovskiy, Institute of Problems in Physics and Institute of High-Pressure Physics, USSR Academy of Sciences, Moscow Institute of Fine Chemical Technology]

[Abstract] Compounds of Ba-Cu oxides with Y or Ln= La,Pr,Nd,Sm,Eu,Gd,Tb,Dy,Ho,Er,Tm,Yb,Lu were produced by reaction in the solid phase, for a determination of the temperature dependence of their electrical resistivity and magnetic susceptance as well a second critical magnetic field intensity in fields of up to 45 T intensity over the 75-102 K temperature range containing the superconducting transition temperature T_c with a 0.5 K wide range. From the correlation between the superconducting transition temperature and the lattice parameters, also the known current-voltage characteristic and critical current density, all correlating with the atomic number of the Y or Ln component, has been estimated by the ratio $2D/k_BT_c$ (2D- energy gap, K_B-Boltzmann constant) equal to 5.3+0.3 J/mol..K^2 for both $Y_{1.8}Ba_{0.2}CuO_4$ and $La_{1.8}Ba_{0.2}CuO_4$. The authors thank Yu. A. Deniskin, I. Varkhulskiy, and A. Gilevskiy for assisting with measurements, L. N. Bogacheva, I. Z. Bagryanskaya, and S. V. Petrov for assisting in preparation of specimens. Figures 2; tables 1; references 3: 1 Russian, 2 Western.

2415/08309

Mercero Effect in Josephson Point Junctions of $YBa_2Cu_2O_{9-x}$ Ceramic at Liquid-Nitrogen Temperatures

18620057c Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian
Vol 46, 1987 pp 55-58

[Article by B. A. Aminov, I. E. Graboy, A. R. Kaul, Nguen Chin Tkhu, Ya. G. Ponomarev, M. V. Sudakova, and Yu. D. Tretyakov, Chair of Physics, Moscow State University]

[Abstract] Tunnel structures of the S-I-S kind were produced with $YBa_2Cu_3O_{9-x}$ ceramic, its superconducting transition temperature being 90+0.5 K, and point junctions were then produced mechanically by pressing grains of the superconducting phase into In-electrodes at liquid-nitrogen temperatures. Their current-voltage as well as (dI/dV) and (d^2I/dV^2) characteristics, also the energy gap and the dependence of dI/dV on the magnetic field intensity at zero bias voltage, were measured at temperatures of 1.64-95 K and in magnetic fields of up to 60 k0e intensity. The results have revealed two kinds of junctions. The high-resistance junctions with one-particle tunneling were found to have a superconducting transition temperature lower than 90+0.5 K, evidently owing to the presence of impurities. The low-resistance junctions with Josephson tunneling were found to remain superconducting up to 90 K but to have a blurred current-voltage characteristic with no superconducting current flowing at zero bias voltage even at liquid-helium temperatures. A pronounced Mercero effect in these latter junctions, oscillations of dI/dV as a function of the magnetic field intensity, indicates retention of phase coherence during strong thermal fluctuations. The authors thank G .P. Kudryavtseva and V. K. Garanin in Department of Geology of Moscow State University for structural and phase analysis of specimens with a microprobe, also N. B. Brandt and V. V. Moshalkov for supplying specimens of superconducting ceramics and for helpful discussions. Figures 8; references 4: 2 Russian, 2 Western (both in Russian translation).

2415/08309

Magnetic Properties of $YBa_2Cu_3O_{6.5+y}$ Oxide System

18620057h Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian
Vol 46, 1987 pp 90-93

[Article by V. I. Aleksandrov, M. A. Borik, V. G. Veselago, V. V. Voronov, Yu. K. Voronko, P. A. Ivanov, G. V. Maksimova, V. Ye. Makhotkin, V. A. Myzina, V. V. Osiko, A. M. Prokhorov, V. M. Tatarintsev, V. T. Udovenchik, V. A. Fradkov, and M. A. Chernikov, Institute of General Physics, USSR Academy of Sciences]

[Abstract] An experimental study of Y-Ba-Cu ternary oxides with a superconducting transition temperature of 93 K was made, for the purpose of determining the temperature dependence of their diamagnetic response and of their magnetization curve. Ceramic specimens were produced by sintering a Y_2O_3+ $4BaCO_3$+ 6CuO mixture. Powder specimens were produced by precipitation of Y, Ba, Cu nitrates from aqueous solution and their subsequent chemical decomposition. The reactions in solid phase were monitored by thermal and x-ray phase as well electron-microscope and electron-probe analyses. The results of measurements indicate a partial loss of oxygen upon heating in air up to 930 deg C and absorption of oxygen upon cooling to 880 deg C, with an exothermic peak at 900 deg C but without singularities on differential thermal, thermogravimetric, and differential thermogravimetric curves, this applying to specimens of both kinds. In an argon atmosphere heating resulted in some loss of weight but cooling did not result in a gain of weight, and repetitive temperature cycling did not produce a diamagnetic response. The endothermic peak at 815 deg C appearing only for the specimens

produced by synthesis indicates completion of that reaction, its magnitude decreasing with increasing length of sintering time. The magnetization curves for all specimens were found to be irreversible in the high-intensity range and characteristic of type-II superconductors, with the lower critical magnetic field intensity H_{cl} not higher than 500 Oe at a temperature of 4.2 K. Ceramic specimens exhibited a full Meissner effect far below H_{cl} and a partial one closer to H_{cl}. The temperature dependence of magnetization, obtained in a heating-cooling cycle in a magnetic field after cooling at 4.2 K without a magnetic field, confirms the significant role of weak links in ceramic $YBa_2Cu_3O_{6.5+y}$. Figures 2; references 1: Western.

2415/08309

Plasmon and Bipolaron Mechanisms of High-Temperature Superconductivity

18620057j Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 124-127

[Article by E. A. Pashitskiy and B. L. Vinetskiy, Institute of Physics, UkSSR Academy of Sciences]

[Abstract] Two possible mechanisms of high-temperature superconductivity characterizing complex metal oxides with variable valence of Cu ions and strong ionic bond are considered, the superconducting transition temperatures of $La_{2-x}(Ba,Sr)CuO_{4-y}$ and $YBa_2Cu_3O_{7-d}$ lying within the 30-100 K range. The plasmon mechanism involves dynamic overshielding of electron-ion Coulomb interaction by low-frequency acoustic plasmons in the system of light and heavy fermions. The bipolaron mechanism involves superfluidity of a charged bipolaron Bose gas in an anisotropic crystal. References 18: 12 Russian, 6 Western.

2415/08309

Microstructure and Junction Properties of Y-Ba-Cu-O High-Temperature Superconductor Ceramics

18620057d Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 59-62

[Article by A. V. Varlashkin, A. L. Vasilyev, A. I. Golovashkin, O. M. Ivanenko, N. A. Kiselev, L. S. Kuzmin, K. K. Likharev, K. V. Mitsen, G. V. Romanchikova, and Ye. S. Soldatov, Chair of Physics, Moscow State University, Institute of Crystallography and Institute of Physics, USSR Academy of Sciences, Moscow]

[Abstract] Various Y-Ba-Cu-O ceramics were produced by high-temperature sintering, for microstructural examination and measurement ofjunction properties. Monophase ceramic of the $YBa_2Cu_3O_7$ composition had a superconducting transition temperature of 93 K with a less than 2 K wide range and exhibited an almost full Meissner effect already at a temperature of 80 K. Polyphase ceramics of other compositions had a wider than 2 K range of superconducting transition temperature and their magnetic susceptance decreased smoothly with decreasing temperature down to liquid-helium level. Microstructural examination was done under a high-resolution transmission electron microscope. Junctions were produced by pressing ceramic grains onto In, InSb, PbSn electrodes and their properties were found to depend largely on the contact pressure. The current-voltage characteristics of low-resistance junctions, measured with minimum variation of junction parameters, revealed singularities such as those of Josephson junctions with loss of superconductivity in weakly-coupled regions and with a multitude of current steps rather than smooth current increase as function of the voltage in a microwave field (more than 40 current steps in a microwave field of 9.7 GHz frequency). Figures 3; references 3: all Western.

2415/08309

Microjunctions of Y-Ba-Cu-O Ceramics

18620057e Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 71-74

[Article by N. A. Tulina, V. A. Borodin, S. F. Kondakov, and L. I. Chernyshova]

[Abstract] A comparative study of Al-Cu-Pb ceramic microheterojunctions and Y-Ba-Cu-O ceramic micromonojunctions produced by standard technology was made, Y-Ba-Cu-O ceramic having been produced either from monophase $Y_{1.2}Ba_{0.8}CuO_4$ powder or into a "1-2-3" structure. Their current-voltage characteristic and dynamic resistance were measured, both found to depend largely on the ceramic-electrode contact pressure. These measurements revealed accordingly three types of monojunctions with different ranges of static resistance: high-resistance tunnel junctions with R_O= 1 kohm or higher, medium-resistance nonhomogeneous junctions with R_O= 0.01-1 kohm, and low-resistance junctions with R_O lower than 10 ohm. The dynamic resistance dV/dI of the first type has no singularities, that of the second type has gap singularities, and that of the third type characterizes metallic behavior with evidence of a superconduction current. The heterojunctions have a (dV/dI)-voltage characteristic with resonance lines indicating gap singularities, also resonance lines of yet unknown nature outside the gap range more likely associated with Tomash oscillation than with electron-phonon interaction. Figures 3; references 7: 2 Russian, 5 Western.

2415/08309

Specific Heat of $YBa_2Cu_3O_7$ Superconductor Compound in Magnetic Field

18620057f Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 79-81

[Article by G. Kh. Panova, M. N. Khlopkin, N.A . Chernoplekov, and A. A. Shikov, Institute of Atomic Energy imeni I. V. Kurchatov, Moscow, B. Fogarasi, D. Granasi, S. Pekkr and D. Mihai, Central Research Institute of Physics, Budapest/Hungary]

[Abstract] In an experimental study of $YBa_2Cu_3O_7$ superconductor ceramic, its specific heat was measured at temperatures of 3-85 K without a magnetic field and in magnetic fields of up to 8 T intensity. The specimen weighing 0.628 g, a disk 10 mm in diameter and 2.2 mm thick, had been produced at the Central Research Institute of Physics in Budapest. The specimen was porous and had a rhombic structure, its electrical resistance with temperatures from 5 Mohm at 300 K to 2.4 Mohm at 100 K. The data, plotted in C/T,T coordinates (C in mJ/g-atom, T in deg K), have yielded a $C= s_nT + bT^3$ temperature dependence of C not very sensitive to a magnetic field over the 3-12 K range and a $C/T= k + aT^2$ temperature dependence above 10 K with C/T^3 peaking to a maximum about T= 23 K while k decreases as the magnetic field intensity is increased. The data have yielded, in accordance with the Bardeen-Cooper-Schrieffer theory, both the Sommerfeld parameter s= 4 mJ/)g-atom.K^2) and the Debye temperature T_D- 384 K. Figures 2; references 3: 1 Russian, 2 Western.

2415/08309

Magnetic Properties of $YBa_2Cu_3O_{9-y}$ Superconductor Bulk and Powder Specimens

18620057g Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 86-89

[Article by L. Z. Avdeyev, N. B. Brandt, A. V. Volkhozub, A. A. Gippius, I. E. Graboy, A. R. Kaul, V. V. Moshalkov, O. V. Snigirev, Yu. D. Tretyakov, V. V. Khanin, and Ho Hyu Hyan, Moscow State University]

[Abstract] An experimental study of $YBa_2Cu_3O_{9-y}$ superconductor bulk and powder was made, for the purpose of determining the temperature dependence and the field dependence of their magnetic susceptiblity and permeability over the respective 4.2-120 K and 0.05-100 Oe ranges. Monophase specimens were produced by three methods: 1) mixing the components in aqueous solution with subsequent precipitation of oxalates upon addition of saturated $(COOH)_2$ solution, 2) rapid freezing of aqueous solution containing Y, Ba, Cu salts with subsequent dehydration of the cryogranulate mass and then thermal decomposition of the salt mixture, 3) from hydroxides of cationic components. All specimens were identically heat treated into final state for testing. Measurements were made with a SQUID magneto-meter in magnetic fields weaker than 1 Oe and with a vibration magnetometer in fields stronger than 100 Oe. The results indicate presence of multilink superconductor domains constituting a 90-95 percent effective magnetic shield throughout the volume in bulk specimens but not in powder specimen, magnetic shielding in the latter being only 60 percent effective. Figures 4.

2415/08309

Structural Features, Superconductivity, and Percolation Effects in Y-Ba-Cu-O System

18620057k Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 168-171

[Article by V. G. Baryakhtar, V. M. Pan, V. G. Prokhorov, V. S. Flis, A. G. Popov, G. G. Kaminskiy, I. G. Mikhaylov, M. A. Kuznetsov, M. G. Vasilenko-Sheremetyev, V. I. Matsuy, K. G. Tretyachenko, A. A. Flis, V. D. Valentinov, V. A. Lyashko, I. V. Manzheleyev, and V. Ye. Yachmenev, Institute of Metal Physics, Institute of Problems in Materialogy, Institute of Superhard Materials, and Institute of Geochemistry and Mineral Physics, UkSSR Academy of Sciences]

[Abstract] An experimental study of $Y_{1.2}Ba_{0.8}CuO_{4-d}$ ceramic was made, for a determination of its structural features and physical properties as well as behavior when carrying electric current in a magnetic field. Specimens were produced according to the Y_2O_3-BaO-CuO ternary constitution diagram. Microstructural examination under a scanning electron microscope with a "Camscan" electronic microprobe and phase analysis in an x-ray diffractometer revealed not only two orthorhombic phases $YBa_2Cu_3O_7$ and Y_2BACuO_5 but also a solid solution of Y and Ba in CuO constituting a third phase. The temperature dependence of electrical resistance and magnetic susceptance, the latter measured by the Faraday method in magnetic fields of up to 5 T intensity, revealed a superconducting transition temperature of 93 K with a 3-4 K wide range for $YBa_2Cu_3O_7$ as well as for $Y_{1.2}Ba_{0.8}CuO_{4-d}$ but 59-30 K for $Y_2BaCu_3O_x$. The current-voltage and (dV/dI)-current characteristics revealed loss of superconductivity in $YBa_2Cu_3O_x$ by an electric current, in a transverse magnetic field of up to 4.5 T intensity, the true "lower" critical current density (with a 1 microvolt/cm electric field intensity as criterion) not exceeding 1 A/cm^2 in absence of a magnetic field at a 4.2 K temperature and the apparent "upper" critical current density being approximately 300 A/cm^2 in absence of a magnetic field at a 60 K temperature. The authors thank A. S. Shpigel, S. K. Tolpyy, and V. S. Melnikov for helpful discussions and comments. Figures 4; references 2: Western.

2415/08309

Possible Mechanism Responsible for Both Superconductivity and Linear Temperature Dependence of Electrical Resistivity

18620057i Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 94-97

[Article by G. M. Eliashberg, Institute of Theoretical Physics imeni L.D. Landau, USSR Academy of Sciences]

[Abstract] A hypothetical mechanism responsible for the linear temperature dependence of the electrical resistivity of compounds with variable valence of Cu ions and with high superconducting transition temperature is proposed as an alternative to the hypothetical mechanism of a soft harmonic mode, with specific interest in compounds such as optimally doped La_2CuO_4 whose electrical properties are determined by the Cu-O complexes and depend critically on the degree of Cu oxidation. The mechanism involves establishment of a certain hole concentration within a wide energy band and occupation of quasi-localized states within a narrower energy band by the corresponding number of electrons, a dynamic equilibrium then existing between both with a net chemical potential within that narrower band. Scattering of holes by localized electrons is also accounted for. The author thanks L.P. Gorkov for fruitful discussions. Figures 1; references 13: 7 Russian, 6 Western.

2415/08309

Electrical, Magnetic, and Microwave Properties of Y-Ba-Cu-O System

18620057m Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 204-207

[Article by A. A. Bush, S. N. Gordeyev, I. S. Dubenko, A. A. Yevdokimov, A. A. Zhukov, and V. F. Meshcheryakov]

[Abstract] An experimental study of $YBa_2Cu_3O_x$ ceramic synthesized by the process of multiple homogenizing-compacting-annealing cycles has revealed that its superconducting transition temperature as well as the temperature dependence of its electric resistivity, magnetic susceptibility, and upper critical magnetic field intensity vary depending on the process conditions. This is indicated by the data on specimens respectively quenched from 800 deg C in air, rapidly cooled (200 deg/h) from 650 deg C in air, rapidly cooled (200 deg/h) from 800 deg C in oxygen, slowly cooled (10 deg/h) in air, slowly cooled (10 deg/h) in oxygen, and then annealed under pressures of 1-40 atm. These results correlate with the degree of rhombic distortion of the tetragonal structure. Measurement of microwave properties at a frequency of 9.8 GHz revealed a steep increase in nonresonant microwave absorption with the temperature dropping 5-10 K below the upper end of the superconducting transition range. Figures 3; references 2: Western (1 in Russian translation).

2415/08309

Conduction Characteristics of $YBa_2Cu_3O_{7-d}$ Superconductor Crystals

18620057n Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 208-210

[Article by A. V. Zvarykina, V. N. Laukhin, M. K. Makova, V. A. Merzhanov, L. P. Rozenberg, V. N. Topnikov, A. G. Khomenko, R. P. Shivayeva, and E. B. Yagubskiy, Institute of Chemical Physics, USSR Academy of Sciences]

[Abstract] An experimental study of superconducting $YBa_2Cu_3O_{7-d}$ crystals was made, for the purpose of determining their conduction characteristics and comparing the latter as well as their structural characteristics with those of the polycrystalline superconductor. Specimens annealed at temperatures of 950-1100 deg C in an oxygen atmosphere, after sintering, yielded 0.005-0.007 mm thick and 0.2-0.4 mm wide wafers for measurement of the lattice parameters and of the temperature dependence of electrical resistance and magnetic susceptibility. The electrical conductivity at room temperature was measured by the standard current-voltage method with direct current. It was found to vary widely over a 20-1400 mho.cm range depending on the degree of crystal perfection, and indicating a nonmetallic behavior attributable, most likely, to a similarly varying oxygen content. Figures 4; references 2: Western.

2415/08309

Surface Resistance of Y-Ba-Cu-O Ceramic at Very High and Superhigh to Extremely High Frequencies

18620057l Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 172-175

[Article by M. Belskiy, O. G. Vendik, M. M. Gaydukov, Ye. K. Golman, S.. Karmanenko, A. B. Kozyrev, S. G. Kolesov, and T. B. Samoylova, Leningrad Institute of Electrical Engineering imeni V. I. Ulyanov (Lenin)]

[Abstract] An experimental study was made with 12 specimens of Y-Ba-Cu-O ceramic, their superconducting transition temperatures being 90-95 K with a 7-10 K wide range (on the basis of 50 percent electrical resistance in the normal state just above transition), for a determination of their surface resistance and its temperature dependence over the 4.2-300 K range at very high 30-300 MHz, superhigh 5-7 GHz, and extremely high 60

GHz frequencies. Measurements were made with a resonator in the form of a shielded helical line segment open at both ends and containing specimens, disks 10 mm in diameter and 2 mm thick, within crests of the axial magnetic field component. The current-voltage characteristic was measured at those frequencies, also the Q-factor of the resonator, whereupon the surface impedance of specimens and its real part representing their surface resistance were calculated. Specimens were cooled from 300 K to 20 K in a constant magnetic field, which was removed at 20 K for further cooling so as to prevent freezing of the magnetic flux inside the resonator wall. The authors thank A. I. Golovashkin, K. V. Mitsin, and O. M. Ivanenko for exhaustive consultations on the technology of producing Y-Ba-Cu-O ceramic. Figures 3; references 2: 1 Russian, 1 Western.

2415/08309

Radiative Heating of Electrons and Inelastic Electron-Phonon Scattering Time in Y-Ba-Cu-O Compound

18620045a Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TOERETICHESKOY FIZIKI in Russian Vol 46 No 6, 25 Sep 87 (manuscript received 15 Jul 87) pp 226-228

[Article by Ye. M. Gershenzon, M. Ye. Gershenzon, G. N. Goltsman, B. S. Karasik, A. D. Semenov, and A. V. Sergeyev, Moscow Pedagogical Institute imeni V.I. Lenin]

[Abstract] It is possible to determine the electron energy relaxation time in a Y-Ba-Cu-O superconducting compound as a result of electron-phonon interaction by measuring the time taken by its electronic subsystem to cool down while a film of the material in the resistive state is exposed to radiation. Such measurements were made in an experiment with $YBa_2Cu_3O_{7-x}$ films produced by high-frequency sputtering of a ceramic target with a magnetron in an argon atmosphere and deposition on polycrystalline leucosapphire substrates. The thickness of films was varied over the 0.3-1 um range and the films were annealed so as to spread the resistive transition temperature over the 10-80 K range, a resistive state below the transition temperature being then attained by sending a current of 1-10 mA through the film and applying a magnetic field of approximately 50 k0e intensity normally to the film surface. Measurements were made at the beat frequency, with two backward traveling-wave tubes generating radiation within the 2 mm wave band and that beat frequency being varied over the 0.01-2 GHz range. The dependence of the change of voltage gDV across a film on the heat frequency f was measured at two temperatures, 4.2 K and 1.6 K. The results have yielded a relaxation time close to 10^{-10} s at 1.6 K, with the ratio $gDV_{1.6}/gDV_{4.2}$ remaining equal to 1.0 over the f= 0.01-1 GHz frequency range and dropping below 0.4 at f= 2 GHz. Figures 1; references 2: 1 Russian, 1 Western.

2415/08309

UDC 537.312.62

Hysteresis Losses in Twisted 'in Situ' Composite Superconducting Materials

18620037a Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 57 No 8, Aug 87 (manuscript received 6 Jan 86, in final version 20 Jun 86) pp 1623-1631

[Article by A. L. Rakhmanov, Institute of High Temperatures, USSR Academy of Sciences, Moscow]

[Abstract] The performance of fibrous "in situ" composite superconducting materials with helically twisted fibers is analyzed theoretically, for the determination of hysteresis losses associated with a transverse current ordinarily much weaker than the longitudinal conduction current. The transverse current is generated either by random touching and fusion of adjacent fibers or owing to the proximity effect where the distance between fibers is comparable to the coherence length in a normal metal. The first mechanism is dominant in strong magnetic fields, while both mechanisms operate in weak ones. Current and power calculations are, accordingly, made for a cylindrical "in situ" composite conductor first in a weak magnetic field, the results for a conductor having twisted fibers being compared with those for a conductor having straight ones, whereupon calculations are made for such a conductor with twisted fibers carrying an alternating conduction current. The results indicate that the hysteresis losses can be minimized by minimizing the transverse current but allowing the superconduction current to "jump" from fiber to fiber. Figures 3; references 8: all Western (2 by author).

2415/08309

UDC 539.621

Anomalous Friction in Superconductor Pairs

18620037b Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 57 No 8, Aug 87 (manuscript received 26 Mar 86, in final version 25 Mar 87) pp 1668-1670

[Article by Ye. A. Dukhovskoy, S. A. Zinenko, and A. A. Silin]

[Abstract] A special study of friction in various superconductor pairs has revealed some laws governing it and confirmed an anomaly unknown before its discovery in Nb-Nb pairs, namely a steep decrease of the friction coefficient by an order of magnitude after a few hours of run-in. Experiments were performed on Ta-Ta and V-V as well as Nb-Nb pairs, their superconducting transition temperature being 4.48 K, 5.38 K, and 9.20 K respectively. Friction tests with a rubbing velocity of 5 mm/s under a pressure of 1+ 0.05 N were performed at temperatures covering the 3.5-300 K range, after run-in

at a temperature below the superconducting transition point. The results indicate that, while in Nb-Nb and V-V pairs the friction coefficient remains low at a constant value throughout the entire temperature range, in Ta-Ta pairs it increases within the 30-70 K range from a very low value to a high value which also remains constant as the temperature further rises. Similar tests were performed on specimens after they had been soaked at room temperature for 50 h, following run-in at a temperature below the transition point. Here, while again Nb-Nb and V-V pairs the friction coefficient decreased steeply within one hour of testing, after an initial increase, in Ta-Ta pairs it remained constant at the same high value throughout the testing time. Metallographical and topological examination of friction surfaces was done under Camebax and Stereoscan S-4 scanning electron microscopes with x2000 and x5000 magnification, respectively. Figures 3; references 2: Russian.

2415/08309

Superconductivity and Charge-Density Waves of Electron Fluid in Strongly Anisotropic Polar Semiconductors

18620045c Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORTICHESKOY FIZIKI in Russian Vol 46 No 6, Sep 87 (manuscript received 11 Aug 87) pp 239-241

[Article by V. S. Babichenko, Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] The properties of an electron fluid in a strongly anisotropic polar semiconductor with l charge-density waves and a charge density n within the $_4$ range are analyzed in the random-phase approximation, applicable here, taking into account Coulomb interaction and frequency dispersion of the dielectric permittivity. Integration of the Dyson equation, near the Fermi surface, with respect to the internal momentum at the $gG_0(p_1p_2)$-vertex and at the gi-vertex on the sequence of ladder diagrams representing interactions with zero net momentum reveals that such an electron fluid becomes superconducting when the charge density exceeds a critical point and that the effective interelectron interaction intensifies as the charge density decreases approaching the critical point, a transition with formation of a charge-density wave occurring as the charge density drops below the critical point. Figures 2; references 5: all Russian.

2415/08309

Anomality of Structural Parameters of $YBa_2Cu_30_7$ Ceramic in Vicinity of Superconducting Transition

18620058a Moscow PISMA V EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 46 No 8, 25 Oct 87 (manuscript received 15 Jul 87) pp 325-327

[Article by A. I. Golovashkin, O. M. Ivanenko, G. I. Leytus, K. V. Mitsen, O. G. Karpinskiy, and V. F. Shamray, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] An experimental study of $YBa_2Cu_30_7$ ceramic was made, to verify the hypothesis of lattice deformations within the temperature range of its superconducting transition: 93-92 K on the basis of electrical resistance measurements and 91-89 K on the basis of magnetic susceptance measurements in a magnetic field of 0.5 Oe intensity. Structural examination of homogeneous pure specimens by the powder method in a DRON-2 x-ray diffractometer with K. alpha-Fe radiation source and the temperature dependence of the lattice parameters, the lattice being an orthorhombic one, revealed a dip in that otherwise linear dependence over the 300-77 K range: an anomalous decrease of their magnitudes within a narrow temperature range just above the transition range. This indicates a structural relaxation by diffusion within that temperature range, possibly associated with an ordering of oxygen vacancies in a hypothetically "soft" oxygen sublattice responsible for strong electron-electron interaction or possibly but much less likely as a result of ice formation in pores of the ceramic material. Figures 2; references 3: 1 Russian, 2 Western (1 in Russian translation).

2415/08309

Anomalous Velocity of Sound and Moduli of Elasticity in $YBa_2Cu_3O_7$ Ceramic in Vicnity of Superconducting Transition

18620055a Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 46 No 7, 10 Oct 87 (manuscript received 15 Jul 87) pp 273-275

[Article by A. I. Golovashkin, V. A. Danilov, O. M. Ivanenko, K. V. Mitsen, and I. I. Perepenko, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] In a study concerning the mechanism of superconductivity in high-temperature ceramics, the acoustic velocity in the $YBa_2Cu_3O_7$ material was measured over the 80-120 K temperature range along with the magnetic susceptance and the electrical resistance. Specimens of this material for the experiment were produced from fine Y_2O_3, BaO, CuO powders by compaction under a pressure of 2-5 kbar and subsequent annealing in an oxygen stream at a temperature of 900 degrees centigrade for 12 h, after surface grinding, which yielded a pure $YBa_2Cu_3O_7$ phase of 5.3 g/cm^3 density without carbon inclusions. Cylinders 15 mm in diameter and of various lengths were tested. Superconducting transition was found to begin at 93 K and end at 92 K, with the magnetic susceptance dropping from slightly above zero to -1 at 77.4 K and the electrical resistance beginning to decrease more than linearly at 113 K before dropping to zero. The velocities of longitudinal and transverse ultrasonic waves were measured with $LiNbO_3$ plastics as transduers at a frequency of 2.4 MHz. On the basis of the data, assuming a constant density, the temperature dependence of the dymanic Young's modulus, bulk modulus, shear modulus, and Poisson's ratio, also the Debye temperature (300 K) and the coefficient of linear expansion according to the empirical Barker

formula have been calculated. The results reveal an anomalous behavior of these properties in the vicinity of the superconducting transition. Figures 4; references 4: 3 Russian, 1 Western. 2415/08309

Reflection of Infrared Radiation and Raman Scattering of Light and Energy Gap in Y-Ba-Cu-O Superconductor

18620057b Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI: PRILOZHENIYE in Russian Vol 46, 1987 pp 35-38

[Article by A. V. Bazhenov, A. V. Gorbunov, N. V. Klassen, S. F. Kondakov, I. V. Kukushkin, V. D. Kulakovskiy, O. V. Misochko, V. B. Timofeyev, L. I. Chernyshova, and B. N. Shepel, Institute of Solid-State Physics, USSR Academy of Sciences, Chernogolovka]

[Abstract] An experimental study of $Y_{1.2}Ba_{0.8}CuO_4$ and $YBa_2Cu_3O_{9-x}$ was made, for a determination of their optical characteristics and energy gap, their superconducting transition temperatures being 90.5 K with a 2-3 K wide range and 93 K with a 1 K wide range respectively. Specimens of both were produced by high-temperature synthesis in the solid phase, and their surface was left rough for optical measurements. Their reflection spectra measured at a temperature of 293 K were found to have a rather discrete structure within the 50-500 cm^{-1} range of far infrared. The spectrum of their $(R_S-R_N)/R_N$ relative difference between reflection coefficients R_S in the superconducting state and R_N in the normal state at 100 K temperature was found to peak below the superconducting gap and to dip into the negative range above that gap, the gap being 30+2 meV wide. Their Raman scattering spectra were measured with an Ar^+-laser (514.5 nm and 488 nm wavelengths) and with a Kr^+-laser (457.9 nm and 647.1 nm wavelengths) in the backscattering configuration at temperatures of 1.5-600 K. These spectra were found to contain several narrow peaks superposed on a wide band, the level of the latter rising with decreasing energy. The contribution of electron excitation across the energy gap in the superconducting state was determined from the difference between the spectra at 1.5 K and 100 K. Figures 4; references 7: 2 Russian, 5 Western.

2415/08309

Ramam Scattering of Light by Electrons in Superconductors With Small Correlation Length

18620045b Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKA in Russian Vol 46 No 6, 25 Sep 87 (manuscript received 11 Aug 87) pp 236-238

[Article by A. A. Abrikosov and L. A. Falkovskiy, Institute of Theoretical Physics imeni L.D. Landau, USSR Academy of Sciences]

[Abstract] Raman scattering of light in pure superconductors such as Nb_3S with a correlation length much smaller than the light penetration depth is analyzed theoretically, the case of a much larger correlation length having already been considered. For calculations yielding the reflection coefficient, the entire sequence of chain diagrams is added to the diagram of zeroth-order electron-electron interaction with pairing and integration is performed over the entire Fermi surface. Calculations are made assuming a zero temperature, first for an isotropic material and then with anisotropy taken into account. The form of the resulting expression is the same for a single crystal as for a polycrystalline superconductor consisting of variously oriented identical grains. Numerical results based on this expression agree closely with experimental data pertaining to a superconductor with correlation length and light penetration depth of comparable magnitudes. Figures 1; references 4: 3 Russian, 1 Western.

2415/08309

Nash's Problem of Equilibrium Situation in n-Person Positional Game With Memory

18620000f Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 51 No 2, Mar-Apr 87 (manuscript received 24 Jun 86) pp 201-208

[Article by Yu. Ye. Chistyakov, Moscow]

[Abstract] The convergence problem for a sheaf of trajectories with a time limit is considered where the player on the control side uses piecewise-constant strategies with memory but does not know the discrete parameter on which the dynamic system and the terminal set of trajectories depend. It is demonstrated, with the aid of a theorem, that this set can be constructed from the solutions to several standard convergence problems in positional strategies without memory and thus including all initial positions. It is also demonstrated that this set has the property of a bridge, characteristic of solutions to positional convergence problems without indeterminate parameters. The problem is then reduced to the problem of equilibrium situation in an n-person positional differential game, the necessary and sufficient condition for equilibrium of a trajectory being established by a theorem which states that the entire trajectory must be contained in the set of indeterminate parameters. This theorem is followed by two lemmas and two theorems which allow the necessary and sufficient conditions for equilibrium of a trajectory to be reformulated in terms of sets of initial positions. Figures 1; references 3: all Russian.

Nash's, Pareto's, and Stackelberg's Solutions in Nonzero-Sum Differential Games

18620000f Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 51 No 2, Mar-Apr 87 (manuscript received 1 Sep 86) pp 209-215

[Article by A. F. Kleymenov, Sverdlovsk]

[Abstract] A two-person nonzero-sum differential game is considered for a dynamic system, both players having perfect information about the current status of the game so that each can use a positional strategy. The pair of strategies is chosen in three different ways, according to Nash's, Pareto's nonclassical, and Stackelberg's definitions of a solution respectively. Each definition leads to a different set of solutions to four nonstandard problems, one problem of control and three problems of optimum control. An interrelation between the three sets of solutions is established which reveals a common structure. Plane motion of a material point under the resultant action of two control forces, each applied by a different player is examined as an example. Figures 1; references 11: 10 Russian, 1 Western.

2415/9604

UDC 518.7

Optimization Problem for Hammerstein Equation

18620066b Kiev UKRAINSKIY MATEMATICHESKIY ZHURNAL in Russian Vol 38 No 6, Nov-Dec 87 (manuscript received 1 Apr 86, after completion 15 Dec 86) pp 793-796

[Article by Nguyen Byong, VIETNAM]

[Abstract] The optimization problem in the set of solutions to the Hammerstein equation, one with a real intrinsically convex functional weakly semicontinuous from below and with maximal monotonic operators in Banach spaces, is formulated first as a general minimization problem and then as an equivalent variational inequality. A method of regularization based on three theorems, their proof given here, is applied to the optimization problem in original form for a functional consisting of two additive terms and then to the equivalent variational inequality. References 8: 3 Russian, 1 Polish, 4 Western.

2415/08309

UDC 517.9

Validation of Asymptotic Decomposition Algorithm for Finite Number of Approximations

18620066a Kiev UKRAINSKIY MATEMATICHESKIY ZHURNAL in Russian Vol 38 No 6, Nov-Dec 87 (manuscript received 1 Jul 86) pp 732-737

[Article by A. K. Lopatin, Institute of Mathematics, UkSSR Academy of Sciences, Kiev]

[Abstract] The algorithm of asymptotic decomposition is validated by juxtaposition of the original system of equations with perturbatin and a centralized system of equations, the latter obtained from the former by expanding the variables into a Lie series which is then trancated. The solution in the first approximation is considered to establish the principle. In accordance with the existence theorem, aided by convergence and correspondence corollaries after proof, the solution to the truncated centralized system yields the solution to the original system within the Poincare (accent over e) region as well as within some closed subregion. References 5: all Russian.

2415/08309

Problems of Correcting Object Parameters in Image Recognition

18620000g Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 27 No 4, Apr 87 (manuscript received 10 Oct 85) pp 610-616

[Article by N. G. Beletskiy, Sverdlovsk]

[Abstract] The problem of image recognition such as for medical diagnosis is formulated as one of minimizing the change in the description of an object S which is metrically closest to that object and for which the recognition algorithm yields the information vector. The problem is solved for a set of descriptions (αS) [included in] R^n, for nonintersecting classes of objects, and where the recognition algorithm is used for discriminant analysis a "seniority board" algorithm consisting of a sequence of linear algorithms is also employed. Assuming that space R^n is an n-dimensional parallelepiped, this problem of correcting the object parameters and minimizing the correction is transformed into a sequence of problems of convex programming and solved as such by the method of Feuer mappings on the basis of two validating lemmas. The original problem is solvable thus with any a priori prescribed accuracy, in accordance with a theorem which also states what the corresponding sufficient number of problems of convex programming will be. References 5: all Russian.

Decomposition Method for Non-Block-Separable Optimization Problems

18620000g Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 27 No 3, Mar 87 (manuscript received 4 Jul 85, after revision 1 Jul 86) pp 532-539

[Article by I. S. Litvinchev, Moscow]

[Abstract] A decomposition method is proposed for programming optimization problems which do not have a block-separable structure. It involves aggregation of variables in accordance with a block programming scheme and subsequent aggregation of constraints. A maximizable convex function of separated variables is thus replaced by a generally nonconvex function which represents the optimum value of the corresponding maximizable function of aggregate variables. Both the direct problem of maximization and its counterpart minimization problem are solved by this method in two steps, with an arbitrary initial approximation and with the direction of iterations selected in the first step. The effectiveness of this method is based on two existence theorems for disaggregated solutions which yield a local maximum or minimum and two convergence theorems for sequences of disaggregated solutions obtainable by the method of feasible directions. References 8: 7 Russian, 1 Western (in Russian translation).

Efficiency of Reduction of Measurements in Some Problems of Synthesis of Measuring and Computing Systems

18620000g Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 27 No 3, Mar 87 (manuscript received 4 Jul 86, after revision 27 Sep 86) pp 323-331

[Article by A. A. Kozlov and Yu. P. Pytyev, Moscow]

[Abstract] Synthesis of a measuring and computing system on the basis of an experiment with a linear scheme of indirect measurements and on the basis of a model with a priori information on the signal to be processed by that system is considered, the object being to establish the efficiency of reducing those measurements in terms of accuracy tradeoff. A linear reduction operator is defined according to the criterion of minimum total reduction error and relative to a given Hilbert-Schmidt operator symbolizing a standard reference instrument. The efficiency of reduction, a function of technological parameters and model parameters, as well as its upper and lower bounds in the set of all classes of input signals are determined on the basis of two theorems. The results are partly extended to the general case of Hilbert spaces on the basis of three theorems and a corollary to one of them. The efficiency of first-order instrument transducers is determined on the basis of additional theorems. With the classes of input signals for which the efficiency of reducing measurements is maximum and minimum established, it is found that signals of many classes are more efficiently processed on the basis of a priori information than on the basis of instrument readings. References 4: all Russian.

Numerical Experiments in Linear Programming With New Class of Algorithms

18620000g Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 27 No 3, Mar 87 (manuscript received 10 Sep 85) pp 349-356

[Article by S. K. Andrusenko, Ye. A. Nurminskiy, and P. I. Stetsyuk, Kiev]

[Abstract] A new polynomial approximation algorithm is proposed for linear programming, a modification of the Karmarkar algorithm involving projective transformation with a compact constraint matrix and proper selection of the maximum step. Cumbersome a priori estimation of the minimum of the target function is replaced with a priori definition of an indeterminacy interval containing that minimum. Two generators have been constructed for implementation of this method, one generating a problem in the format of an automatic control system and one generating a standard packed structure, both written in FORTRAN with some RATFOR preprocessing. The algorithm was used for solving a problem of balanced single-product transport as well as of three other test problems (ACM TRANS. MATHEMATICAL SOFTWARE Vol 5, No 4, 1979): SC205

problem of economic planning, SCAGR7 problem of scheduling agricultural production, and SCSD1 problem of engineering design. The results of numerical experiments indicate adequate numerical stability and fast convergence. The method already excels the MINOS modification of the simplex method and, when perfected, may excel other methods as well. Tables 5; references 13: 5 Russian, 8 Western (2 in Russian translation).

Problem of Nonlinear Programming With Decrease of Cost Function and Properties of Its Solution

18620000g Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 27 No 3, Mar 87 (manuscript received 9 Jul 85, after revision 4 Apr 86) pp 357-367

[Article by N. B. Zyabrev, Moscow]

[Abstract] Programming with a nonlinear functional and nonlinear constraints is considered, namely of problems with a decrease of the cost function analogous to problems of dynamic programming with convex and concave cost functions. The two specific problems are devising optimum plans for production of an intricate article when the labor invested in main production depends on the volume of ancillary production, in one case with a time constraint and in one case global cost minimization without a time constraint. Definitions of plans completely modified with respect to either of two or both production variables as well as of a consistent plan and of an optimum plan are given for the case of fixed main production as a function of the allotted time. Necessary and sufficient conditions for existence and uniqueness of a solution, a consistent optimum plan, are established on the basis of two theorems with the aid of three lemmas. Following an analysis of the algorithms of the solution, five properties of optimum plans and cost functionals as well as the upper bounds for the minimum of a cost functional are established on the basis of four theorems altogether, a corollary to one, and three statements. References 7: 4 Russian, 3 Western (all in Russian translation).

Algorithm of Simplex Embeddings in Convex Programming

18620000g Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 27 No 3, Mar 87 (manuscript received 25 Apr 84, after revision 14 Jul 86) pp 377-384

[Article by Ye. G. Antsiferov and V. P. Bulatov]

[Abstract] An algorithm representing a variant of the centers-of-gravity method is proposed for convex programming within a limited convex space which satisfies the Slater condition of regularity, with n-dimensional simplexes replacing minimum-volume ellipsoids. A simplex containing a given truncated one is constructed on the basis of a theorem aided by a lemma pertaining to convex uniform minimization. The volume of the optimum simplex containing a given truncated one is estimated, namely its upper bound is established, on the basis of another theorem also aided by a lemma. The algorithm of simplex embeddings consisting of 12 steps, is validated by a third theorem. A comparison of this variant of the centers-of-gravity method with the method of ellipsoids reveals the advantage of the former, namely that the magnitude of volume reduction and thus the convergence rate in each iteration depends here on the number of intercepted vertices rather than being uniform. It also yields an efficient estimate of the indeterminacy interval containing the minimum of the target function. Tables 1; references 3: all Russian.

Optimization of Group Assembly in Automatic Production

18620000g Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 294 No 2, May 87 (manuscript received 10 Dec 85) pp 293-296

[Article by V. N. Burkov and G. S. Khulap]

[Abstract] Conversion of automatic production to group assembly and installation is considered, the main task being to optimally subdivide the entire technological process into groups of operations and to shorten the normative time of individual operations so that, with a given number of groups, the length of the assembly and installation cycle will be as required at a minimum cost of the time reduction. The problem is formulated as one of finding the feasible groupings of operations and the magnitudes of their normative time reduction which will minimize the total cost of that reduction, under the constraints that the time reduction for any operation have zero as the lower bound and the present normative time as the upper bound and that total reduced normative time does not exceed the required length of the assembly and installation cycle. The problem is addressed by an approximate algorithm of graph decomposition which decomposes the graph of technological relations including branches and boundaries, with local optimization, which then solves the problem under two relevant sets of constraints and so yields a decreasing convex total cost function in the optimum solution. The method is validated by a lemma pertaining to existence of such a function and an existence theorem for an optimum grouping of operations. Article was presented by Academician A.A. Voronov on 10 November 1985. Figures 1; references 4: 3 Russian, 1 Western.

Iteration Methods With Saddle Operators

18620000g Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 292 No 5, May 87 (manuscript received 4 Oct 85) pp 1037-1041

[Article by Ye. G. Dyakonov, Moscow State University imeni M. V. Lomonosov]

[Abstract] Efficient iteration methods of seeking saddle points in a Euclidean space for operator equations occurring in many problems of mechanics and physics, are

validated on the basis of six convergence theorems with one lemma for linear saddle operators. Extension to nonlinear saddle operators is possible by using theorems analogous to the key fifth one for linear saddle operators. The efficient iterative search of saddle points based on minimization of a functional in a Euclidean or Hilbert space is examined as an example. Article was presented by Academician S. L. Sobolev on 1 May 1985. References 13: 10 Russian, 3 Western (1 in Russian translation).

Computer-Oriented Algorithm for Solution of Control Problems in Games

18620000g Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 51 No 2, Mar-Apr 87 (manuscript received 30 Oct 85) pp 216-222

[Article by A. M. Tarasyev, V. N. Ushakov, and A. P. Khripunov, Sverdlovsk]

[Abstract] The positional differential game of approaching a target is considered, and an algorithm is constructed for approximate computer simulation of the positional absorption set to control a dynamic system in a plane over some period of time. This algorithm is based on the concepts of a stable-absorption operator and a control-stable bridge, control-stability having time-discrete analogs in accordance with the definition of an approximating system of sets and being covered by two theorems which pertain to a maximally stable bridge and to such a set as a locus respectively. The algorithm is demonstrated using sample discrete approximations including a digitization step which converges at zero, where elements of the approximating set constitute singly-connected sets in the phase space. Figures 1; references 12: all Russian.

Algorithm for Approximate Solution of Traveling-Salesman Problem with Large Number of Target Points and Its Computer-Aided Implementation

18620000g Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 27 No 8, Aug 87 (manuscript received 27 May 86, after revision 26 Jan 87) pp 1145-1153

[Article by I. Kh. Sigal, Moscow]

[Abstract] The traveling-salesman problem is considered, with so many target points that its solution by hybrid branch and bound algorithms ceases to be feasible. For an approximate solution of this problem after input of the initial itinerary an algorithm is proposed which involves successive decomposition of the set of target points into nonintersecting subsets and formation of a tree of corresponding subproblems. Formation of such a tree includes a scan of available information, buildup of the tree, thinning of the tree, and formation of paths. The solution to the problem is then constructed in three steps from the solutions to all subproblems, with local optimization. The algorithm has been programmed for implementation on a computer such as a high-speed BESM-5. It was tested on problems with 48, 57, 74, 100, 105 points respectively, also on a compound problem with 179= 74+ 105 points. The results indicate that it is most effective when all points lie in one plane, interactive correction then becoming feasible. Most effective is also fragment-by-fragment optimization. The machine time economy depends largely on the layout of the computation process. The author thanks A. A. Korbut, Yu. Yu. Finkelshteyn, and V. R. Khachaturov for helpful discussions, V. Z. Sokolovskiy and R. A. Lentsevichyus for providing information about solution of problems. Figures 2; tables 1; references 17: 12 Russian, 5 Western (1 in Russian translation).

2415/9604

Classification of Singularities and Controllability Criteria Pertaining To Bilinear Systems in Plane

18620000h Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 295 No 1, Jul-Aug 87 (manuscript received 4 Mar 86) pp 42-46

[Article by Academician S. V. Yemelyanov, S. K. Korovin, and S. V. Nikitin, All-Union Scientific Research Institute of Systems Research]

[Abstract] The problem of exhaustively classifying autonomous bilinear systems in a two-dimensional space is tackled, such systems being described by the general equation [first derivative of x with respect to time] = f(x) + b(x)·u = Ax+ a- (Bx+ b)u (x- state vector, u- control, A,B- 2x2 matrices, a,b- vectors out of the plane). Affinely equivalent bilinear systems are defined as relating to the same class of second-degree curves and to the same kind of singularity or no singularity. Three classification tables are accordingly constructed. The N-table lists 11 curves including a straight line, two merging straight lines, two intersecting straight lines, and two parallel straight lines as degenerate second-degree curves, also the entire plane as an extreme case. The n-table lists 7 singular points and 2 special cases (B [is not equal to] 0, B = 0) of no singular point. The K-table consists of N= 11 rows and n= 9 columns, subject to a theorem stating that one and only one (N,n) element corresponds to any bilinear system describable by the aforementioned equation. Controllability criteria are established on the basis of six theorems for bilinear systems characterizable according to the N-table. These classifications are interpreted geometrically and illustrated on two typical bilinear systems. Their equivalence classes are referred to a point on a sphere, the three coordinates gl_1, gl_2, gl_3 of this point determining whether the two systems are elliptic ($gl^2/_3 gl_1 gl_2$ [is less than] 0), parabolic ($gl^2/_3 gl_1 gl_2 = 0$), or hyperbolic ($gl^2/_3 gl_1 gl_2$ [is greater than] 0). According to the controllability criteria established here, elliptic systems are controllable, hyperbolic systems are not controllable, and parabolic systems include controllable as well as not controllable ones. The authors thank I.G. Mamedov for helpful discussions. Figures 1; tables 3; references 9: 6 Russian, 3 Western.

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Derivation of One Integrodifferential Equation in Theory of Diffraction

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKOMATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 4, Apr 87 (manuscript received 26 Mar 86) pp 21-25

[Article by Yu. A. Tuchkin, Institute of Radiophysics and Electronics, UkSSR Academy of Sciences, Kharkov]

[Abstract] The integrodifferential equation to which a two-dimensional boundary-value problem in the theory of diffraction reduces is rigorously derived and the conditions for their equivalence are established, for diffraction of acoustic or electromagnetic waves by a simply-connected not self-closing smooth cylindrical shield with the Neumann boundary condition. The derivation is based on a theorem pertaining to integral representation and on natural parametrization with two functions of an argument proportional to the arc length acting as like coordinates of a point on a surface contour. This theorem is followed by three lemmas leading to two other theorems, one pertaining to the function of the same argument which satisfies the integrodifferential equation and one pertaining to this equation. The fourth theorem, which the other three prove, establishes the equivalence of solutions to the boundary-value problem and to the integrodifferential equation, if a solution to the latter exists, under given constraints on the contour. Article was presented by Academician (UkSSR Academy of Sciences) V.P. Shestopalov. References 10: 7 Russian, 3 Western (2 in Russian translation).

Strategy of Second Player in Linear Differential Game

18620000i Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 51 No 2, Mar-Apr 87 (manuscript received 15 Oct 85) pp 193-200

[Article by M. A. Zarkh and V. S. Patsko, Sverdlovsk]

[Abstract] A linear two-player zero-sum differential game is considered with a time limit and with a convex payoff function of only some coordinates of the phase vector. A stable quasi-optimum strategy is constructed for the second player which will guarantee him an outcome close to the stake regardless of his initial position within a given compact. The basic algorithm of this strategy uses information from the payoff polyhedra and their sections in finite-dimensional spaces which, having only a few vertices, limit his choices. This algorithm is expanded to include correction. The problem of landing an aircraft has been reduced to such a game by V. K. Keyn and A. I. Krasov, with the pilot acting as second player against worst possible perturbations caused by wind and exercising vertical control by the feedback method. Figures 5; references 12: all Russian.

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