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UDC 534.2:539.4:548.4

Acoustic Emission Accompanying Elementary Events of Plastic Deformation and Fracture in Solids

18620130a Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 22 Apr 87, in final edition 7 Sep 87) pp 746-723

[Article by V. S. Boyko and L. F. Krivenko, Kharkov Institute of Engineering Physics, UkSSR Academy of Sciences, Kharkov]

[Abstract] Acoustic emission accompanying elastic deformation and fracture events in solids is analyzed on both theoretical and experimental basis. The theory of twinning dynamics applied and a self-adjoint solution to its system of nonlinear integrodifferential equations is obtained for a twin leaving the host crystal after having grown inside, it, a general solution to this system of equations not being obtainable. Experimentally acoustic emission pulses were recorded upon formation of microcracks in Zr, Si, B_4C_3 crystals, the results of measurements agreeing closely with the twinning mechanism. No appreciable acoustic emission was found to accompany microcracking in LiF crystals, which can be explained in terms of the slipping mechanism. The authors thank V. D. Natsik for discussion of the results, L. G. Ivanchenko having assisted with the measurements. Figures 4; references 33: 27 Russian, 6 Western.

12223

Scanning Acoustic Microscope Operating in Ultrasonic Mode

18620112a Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 1, 12 Jan 88 (manuscript received 4 Jul 87) pp 22-24

[Article by S. A. Titov, Moscow Institute of Radio Engineering, Electronics, and Automation]

[Abstract] A scheme for visualization of ultrasonic fields under a scanning acoustic microscope with a linear and space-invariant image forming device is described, the external source of such a field lying in the focal plane of the ultrasonic component. The latter consists of a lens, a sound guide, and a converter. The converter voltage is expressible as a double integral with respect to Cartesian coordinates in the focal plane, the integrand being a convolution of the distribution of the complex field amplitude by the pulse response of the ultrasonic component to a point source. That pulse response is expressible as the Fourier transform of the generalized aperture function. The practicality of this scheme has been established experimentally with a piezosemiconductor-type (ZnO film) converter on the surface of a sapphire single crystal serving as sound guide. Ultrasound was transmitted and received at a frequency of 520 MHz. Mercury was used as immersion fluid so as to ensure a signal-to-noise ratio sufficiently high for revealing the first diffraction ring. The results do not quite agree with numerical evaluation of the Rayleigh diffraction integral for a converter-radiator operating in the piston mode, converter design intricacy and manufacturing imprecision as well as inadequacy of the mathematical model being most likely responsible for the not only quantitative but also qualitative differences. Figures 2; references 4: 1 Russian, 3 Western.

Acoustic Response of Aerosol Medium to Action of Optical Radiation Pulses

18620112b Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 1, 12 Jan 88 (manuscript received 26 Jun 87) pp 25-29

[Article by N. N. Bochkarev, A. A. Zemlyanov, N. P. Krasnenko, V. A. Pogodayev, and A. Ye. Rozhdestvenskiy, Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] In connection with optoacoustic inspection of aerosols, theoretical relations characterizing generation of sound during phase transitions in an aqueous quasi-monodisperse aerosol upon its exposure to laser radiation pulses are used for evaluating the dependence of the total acoustic power on the aerosol concentration and on the surface density of laser pulse energy. The results of calculations, taking into account both evaporation and burst mechanisms of sound generation, are found to agree closely with experimental results pertaining to action of a transverse-excitation atmospheric-pressure CO_2-laser in pulses of 5 J energy and 0.003 ms duration on aqueous aerosol droplets of the 0.0027 mm radius fraction over an interaction space in the form of a 4x4x4 mm^3 cube. A jet of this aerosol was injected through an atomizing nozzle into the caustic region of a spherical mirror focusing the laser radiation after the latter had been passed through semitransparent beam splitters for monitoring purposes. Figures 2; references 4: all Russian.

12223

UDC 537.311.33:534.2

Propagation of Acoustic Phonons in Direction Near to 001 Slip Direction in GaAs

18620102b Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 1, Jan 88 (manuscript received 29 Jun 87) pp 40-44

[Article by B. A. Danilchenko and M. I. Slutskiy, Institute of Physics, UkSSR Academy of Sciences, Kiev]

[Abstract] An experimental study of ballistic acoustic phonons propagating in a direction near the 001 slip direction in GaAs was made, for the purpose of determining their flux distribution as well as their velocities

and the spatial distribution of their group velocities. As specimen was used an n-GaAs crystal with a donor concentration of 5.10^{15} cm^{-3} bounded by (100) planes, 0.86 cm long so as to ensure an adequate resolution of phonon fluxes with a negligible velocity dispersion and 0.8x0.8 cm^2 in cross-section. Measurements were made by the method of heat pulses, using a bolometer with a wideband signal amplifier of signals fed to a programmable stroboscopic oscillograph and using a control microcomputer. Nonequilibrium phonons were generated at one end of the crystal by heating an Au film deposited on the surface with radiation pulses of 10 ns duration from an LGI-21 N_2-laser and were collected at the opposite end by an In film deposited on the surface. The group velocities calculated on the basis of these measurements agree closely with those calculated from polar and azimuthal F-angles of the phonon wave vector in one-frequency planes for given s-angles of the group-velocity vector. The authors thank O. G. Sarbeya for steady interest and helpful discussion of the results. Figures 2; tables 1; references 9: all Western.

12223

UDC 537.311.62

Hole Superconductivity of Mott-Hubbard Insulators

18620130b Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 22 Sep 87) pp 901-903

[Article by B. Ya. Moyzhes and S. G. Suprun, All-Union Scientific Research, Design Engineering, and Manufacturing Engineering Institute of Direct Current, Leningrad]

[Abstract] Hole superconductivity of La_2CuO_4 is evaluated, this compound having one hole in the d-shell of its Cu^{2+} ion and being a Mott-Hubbard insulator characterized by antiferromagnetic ordering detectable by the method of neutron scattering. Calculations based on the Anderson-Hubbard hamiltonian indicate that hole pairs form in neighboring nodes with an additional energy gain owing to localization and, moreover, with retention of the antiferromagnetic state rather than with lossy transition to the ferromagnetic state. Figures 1; references 9: all Western (1 in Russian translation).

12223

UDC 621.315.592:548.522.22

Kinetics of Growth and Doping During Epitaxy of GaAs:S

18620113a Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 31 No 1, Jan 88 (manuscript received 16 Apr 86) pp 71-76

[Article by M. D. Vilisova, L. G. Lavrentyeva, L. P. Porokhovnichenko, and N. A. Chernov, Siberian Institute of Engineering Physics imeni V. D. Kuznetsov, Tomsk State University]

[Abstract] An experimental study concerning epitaxy of GaAs doped with sulfur was made, for the purpose of examining the dependence of growth and doping kinetics on the process conditions. Epitaxial layers of GaAs were grown from the Ga-$AsCl_3$-H_2 system on semi-insulated substrates with $2^{zero}(100)$ orientation and doped with S from Sf_6 plus He gas mixture through a retrodiffusion cell. Three process parameters were varied in a separate experiment each. The deposition temperature was varied over the 675-775 deg C range, with the temperature of the Ga source held constant at the standard 830 deg C or with the difference between the two temperatures held constant at 80 deg C, with the gas flow rate held constant at the standard 30 dm^3/h, and with the $AsCl_3$ concentration in H_2 held constant at the standard 0.4 mol.percent level. The gas flow rate was varied over the 15-110 dm^3/h range under otherwise standard conditions including a 750 deg C deposition temperature. The supersaturation was varied by varying the temperature of the Ga source over the 790-870 deg C range. Evaluation of the results, taking into account attendant chemical reactions which produce adsorbable compounds (H^2S, GaCl) and volatile ones (HCl) in the process, reveals a temperature dependence of the equilibrium impurity distribution as well as a correlation between the epitaxial growth rate and the doping level as either the gas flow rate or the supersaturation level is raised. This correlation indicates that interaction of impurity atoms and host substance with resulting nonequilibrium doping takes place in the adsorption layer. Figures 3; references 17: 5 Russian, 12 Western (1 in Russian translation).

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Desorption of Ions Generated on Molecular Crystal Surface by Femtosecond Laser Pulse

18620125b Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOSY FIZIKI in Russian Vol 47 No 6, 25 Mar 88 (manuscript received 6 Jan 88) pp 294-296

[Article by A. A. Kozlov, V. S. Letokhov, Yu. A. Matveyets, S. V. Chekalin, and A. P. Yartsev, Institute of Spectroscopy, USSR Academy of Sciences]

[Abstract] Photodesorption of molecular ions which had been generated on the surface of polycrystalline metal-free phthalocyanine by a femtosecond pulse of visible or ultraviolet laser radiation was demonstrated in an experiment involving mass-spectroscopy of such ions. A thick layer of fine-dispersed phthalocyanine powder on a metal substrate was treated with laser pulses in two configurations facilitating generation of ions on the surface and in the gaseous phase above the surface, respectively. In the first case 300 fs laser pulses, one of 615 nm visible radiation and one of 308 nm ultraviolet radiation were, in separate tests, focused on the specimen surface inside a time-of-flight mass-spectrometer. In the second case these pulses were focused a fraction of a millimeter above the surface and molecules of the given substance were desorbed by a 10 ns long laser pulse preceding the other by at least 500 ns, a pulse of 532 nm radiation or 1064 nm radiation, under conditions ensuring that none of the laser pulses alone generated an ionic signal. Desorption of ions from the surface was indicated by a lower threshold and a much lower degree of molecule fragmentation than those characterizing desorption from the gaseous phase at such high rates of energy injection, ultraviolet radiation producing even fewer fragment and a larger fraction of molecular ions than visible radiation. Figures 1; references 5: all Russian.

Nonlinear Mode Coupling in Multimode Fiber Optics: Generation of Femtosecond Stimulated-Raman-Scattering Solitons

18620125c Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 6, 25 Mar 88 (manuscript received 26 Jan 88) pp 297-300

[Article by A. B. Grudinin, Ye. M. Lianov, D. V. Korobkin, A. M. Prokhorov, and D. V. Khaydarov, Institute of General Physics, USSR Academy of Sciences]

[Abstract] An experimental study of high-intensity radiation propagating through multimode fiber optics was made, for the purpose of determining its space and time characteristics on the basis of its stimulated Raman scattering. A YAG:Nd^{3+}-laser (1064 nm wavelength) with simultaneous mode locking and Q-switching, pulses of 150 ps duration with a peak power of 600 kW entering a 500 m long optical fiber served as the radiation source. The characteristics of Raman scattering were measured as follows. Its temporal characteristics were measured by the method of background-free intensity autocorrelation, the autocorrelator having a 12-15 fs temporal resolution. Its spectral characteristics were measured with an MDR-4 monochromator and a Ge-photodiode. Its spatial characteristics were measured by comparative scanning of a single-mode fiber with known distribution of the fundamental mode relative to the exit aperture of this multimode fiber. The results revealed formation of femtosecond Raman solitons in the multimode fiber. Although the mechanism of this phenomenon cannot yet be explained, it is evident that the intensity distribution in the exit aperture depends neither on the fiber length nor significantly on the power of entering radiation once the Stokes threshold has been reached, that the intensity distribution within the region of chromatic dispersion represents a superposition of many modes, and that the temporal characteristics of stimulated Raman scattering in a multimode fiber within the region of negative group-velocity dispersion are analogous to those in a single-mode fiber. Figures 3; references 5: 2 Russian, 3 Western (1 in Russian translation).

12223

Giant Raman Scattering and Laser-Induced Desorption

18620112c Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 1, 12 Jan 88 (manuscript received 14 Sep 87) pp 14-17

[Article by O. A. Aktsipetrov and Ye. D. Mishina, Moscow State University imeni M. V. Lomonosov]

[Abstract] Spectroscopy of giant Raman scattering was for the first time used for examining laser-induced desorption of molecules of organic compounds from a metal-fluid interface, the advantage of this method being the large scattering cross-section of such molecules so that their adsorption and desorption can be examined directly at the interface. In the experiment pyridine (C_5H_5N) with a 1010 cm^{-1} molecular-vibration line for giant Raman scattering was first adsorbed by 0.9999 pure polycrystalline silver from a solution of 0.1 mol./l KCl plus 0.05 mol./l C_5H_5N, whereupon the silver surface was anodically etched at a potential of 0.05 V relative to a saturated-AgCl reference electrode with a charge density of 200 mC/cm^2. Surface segments excited for giant Raman scattering were exposed some to 337 nm ultraviolet radiation of a N_2-laser emitting pulses of 7 ns duration at a repetition rate of 1 kHz and some to 1064 nm infrared radiation of a YAG:Nd^{3+}-laser emitting pulses of 15 ns duration at a repetition rate of 12.5 Hz. The intensity of giant Raman scattering during desorption varied in time differently depending on the wavelength of laser radiation and on the surface density of laser pulse energy, revealing a reversible mode of desorption under weak irradiation and an irreversible one under strong irradiation with the transition occurring at about 25 mJ/cm^2 of infrared radiation and about 0.1 mJ/cm^2 of ultraviolet radiation. These results are

explained by coexistence of chemically adsorbed and physically adsorbed pyridine molecules on the silver surface as well as of organosilver complexes acting as binder during etching. Figures 3; references 3: 2 Russian, 1 Western (in Russian translation).

12223

UDC 621.373:535

Use of Phototropic Shutter on Microporous Glass Impregnated With Dye Solution in Nd-Glass Laser Emitting Ultrashort Light Pulses

18620111g Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 64 No 1, Jan 88 (manuscript received 4 Dec 86) pp 213-215

[Article by Ye. G. Pivinskiy and D. S. Prilezhayev]

[Abstract] Experimental results obtained earlier (1985) by other authors and pertaining to use of a phototropic shutter on microporous glass impregnated with isobutanol solution of 3274u dye in a silicate(Nd) glass laser for generating ultrashort light pulses were not only duplicated but also extended in an experiment with a 1 mm thick glass plate immersed in dye solution between two glass wedges and with a 140 mm long cylindrical 10 mm in diameter of GLS-2 silicate(Nd) glass or 7 mm in diameter of GLS-22 phosphate(Nd) glass. The laser emission in this experiment was not directly influenced by insertion of the shutter into the cavity but was determined by the cavity configuration, the latter depending on thermal strains of the active medium. Laser emission pulses were recorded on an AGAT-SF-1 photochronograph for measurement of their duration. Pulses of 15-16 ps average duration and 9 ps minimum duration were generated in a plane cavity with a 1.1 m long base. With the shutter in one fixed position, ultrashort pulses were obtained within 20-30 scintillations but the transparence threshold of the shutter dropped steadily owing to photodiscoloration of the dye and the fraction of free emission increased correspondingly. The only advantage of such a shutter over a liquid one is, therefore, precise repetition of an ultrashort pulse once within successive axial periods. References 7: 4 Russian, 3 Western.

12223

Effervescence of Liquid in Closed Volume Upon Heating by Laser Radiation

18620103c Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 2, 16 Jan 88 (manuscript received 1 Oct 87) pp 157-162

[Article by A. F. Vitshas, N. I. Dmitriyev, V. V. Korneyev, A. A. Kostylev, L. P. Menakhin, and A. M. Soroka, All-Union Institute of Electrical Engineering imeni V. I. Lenin]

[Abstract] An original experimental study was made concerning generation of sound during effervescence of a liquid heated by laser radiation. Water in a vessel with rigid walls was heated with radiation pulses of 9 mks duration from a CO_2-laser, the laser beam being injected from above through a 16 mm thick plate of BaF_2 covering the water surface. Each radiation pulse consisted of a 70 ns wide peak containing 5 percent of the total energy and a much wider tail containing the remainder. The maximum intensity within the pulse peak was varied over the 0.9-7.5 MW/cm^2 range, corresponding to as 0.9-7.5 J/cm^2 range of energy density delivered by a pulse. Pressure measurements at a depth of 5 mm revealed a peak on the trailing edge of the thermoelastic response signal, indicating a thermal mechanism of effervescence with input energy below the 1.7 J/cm^2 threshold, and a second peak with input energy above this threshold indicative of a detonation mechanism. A theoretical interpretation of the results in terms of vapor pressure building up in a constant volume and taking into account the thermophysical characteristics of water, the temperature dependence of its volumetric thermal expansivity assumed to be linear over a wide range, indicates a record high efficiency of energy conversion from optical to acoustical, a much more efficient conversion than in a water layer with free surface. The authors thank L. M. Doroshkin for supplying piezoelectric pressure transducers. Figures 2; references 7: all Russian.

12223

UDC 537.226.33

Effect of Adsorption of Polar Molecules on Formation of Solitons in Noncommensurate Phase of Intrinsic Ferroelectric $Sn_2P_2Se_6$

18620130c Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 27 Apr 87, in final edition 6 Jul 87) pp 870-873

[Article by Yu. V. Popik, I. D. Seykovskiy, and V. N. Zhikharev, Uzhgorod State University, Uzhgorod]

[Abstract] An experimental study of an intrinsic ferroelectric with a noncommensurate phase was made, concerning possible formation of a domain-like periodic structure and its controllability by adsorption of a shielding substance. Specimens of such a ferroelectric, namely $S_2P_2Se_6$ single crystals, were heat treated at 420 K under a vacuum of 7.10^{-7} Pa for 10 h so as to ensure clean surfaces. They were then tested in an O_2 atmosphere under a pressure of 10 Pa and in an atmosphere of CH_3OH vapor, in the latter with temperature cycling over the 170-290 K range and with pressure cycling over the 2-13 Pa range. Both temperature and pressure dependence of the dielectric permittivity in CH_3OH vapor were obtained on the basis of steady-state capacitance and Q-factor measurements at a frequency of 50 kHz, no effect of a domain-like structure having been detected at higher frequencies. Under pressures of 3-13 Pa the dielectric permittivity was found to increase sharply during cooling to 198 K, with an anomalously large hysteresis within the T_{ic} range of the noncommensurate phase. The dielectric permittivity at 198 K was found to increase steeply to a peak under 13 Pa pressure during vapor admission and to decrease steeply after the pressure had dropped to 7 Pa during vapor withdrawal, without hysteresis in the ferroelectric phase and in the para-phase. An interpretation of the results leads to the conclusion that adsorption of dipole molecules facilitates transformation of a polarization wave in such a ferroelectric into a soliton lattice very sensitive to external factors such as temperature and pressure changes. Figures 2; references 7: all Russian

12223

UDC 546.881:539.26

Electronic Structure and Anisotropy of X-Ray Emission and Absorption Spectra of V_2O_5 Single Crystal

18620115a Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 2, Feb 88 (manuscript received 15 Jul 87) pp 386-391

[Article by V. M. Cherkashenko, V. Ye. Dolgikh, and V. L. Volkov, Institute of Metal Physics, Ural Science Center, USSR Academy of Sciences, Sverdlovsk]

[Abstract] The electronic structure of a V_2O_5 single crystal is examined on the basis of its K emission and absorption spectra characterizing its $4p_x$ and $4p_y$ states. The aniotropy of these spectra indicates that the wave functions bridging O_3 atoms are not involved in the lower part of the conduction band, the electrical conductivity of such a crystal therefore being much lower in the data obtained at room temperature. The authors thank V. I. Anisimov for discussion. Figures 3; reference 9: 3 Russian, 6 Western.

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Description of Differential Cross-Section for pp-Scattering With 546 GeV Energy (Square Root of s) Within Coulomb-Nuclear Interference Range

18620125a Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 6, 25 Mar 88 (manuscript received 5 Feb 88) pp 288-291

[Article by L. L. Yenkovskiy and B. V. Struminskiy, Institute of Theoretical Physics, UkSSR Academy of Sciences, and A. N. Shelkovenko, Institute of High-Energy Physics, Serpukhov]

[Abstract] New experimental data on forward pp-scattering with 546 GeV energy and a much larger real part than imaginary part of the Coulomb scattering amplitude are compared with calculations according to the authors' model of elastic scattering. After some curve fitting, the time derivative of the cross-section for that 546 GeV pp-scattering as well as its strong-interaction component are found to agree closely with the calculated ones over the up to 0.040 GeV/s^2 range. Extrapolation allows predicting that differential cross-section within the Tevatron energy range with the square-root of s equal to 1.8 TeV. Figures 3; references 8: 1 Russian, 7 Western.

12223

Interpretation of Events Recorded by Underground Detectors on 23 February 1987 at 7:35 Universal Time

18620124a Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 5, 10 Mar 88 (manuscript received 29 Jan 88) pp 236-239

[Article by O. G. Ryazhskaya and V. G. Ryasnyy, Institute of Nuclear Research, USSR Academy of Sciences]

[Abstract] A new interpretation of events recorded by both Kamiokande-2 and IMB underground detectors as well as by the Baksan underground scintillation telescope on 23 February 1987 at about 7:35 Universal Time as events of neutrino-electron interaction involving neutrino fluxes with 3.10^{53} ergs total energy from the supernova CH 1987 A in the Great Magellan Nebula is attempted, their interpretation in terms of random background fluctuation being hardly plausible. Maximum-likelihood estimates of the average numbers of positrons

(isotropic component) and electrons (anisotropic component) on the basis of the electron creation cross-sections and on the resulting electron energy spectrum within 99-percent, 95-percent, and 90-percent confidence limits respectively are not yet quite consistent with available experimental data. Evidently interpretation on the basis of a single hypothesis is inadequate and other factors such as the effect of perturbations in the geomagnetic field on the detector count rate in underground facilities need to be included. The authors thank G. T. Zatsepin, V. L. Dadykin, C. Castagnioli, and G. Cini for discussion. Figures 2; references 18: 6 Russian, 7 Western, 5 ICRC (3 by Russian authors).

12223

Beta-Spectrometer for Measuring Rest Mass of Neutrino

18620112d Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 1, 12 Jan 89 (manuscript received 30 Jul 87) pp 49-52

[Article by M. Ye. Gertsenshteyn, A. V. Zhigunova, and V. V. Klavdiyev, Scientific Research Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonsov]

[Abstract] A special beta-spectrometer for measuring the rest mass of a neutrino is described, this mass being now known to lie between 17 eV and 40 eV according to most recent data and beta spectra having so far yielded only its upper bound. The spectrometer, an integral one using a large source, has a negatively charged hollow cylindrical electrode with an inside radius of 0.2 m acting as electrostatic barrier for electrons moving through it from the source to the detector in a constant and ideally uniform longitudinal magnetic field. A coaxial row of guard rings between the source and the cylinder entrance ensures a smooth potential fall along that space. Unavoidable slight nonuniformity of the magnetic field and appreciable nonuniformity of the electric field cause nonuniform variation of the longitudinal electron momentum along the 1.8 m long path from the source to the plane of the detector inside the cylinder. The resulting distortion of the analyzed beta-spectrum and the attendant statistical error of energy measurement can be reduced to below 1 eV by use of a source about 40 cm in diameter and 10 tritium layers thick. This conclusion is based on an analysis of electron ballistics in such a configuration, considering that only electrons with an initial energy higher than the electrostatic barrier will reach the detector. Figures 1; references 8: 5 Russian, 3 Western.

12223

UDC 539.194.01

Hertzberg-Teller Effect and Intensity Distribution Over Spectra of Resonant Raman Scattering by Monoatomic Molecules

18620111f Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 64 No 1, Jan 88 (manuscript received 28 Mar 86) pp 182-185

[Article by M. V. Priyutov and T. G. Burova]

[Abstract] The intensity distribution of resonant Raman scattering by monoatomic molecules over spectral bands resolvable with respect to symmetry of transitions is calculated, taking into account that components of the scattering tensor are not factorizable into multiplicands representing individual oscillators and the Hertzberg-Teller effect can give rise to forbidden lines just as in the electronic spectra of absorption and emission. With the radiative width of the intermediate state, the Kramers-Heisenberg formula for the Stokes line corresponding to excitation of a vibrational level from ground level of the electronic state is simplified by also disregarding the electronic-vibrational shift of the electronic state and by expressing the matrix elements of the dipole moment in the Hertzberg-Teller approximation. For validation of this procedure, relative intensities of lines in the resonant Raman scattering spectrum by benzene molecules and by toluene molecules upon their excitation by laser radiation at 212.8 nm have been calculated in accordance with group theory and considering that the Franck-Condon integrals are small in the presence of a frequency effect alone. They agree closely enough with the results of measurements. For convenience, moreover, the algorithms of this calculation method have been programmed in FORTRAN language for a Unified System computer. Figures 1; tables 1; references 9: 6 Russian, 3 Western.

12223

Magnetic Moment of Neutrino in Model With Flavor Symmetry of Leptons

18620108a Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 1, 10 Jan 88 (manuscript received 9 Nov 87) pp 3-5

[Article by M. A. Stefanov, Moscow State University imeni M. V. Lomonosov]

[Abstract] The anomalously large magnetic moment of an electronic neutrino cannot be explained on the basis of the standard SU(2)xU(1) model of electroweak interaction with a minimal scalar sector, because this model yields a much smaller magnetic moment. A model with SU(3) flavor symmetry of leptons is proposed which avoids a change of fragrance and evidently yields a value of this magnetic moment much closer to the $1/10^{10}$-th of

a Bohr magneton according to the relation between the number of solar spots and the magnitude of the neutrino flux emitted by the sun. Constraints on the constants g and f in the expression for the magnetic moment of an electronic neutrino are established, taking into account interaction of leptons with additional scalars and consequently efficient four-fermion interaction at the low-energy extreme. The contribution of this interaction to decay of a polarized muon is calculated analytically, taking into account its widening of a muon and the resulting asymmetry. The author thanks M. B. Voloshin for invaluable assistance and support. Figures 1; references 6: 1 Russian, 5 Western.

12223

UDC 535.37.5

Raman Scattering of Light in Solid Solutions With Garnet Structure

18620115b Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 2, Feb 88 (manuscript received 22 May 87, in final version 31 Aug 87) pp 512-519

[Article by Yu. K. Voronko, L. M. Yershova, N. A. Yeskov, A. B. Kudryavtsev, V. V. Osiko, A. A. Sobol, and Ye. V. Sorokin, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] An experimental study of Raman light scattering in crystals of solid solutions with a garnet structure was made, using a Speks-Ramalog 1403 spectrometer for measurement of the spectra and a 1.5 W Ar-laser for excitation at both 514.5 nm and 488 mm wavelengths. Four continuous series of such solid solutions were sampled: two simple ones $(Y_xLu_{1-x})_3Al_5O_{12}$ and $(Ca_xNd_{1-x})_3Ga_2(Ge_xGa_{1-x})_3O_{12}$ in the form of single crystals, two mixed ones $x(Ca_3Nb_{1.5}Ga_{3.5}O_{12})$-(1-x) $(Ca_3Ga_2Ge_3O_{12})$ and x(Ca3Nb1.69Ga3.2square 0.11O12)-(1-x)$(Ca_3Ga_2Ge_3O_{12})$ in the form of single crystals grown from the melt and in the form of polycrystals sintered at 1300 deg C. Measurements were made at temperatures of 295 K and 1525 or 1695 K. The results are systematically evaluated, and interpreted theoretically with consideration of Ia3d(O_h^{10}) cubic symmetry and stoichiometric relations. Figures 4; tables 2; references 17: 14 Russian, 3 Western (1 in Russian translation).

12223

Sharp Focusing of Atomic Beam Into Angstrom Spot by Means of Laser Radiation

18620119b Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 94 No 1, Jan 88 (manuscript received 30 Mar 87) pp 140-150

[Article by V. I. Balykin and V. S. Letokhov, Institute of Spectroscopy, USSR Academy of Sciences]

[Abstract] Focusing an atomic beam in the form of a de Broglie wave by means of a laser beam is considered for microscopy with Angstrom space resolution, the potential field of laser radiation focusing the atomic beam into a spot of the order of a radiation wavelength. The resolution of such a laser objective is limited essentially by four factors, two of them being chromatic aberration caused by strong dependence of the focal length on the atom velocity and spherical aberration caused by nonideal geometry of a real laser radiation field. The other two factors are diffraction of atoms around the aperture and impulsive diffusion of atoms following spontaneous reradiation of photons. Each of these factors is evaluated by analysis of processes occurring in the objective. The density distribution of such an atomic beam in the focal plane is calculated on this basis in the ideal case as well as with each of these factors individually taken into account, with the focal spot one wavelength or ten wavelengths wide and with the laser power 1 W or 0.01 mW. The authors thank S. V. Shulga for assisting with computer calculations, Yu. Ye. Lozovik and V. G. Minogin for helpful discussion of the results, and the reviewer for comments regarding the role of laser radiation fluctuations. Figures 5; references 15: 7 Russian, 8 Western (3 in Russian translation).

Giant Impurity Nonlinearities in Optics of Fractal Clusters

18620119c Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 94 No 1, Jan 88 (manuscript received 16 Mar 87) pp 107-124

[Abstract] An original theory is constructed describing nonlinear optical properties associated with fractal clusters, noninteger-dimensional structures in three-dimensional space. A fractal cluster consisting of N monomers located each at a discrete point with random coordinates and polarizable into dipoles at optical frequencies is considered, the probability of another monomer residing at a certain distance from a given monomer being determined by the pair correlation function. Calculation of its nonlinear optical impurity susceptibility reveals giant enhancement of the latter for coherent anti-Stokes light scattering and phase conjugation. Harmonic analysis of emission amplification indicates an enhancement of the nonlinear optical susceptibility relative to that of free impurity molecules, the resulting gain being high in the third-harmonic mode but becoming smaller in successively higher-order modes. The authors thank Yu. Ye. Nesterikhin, A. K. Popov, and S. G. Rautian for helpful discussions and constant assistance, also S. Yu. Novozhilov and A. M. Shalagin for valuable comments. Figures 3; references 10: 4 Russian, 6 Western (3 in Russian translation).

12223

UDC 543.51.546.26

Discovery of Anomalous Fractionation of Isotopes During Laser Mass-Spectrometry of Heavy Elements

18620113b Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 31, No 1, Jan 88 (manuscript received 21 May 86) pp 89-94

[Article by Yu. A. Bykovskiy, V. T. Timoshin, I. D. Laptev, and E. A. Manykin, Moscow Institute of Engineering Physics]

[Abstract] In an experimental study with a laser mass-spectrometer specimens of rocks, seabed debris, and sea shells were analyzed for isotopic composition of heavy elements. Measurements were made with a JMS 01BM-2

instrument and with plasmas generated by laser irradiation as ion sources, a laser beam with a power density higher than 2.10^9 W/cm^2 producing ion beams with compositions identical to that of the respective materials. The mass-spectra were recorded on Ilford Q-2 photographic film by successive exposures to 3.10^{-4}-10 nC charges and then processed in an MD-100 microdensitometer with a sensitivity range of $100\text{-}10^{-4}$ atom.percent and with a relative error not exceeding 10 percent at the 0.95 confidence level. They have yielded quantitatively Nd,Gd,Dy,Pb isotopes in the rock specimens, Ti,Fe,Br,Ba isotopes in the specimens of seabed debris, and Sr isotopes in the sea shells. Comparison of the results with relevant characteristic of the respective nuclei reveals an anomalous fractionation of isotopes in these materials, this anomaly correlating with the combination of signs of the magnetic moment and the quadrupole electric moment of respective nuclei. Figures 1; tables 1; references 13: 12 Russian, 1 Western.

12223

First Experiment With Image Transmission by Means of Bragg-Fresnel X-Ray Lens

18620112e Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 1, 12 Jan 88 (manuscript received 18 Sep 87) pp 3-6

[Article by V. V. Aristov, Yu. A. Basov, G. N. Kulipanov, V. F. Pindyurin, A. A. Snigirev, and A. S. Sokolov, Institute of Technological Problems in Microelectronics and Extra-Pure Materials, USSR Academy of Sciences]

[Abstract] The first experiment with image transmission by means of a Bragg-Fresnel lens in a field of polychromatic hard X-radiation was performed, using a coil of superconductor material mounted on a VEPP-2M 630 MeV electron-positron storage with 0.200 mm thick beryllium window as source of synchrotron radiation and a linear Fresnel zone plate mounted on a perfect Si single crystal with reflecting surface as lens. This lens was 0.200 mm wide and 1 mm long, all zones being 0.003 mm high mesas with the zone at the center 0.020 mm wide and the zones at the edges 0.005 mm wide. The lens was placed 15 m away from the radiation source between a 0.007 mm thick nickel grid with a 0.020 mm period in both directions serving as object, 15 cm in front of the lens, and an image projector. The grid faced an undulator through a slit. Topograms and densitograms obtained with the sapphire surface reflecting 0.17 nm radiation confirm the feasibility of such image transmission. Figures 2; references 12: 11 Russian, 1 Western.

12223

UDC 535.853-1

New Results in Development and Study of Spectrometers Based on Spontaneous Emission of Coherent Radiation

18620111a Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 64 No 1, Jan 88 (manuscript received 5 Jun 87) pp 3-4

[Article by L. I. Gershteyn, V. L. Vaks, and S. I. Pripolzin]

[Abstract] New achievements in the development of microwave scanning spectrometers which operate with spontaneous emission of coherent radiation include higher sensitivity and resolution. Temporal or spatial separation of the spontaneously emitted radiation from the exciting radiation which polarizes molecules of the lasing gas at the frequency corresponding to the emission line of that gas is achieved by heterodyning the generator of polarizing radiation. This generator at one instant of time interacts with the gas and at another instant of time re-emits polarizing radiation while its frequency departs from the resonance frequency, the resulting frequency deviation being equal to the intermediate frequency in the receiver. Such a frequency switching is made feasible by stabilization of the generator frequency in each mode as well as of the frequency switching amplitude. While the method of frequency switching was tested on a millimetric-wave experimental spectrometer, a new variant was built with a sensitivity only one order of magnitude lower than the theoretically highest level. Such an improvement is attributable to replacement of amplitude detection and subsequent averaging with synchronous detection using a reference signal synthesized in the spectrometer as well as to suppression of the "parasitic" signal associated with amplitude overshoots during frequency switching of the frequency synthesizer used as heterodyne generator and suppression of the weaker "ringing" signal in the receiver by shutting the intermediate-frequency channel for a duration slightly longer than the switching time. The improvement of sensitivity is accompanied by an improvement of resolution, the highest attainable for linear spectroscopy being determined by the Doppler band widening. Figures 1; references 6: 5 Russian, 1 Czechoslovak.

UDC 535.34+539.186

Coherent Two-Photon Absorption of Ultrashort Light Pulses

18620111b Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 64 No 1, Jan 88 (manuscript received 25 Jun 86) pp 42-45

[Article by V. M. Arutyunyan, N. Sh. Badanyan, A. A. Chakhmakhchyan, and N. V. Shakhnazaryan]

[Abstract] Nondegenerate sequential two-photon excitation of atoms by elliptically polarized and coherently propagating light pulses of duration shorter than every relaxation time in the system is analyzed in the one-dimensional approximation. The light pulses are, for convenience, resolved into circular components with dextropolarization and levulopolarization respectively. Two modes of atom transitions successively from ground state 1 to state 2 and from state 2 to state 3, upon absorption of light pulses, are considered: with the total moments J_1, J_2, J_3 equal to 0, 1, 0 respectively or 1/2, 3/2, ½ respectively. The short Maxwell equations for the circular field components and the Schroedinger equation for the amplitudes of states in the approximation of

slowly changing populations are solved simultaneously for appropriate initial conditions in each case. Figures 2; references 3: 1 Russian, 2 Western.

UDC 535.375.5+539.194:546.15

Resonant Raman Scattering of Light by $^3PI_{Ou}^+$-State of Iodine Molecule

18620111c Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 64 No 1, Jan 88 (manuscript received 6 Apr 87) pp 69-72

[Article by I. M. Umanskiy, V. L. Bakhrakh, and S. I. Vetchinkin]

[Abstract] Anomalies of resonant Raman light scattering by iodine molecules, namely rising intensity of higher-order lines and intricate alternation of intensity along the entire sequence of harmonics up to the 80-th recorded experimentally with 514.5 nm exciting radiation at a frequency close to resonance with the $^1sigma_g^+$-transition, is interpreted analytically in accordance with a quasi-classical theory. The $^3pi_{Ou}^+$-term of an I_2 molecule, reconstructed on this basis, is compared and found to agree closely with that obtained from the absorption spectrum by the Rydberg-Klein-Ries method over a wide range of interatomic distances up to 0.4 nm. Figures 3; references 9: 3 Russian, 6 Western.

UDC 535.375.5:539.194:532.783

Effect of Conformative Degrees of Freedom in Molecules on Width of Raman Light Scattering Bands in Liquid Crystal

18620111d Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 64 No 1, Jan 88 (manuscript received 1 Dec 86) pp 210-212

[Article by I. P. Pinkevich and V. Yu. Reshetnyak]

[Abstract] The influence of flexible terminal atom groups in nematic liquid crystals on Raman light scattering by intermolecular vibrations in such crystals and on the orientation characteristics of their rigid skeleton is interpreted in terms of conformative degrees of freedom, conformative mobility of these atomic groups being shown to widen the Raman scattering bands. Theoretical analysis in the Mayer-Saupe approximation and numerical estimates for MOAT liquid crystals indicate that, with the aid of experimental data, it is possible to determine the temperature at which the movement of such atom groups becomes disordered and also the parameters of V_{ij}^{ar} orientational interaction. References 6: all Russian.

12223

Sensitization of Luminescence of Rare-Earth Ions in Glasses by Trivalent Iron

18620108b Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 1, 10 Jan 88 (manuscript received 22 Sep 87) pp 32-34

[Article by G. Ye. Malashkevich, M. V. Korzhik, M. G. Livshits, A. L. Blinov, and M. A. Borik, Institute of Physics, BSSR Academy of Sciences]

[Abstract] It was discovered in an experimental study that trivalent iron, having a high-luminosity band of charge transfer to its ions from ions of bivalent oxygen with attendant emission of ultraviolet light, will activate luminescence of rare-earth ions in alkali-free oxide glasses. This has been revealed by the true absorption, luminescence emission, and luminescence excitation spectra of such glasses activated by Fe^{3+} ions as well as by Nd^{3+}, Er^{3+}, Yb^{3+} ions at a temperature of 298 K. Absorption of visible light by Fe^{3+} ions being associated with spin-forbidden intraconfigurational transition, absorption of light by these glasses must be principally due to charge transfer within a band with a longwave edge. The luminescence emission spectra of these glasses consist of two bands, one with a higher peak about the 490 nm wavelength and one with a lower peak about the 750 nm wavelength. Their luminescence excitation spectra almost coincide with their luminescence emission spectra in the ultraviolet range and are similar to the absorption spectrum of Fe^{3+} ions in the visible and near infrared range. Figures 1; references 5: 4 Russian, 1 Western.

12223

UDC 534.19

Anisotropic Characteristics and Spatial Correlation of Oceanic Noise Field

18620110a Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 34 No 1, Jan 88 (manuscript received 24 Nov 86) pp 8-11

[Article by A. A. Aredov, Institute of Acoustics imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] The space-time correlation functions of the oceanic noise field are determined from its anisotropic characteristics on the basis of a noise generation model, in a geometrical acoustics approximation, for a layerwise homogeneous ocean with noncorrelated acoustic dipoles uniformly spaced over its surface. Two nondirectional receivers a distance d apart are considered in a steady horizontally isotropic and vertically anisotropic noise field of intensity I(a,f) (a- angle from vertical, f- frequency). Using the normalized space correlation function for zero time delay and a finite frequency band with center frequency f_O, calculations of the sound velocity profile have been made for the tropical zone with underwater channel, for the temperature zones in winter, for the circumpolar zone with surface channel, and for a shallow-wave region. Vertical noise radiation patterns have been calculated for a receiver at a large depth of 200 m as well as for receivers at small depths of 100 m and 50 m. The results indicate that while the noise field at a receiver in the tropical zone and in the circumpolar zones is formed by local sources with an energy dip about the horizontal directions and by remote sources with an energy peak about the horizontal directions respectively, in the temperature zones it is appreciably influenced by the ocean bed. The results pertaining to deep-water regions have been generally confirmed by experimental data based on measurements. Figures 2; references 8: 5 Russian, 3 Western.

UDC 551.463

Low-Frequency Dynamic Noise in Randomly Nonhomogeneous Ocean

18620110b Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 34 No 1, Jan 88 (manuscript received 24 Jun 87) pp 12-18

[Article by V. V. Armelnyy, I. N. Didenkulov, and M. A. Rayevskiy, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] Available experimental data on the dynamics of low-frequency noise in oceanic waveguides, underwater acoustic channels, are theoretically interpreted by including multiple scattering of acoustic waves by large-scale inhomogeneities in a randomly nonhomogeneous ocean rather than on the basis of the simpler but inadequate model of a regular lossy plane-laminar oceanic acoustic waveguide. A refractive waveguide is considered within which statistically uniform and horizontally isotropic three-dimensional fluctuations of the acoustic velocity occur. Analysis of the noise dynamics is based on the equation for intensity of normal waveguide modes in the "forward scattering" approximation and assuming a Garret-Munk spectrum of internal waves. The calculated space distribution of noise intensity and frequency characteristic of noise gain agree closely with experimental data based on measurements at low wind velocity, application of the Wentzel-Kramers-Brillouin method being helpful in the case of high wind velocity with dominant effect of local noise sources and negligible dissipation. Figures 3; references 15: 10 Russian, 5 Western.

UDC 534.222

Use of Sound Ray Representation for Calculating Acoustic Field in Oceanic Waveguide by Method of Quasi-Normal Waves

18620110c Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 34 No 1, Jan 88 (manuscript received 7 May 87) pp 44-48

[Article by N. A. Veshev, Leningrad Institute of Aviation Instruments Design]

[Abstract] The acoustic field in an oceanic waveguide is calculated by use of the sound ray representation in a system of dimensionless two horizontal and one vertical coordinates. Analysis of the problem is based on the model of a weakly irregular waveguide rather than a plane-laminar one and on the method of quasi-normal waves, their phase velocity being calculated in the adiabatic approximation and ignoring the continuous part of the spectrum. Not all normal modes contribute to the acoustic field in such waveguides but only those with eigenvalues of the transverse operator in the direction of propagation close to singular points on the eikonal. Eigenfunctions of the transverse operator in the vertical plane in the direction of propagation are expanded into Wentzel-Kramers-Brillouin asymptotic series, whereupon summation of modes is performed according to the Poisson formula with cosines replaced by their exponential equivalents according to the Euler formula. The eikonal is then obtained in terms of Airy functions in the Fock notation and the phase velocity of quasi-normal waves is calculated by solution of the wave equation. Numerical results are shown typical of a point sound source and quasi-normal waves whose source lies between reversal points of the wave equation. The author thanks S. Yu. Slavyan for discussion. Figures 3; tables 1; references 4: all Russian.

UDC 551.463.21

Effect of Absorbent Seabed on Frequency Spectrum of Noise Field in Shallow Water

18620110d Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 34 No 1, Jan 88 (manuscript received 14 Nov 86) pp 172-174

[Article by Ye. I. Derevyagina and B. G. Katsnelson, Voronezh State University imeni Lenin Komsomol]

[Abstract] The spectral intensity density of a noise field produced in shallow water by distributed surface sources is calculated, assuming that the noise sources are statis-

tically independent dipoles. The noise field at frequency f produced by an individual dipole with moment M is proportional to the sum of functions representing normal modes, each multiplied by the value of its first derivative at the source, these modes being obtainable from the solution to the corresponding Sturm problem and expressed here in the Wentzel-Kramers-Brillouin approximation. An analysis of the results reveals that the contribution of nearby noise sources, which produce the continuous part of the spectrum, is negligible for a receiver located above a not too strongly absorbing seabed but not too close to the surface. The effect of the seabed is significant, especially when its boundary is rough so that scattering of acoustic waves occurs. This is confirmed by data on the frequency spectrum of a noise field which indicate much stronger noise attenuation, throughout the 30-1000 Hz frequency range, by a sand bed (rought) than by a clay bed (smooth). Figures 1; references 8: 4 Russian, 4 Western (2 in Russian translation).

12223

Stabilization of Superconducting State in High-Temperature Superconductor Materials

18620138a Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 6, 26 Mar 88 (manuscript received 27 Dec 87) pp 561-564

[Article by A. Vl. Gurevich, R. G. Mints, and A. L. Rakhmanov, Institute of High Temperatures, USSR Academy of Sciences, Moscow]

[Abstract] Stabilization of the superconducting state in high-temperature composite superconductor materials at liquid-nitrogen temperatures is analyzed theoretically, taking into account changes in the build-up of thermomagnetic instabilities as well as nascence and propagation of the normal state as the temperature of the coolant is changed from 4.2 K to 77.4 K. The ratio of coefficients characterizing diffusion of heat and of magnetic flux becomes much smaller than unity at the higher temperature, redistribution of the magnetic flux occurring adiabatically. Considering that the maximum allowable diameter of a superconductor wire is determined by the adiabatic stability criterion for the superconducting state and that erasure of superconductivity by the transport current induced by local heat pulses follows nascence and propagation of the normal state self-sustainable by Joule-effect heating, change from liquid-He cooling to liquid-N_2 cooling is found not to significantly change the level of cryostatic stability of the superconducting state. Neither the value of the stocli parameter nor the minimum current of normal-state propagation change significantly, the former being largely determined by the critical current density. The dynamic stability of the superconducting state against perturbation pulses increases owing to a tremendous increase of the specific heat, by 3-4 orders of magnitude, so that the probability of transition to the normal state after partial stabilization of the superconducting state decreases and the current density can be raised appreciably without loss of superconductivity. References 3: Russian.

12223

UDC 537.312.62

Experimental Detection of Charge Imbalance on Superconductor Quasiparticles in Electromagnetic Field

18620130d Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 22 Jun 87) pp 867-870

[Article by G. A. Ovsyannikov, S. V. Proklov, and I. L. Serpuchenko, Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow]

[Abstract] An experimental study of a a nonequilibrium superconductor was made for detection and evaluation of charge imbalance on its quasiparticles, following injection of excess quasiparticles upon passage of current across the N-S boundary in a weak microwave electromagnetic field. Measurements were made with an S-I-N junction built into a window in an SiO_2 layer covering an Nb superconductor film and in an Al normal-metal top layer, an Al_2O_3 insulator interlayer acting as barrier between these S and N layers. The dependence of its microwave imbalance response voltage and of its differential resistance on both microwave and direct current flowing through the superconductor was measured over the 4.2-7.4 K temperature range with the microwave field modulated so as to minimize the effects of temperature drift and 1/f-noise on the readings, a 15 kHz modulation frequency found to be suitable for recording the microwave response voltage through a cooled transformer and a low-noise amplifier. The results, namely increase of the microwave voltage with increasing superconduction momentum and absence of a microwave response in the normal metal as well as the anomalous response of such an S-I-N junction within the linear range of the direct voltage-current characteristic and concurrence of the maximum microwave response voltage with the peak of the d_2V/dI_2-I curve, indicate that anomalous scattering of holes and electrons during unpairing action is the most likely mechanism of charge unbalance build-up on superconductor quasiparticles. The authors thank A. V. Zaytsev for stimulating discussions, A. N. Vystavkin and V. N. Gubankov for interest, and V. P. Koshelts for assisting with preparation of specimens. Figures 2; references 7: 4 Russian, 3 Western.

UDC 538.975

Anomalies of Linear Thermal Expansion of $YBa_2Cu_3O_{7-x}$ Ceramic

18620130e Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 31 Jul 87) pp 877-879

[Article by G. D. Sulmanov, V. D. Checherskiy, R. M. Mirzababayev, S. G. Ibragimov, and G. D. Guseynov, State Institute of Nitrogen Industry and Organic Synthesis, Moscow]

[Abstract] An experimental study of $YBa_2Cu_3O_{7-x}$ ceramic has revealed anomalies of its linear thermal expansion. Specimens containing at least 97 percent 1-2-3 phase were synthesized by the cryochemical processes involving rapid solidification of a solution of salts and their dehydrating sublimation with subsequent thermal decomposition of the salts followed by heat treatment of the complex-oxide ceramic in air. The coefficient of linear thermal expansion was measured with two "Linsays" dilatometers, in a He atmosphere, with an L-75/80 instrument over the 77-323-77K heating-cooling range and with an L-75/20 instrument over the 293-773-293 K heating cooling range. The results indicate anomalously large dips of this coefficient, one within the 90-120 K range and least two within the 300-700 K range of its otherwise monotonic temperature

dependence. These dips correspond to phase transformation, the minimum value of the coefficient being reached at slightly lower temperatures during cooling than during heating. Figures 2; references 5: 3 Russian, 2 Western.

UDC 538.945:538.951

Temperature Dependence of Acoustic Velocity in Y-Ba-Cu-O Ceramic

18620130f Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 3 Jul 87, in final edition 11 Aug 87) pp 882-884

[Article by L. A. Chernozatonskiy, A. I. Golovashkin, O. M. Ivanenko, K. V. Mitsen, L. L. Paltsev, V. I. Pustovoyt, Ye. F. Tokarev, F. Sh. Khatamov, and V. N. Shorin, All-Union Scientific Research Institute of Physicotechnical and Radiotechnical Measurements, Moscow Oblast]

[Abstract] An experimental acoustic study of $YBa_2Cu_3O_{7-x}$ (x approximately 0.1) superconducting ceramic was made, for the purpose of determining the temperature dependence of the velocity of longitudinal ultrasonic waves in this material. Specimens of at least 99 percent pure 1-2-3 phase with superconducting transition at a temperature of 92 K, 3-5 mm thick disks 8-16 mm in diameter, were tested over the 70-190 K temperature range by the echo pulse-phase method with use of interferograms. The temperature, read with a Pt resistance thermometer, was varied in 1 K steps and stabilized for 30 min at each point. The readings revealed a wide dip of acoustic velocity with the minimum at about 80 K and a sharp dip with the same minimum acoustic velocity at the superconducting transition temperature, followed by a wide peak and slowly decreasing acoustic velocity with soft dips at successively higher temperatures. The sharp dip is attributable to strong fluctuations associated with antiferromagnetic instability as the Neel point approaches the superconducting transition temperature. The temperature dependence of the absorption coefficient could not be accurately recorded on the basis of echo signals, owing to strong scattering in the granular and porous structure, the power density of the ultrasound source being 100 mW/cm^2. The authors thank Z. M. Magomedov for assistance with conducting the experiment and participants of the All-Moscow seminar under the chairmanship of V. L. Ginzburg for discussion of the results. Figures 1; references 8: 1 Russian, 7 Western (2 in Russian translation).

UDC 537.312.8

Stability of Nonlinear Thermomagnetic Wave in Type-II Superconductors

18620130g Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 12 Jan 87, in final edition 31 Aug 87) pp 887-888

[Article by A. A. Adkhamov, I. L. Maksimov, and N. A. Taylanov, Samarkand State University imeni A. Navoi, Samarkand]

[Abstract] The steady state of a nonlinear thermomagnetic wave in a type-II superconductor is analyzed for stability in a field of small thermomagnetic perturbations. The critical state of such a superconductor is considered and the dynamic equation is solved for the spectrum of eigenvalues, after linearization by additive coupling of thermal and electromagnetic perturbations. The corresponding coupled Maxwell equation and equation of heat conduction lead to a fourth-order ordinary differential equation with variable coefficients describing the longitudinal profile of the amplitude of electric field variation, this equation not being solvable in the general case but greatly simplifiable in the case of a plane semiinfinitely long medium only slightly heated above its equilibrium temperature and then reducible to the Schroedinger equation for a particle with an asymmetric potential well. The authors thank A. P. Pardayev for interest and helpful discussions. References 4: all Russian.

UDC 537.32:546

New Condo System $CeNiGa_2$ With Strong Orbital Degeneracy

18620130h Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 21 Sep 87) pp 893-894

[Article by M. D. Koterlin, B. S. Morozhivskiy, and Yu. M. Grin, Lvov State University imeni I. Franko, Lvov]

[Abstract] An experimental study of $CeNiGa_{0.5}$, $CeNiGa_2$, $CeNiGa_3$ compounds was made involving measurement of their thermo-e.m.f. and electrical resistivity over the 4.2-400 K temperature range, these compounds containing a rare-earth element being characterized by a valence instability. The results for $CeNiGa_{0.5}$ revealed a positive thermo-e.m.f. throughout this temperature range, with an anomaly in the form of two peaks about 70 K and 350 K respectively. The results for $CeNiGa_3$ revealed no anomalies of thermo-e.m.f. and electrical resistivity, the thermo-e.m.f. crossing from positive to negative as the temperature exceeded 100 K. The results for $CeNiGa_2$ (Cmmm space group) revealed anomalies of both thermo-e.m.f. and electrical resistivity characteristic of a nonmagnetic Condo lattice, in this case an only 40 K wide single peak of thermo-e.m.f. with 0.052 mV/K maximum within 15-20 K and a much wider single peak of electrical resistivity with 0.070 mohm.cm within the same temperature range. Figures 2; references 8: 6 Russian, 2 Western.

UDC 537.312.62+539.89+66.091

Effect of Quasi-Hydrostatic Pressure Up to 65 kbar on Superconducting Transition in $YBa_2Cu_3O_y$, $GdBa_2Cu_3O_y$, $La_{2-x}Sr_xCuO_y$

18620130i Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 2 Oct 87) pp 904-906

[Article by Yu. A. Osipyan, Ye. G. Ponyatovskiy, V. Yu. Malyshev, G. I. Peresada, I. O. Bashkin, V. I. Rashchupkin, S. F. Kondakov, V. A. Borodin, A. G. Peresada, M. D. Nersesyan, and I. P. Borovinskaya, Institute of Solid-State Physics, USSR Academy of Sciences, Chernogolovka (Moscow Oblast)]

[Abstract] An experimental study of $YBa_2Cu_3O_y$,

$GdBa_2Cu_3O_y$ and $La_{1.9}Sr_{0.1}CuO_y$, $La_{1.8}Sr_{0.2}CuO_y$ was made for a determination of the effect of quasi-hydrostatic pressure up to 65 kbar on their superconducting transition temperature. Specimens of $YBa_2Cu_3O_y$ and $GdBa_2Cu_3O_y$ were synthesized by high-temperature sintering. Specimens of $La_{1.9}Sr_{0.1}CuO_y$ and $La_{1.8}Sr_{0.2}CuO_y$ were produced by self-propagating high-temperature synthesis. Cylindrical specimens 5.5 mm in diameter and 2 mm long were placed inside a toroidal chamber, where the pressure was changed stepwise at room temperature and at each pressure level the temperature was dropped stepwise down to 80 K by cooling with liquid nitrogen. The electrical resistance was at each point measured by the voltage-current method, very fast so as to avoid heating the specimen, while the temperature was measured with a Chromel-Alumel thermocouple. The results for $YBa_2Cu_3O_y$ and $GdBa_2Cu_3O_y$ indicate an incomplete superconducting transition at 80 K, the temperature dependence of their electrical resistance retaining a positive slope dR/dT under pressure up to 63 kbar but the slope dR/dT becoming negative as the pressure is dropped to 30 kbar. The results for $La_{1.9}Sr_{0.1}CuO_y$ and $La_{1.8}Sr_{0.2}CuO_y$ indicate a pressure aftereffect associated with an irreversible change of either phase composition or fine structure, superconductivity at temperatures not exceeding 80 K under pressure even as high as 65 kbar evidently attributable to a not yet identified phase. Figures 2; references 12: 1 Russian, 11 Western.

UDC 535.41-538.958

Propagation of Surface Electromagnetic Waves on $YBa_2Cu_3O_{6+d}$ Ceramic

18620130j Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 3, Mar 88 (manuscript received 27 Oct 87) pp 929-931

[Article by G. N. Zhizhin, K. V. Krayskaya, L. A. Kuzik, F. A. Uvarov, and V. A. Yakovlev, Institute of Spectroscopy, USSR Academy of Sciences, Troitsk (Moscow Oblast)]

[Abstract] An experimental study was made concerning excitation, propagation, and dispersion of polaritons on polished surface of $YBa_2Cu_3O_{6+d}$ ceramic. Specimens of this material 1 mm thick and 8x5 mm^2 large were treated with radiation from a CO_2-laser over the 930-1090 cm^{-1} frequency range by the aperture method, the radiation being focused on a 0.010 mm wide gap between the specimen surface and a knife edge above it. Diffraction produced here a volume wave and a surface polariton, the latter propagating on the surface and being transformed into a volume wave by the nearest barrier or defect before it had reached the specimen edge. Interference of both volume waves was recorded by a pyroelectric detector moving along a circular arc about the aperture. Measurements were made with both s-polarization and p-polarization, at room temperature. An evaluation of the data has yielded the real part of the effective refractive index of this material. Taking into account granularity of the material and assuming a Drude frequency dependence of its dielectric permittivity, its plasma frequency at room temperature can be estimated to lie within the 2500-4500 cm^{-1} infrared range. Figures 2; references 6: 5 Russian, 1 Western.

12223

Polarized-Light Optical Contrast in $YBa_2Cu_3O_{7-x}$ High-Temperature Superconductors

18620125d Moscow PISMA V ZHURNAL EKSPERIMENTALNOY O TEORETICHESKOY FIZIKI in Russian Vol 47 No 6, 25 Mar 88 (manuscript received 10 Feb 88) pp 312-315

[Article by V. K. Vlasko-Vlasov, M. V. Indenbom, and Yu. A. Osipyan, Institute of Solid-State Physics, USSR Academy of Sciences]

[Abstract] An optical study of $YBa_2Cu_3O_{7-x}$ single crystals in polarized light revealed anomalous optical properties relative to only one of the orthorhombic axes, namely the b-axis passing along the C-O chains. In the experiment, square wafers 1x1 mm^2 in the (a,b)-plane and 0.020 mm thick along the c-axis, with a superconducting transition temperature about 90 K, were examined without pretreatment under a polarization microscope in the normal reflection mode. The surface patterns were photographed in crossed polarization filters with a compensator for introduction of a small additional path difference, while a crystal was rotated about the axis of the microscope. The contrast between dark and bright bands was found to run in 110-directions and to reverse upon rotation of a crystal through 90 deg. The patterns were analyzed with the aid of Berek and Senarmon compensators. The analysis as well as the difference between phase shifts upon reflection of b-polarized light and upon reflection of c-polarized light revealed twin domains with all twin boundaries oriented parallel to the c-axis, the is difference being equal to that between phase shifts upon reflection of b-polarized light and a-polarized light but the difference between phase shifts upon reflection of a-polarized light and upon reflection of c-polarized light being zero within measurement accuracy. A phenomenological interpretation of these findings suggests a uniform electrical conductivity parallel to the b-axis and confirms the Cu-O chain model. The authors thank G. A. Yemelchenko for supplying $YBa_2Cu_3O_{7-x}$ single crystals. Figures 2; references 6: 3 Russian, 3 Western

Electrical Conductivity of $YBa_2Cu_3O_{7-x}$ Single Crystals Over Wide Frequency Range

18620125e Moscow PISMA Z ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 6, 25 Mar 88 (manuscript received 12 Jan 88) pp 317-320

[Article by B. Ya. Kotozhanskiy and L. Ye. Svistov, Institute of Crystallography imeni A. V. Shubnikov, USSR Academy of Sciences]

[Abstract] In an experimental study of $YBa_2Cu_3O_{7-x}$ single crystals the temperature dependence of their parallel electrical resistivity was measured over a broad

frequency range. Two batches of crystals, variously grown and of different quality, were tested. The ratio of transverse resistivity to parallel resistivity, and indicator of electrical anisotropy, was at temperatures within the superconducting transition range, approximately 100 for the higher-grade "A" specimens and approximately 700 for the lower-grade "B" specimens. The ratio of parallel resistivity at 300 K and 100 K respectively was very close to 4 for specimens in both batches. Measurements were made by two methods, by the d.c. 4-point contact method and by the contactless induction method with an LC-circuit having a natural frequency in the vicinity of 10 MHz. In the latter case the resistance of specimens was determined on the basis of Q-factor readings, at two high frequencies; 4 MHz and 18 MHz. The resistive component of the impedance was also measured at two microwave frequencies, 25 GHz and 36 GHz, with shielding currents in planes perpendicular to the crystallographic c-axis. At these frequencies superconducting transition in $YBa_2Cu_3O_{7-y}$ single crystals, unlike in $YBa_2Cu_3O_{7-y}$ ceramic, was found to take place within a rather narrow temperature range. The authors thank L. A. Prozorova for interest and discussion as well as O. K. Melnikov for supplying the single crystals. Figures 3; references 5: 4 Russian, 1 Western

Optical Study of Thin $YBa_2Cu_3O_{7-x}$ Films With Synchrotron Radiation Within 4-30 eV Energy Range

18620125f Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 6, 25 Mar 88 (manuscript received 12 Feb 88) pp 321-323

[Article by V. G. Stankevich, N. Yu. Svechnikov, K. V. Kaznacheyev, R. A. Kink, V. N. Golubev, V. Ya. Kosyyev, Yu. N. Simirskiy, and M. B. Tsetlin, Institute of Atomic Energy imeni I. V. Kurchatov and Institute of Applied Physics, USSR Academy of Sciences, and H. E. Nizdraus Institute of Physics, ESSR Academy of Sciences]

[Abstract] In an experimental study, first of its kind, reflection and emission as well as luminescence excitation spectra of thin $YBa_2Cu_3O_{7-x}$ films were measured over the 200-9 K temperature range with use of synchrotron radiation within the 4-30 eV energy range as excitation source. These superconductor films were deposited on $SrTiO_3$ substrates by laser pulses in an oxygen atmosphere. Their critical temperature was 85.7 K, within a 1.6 K wide range, and their critical current density at 77 K was of the order of 10^6 A/cm^2. Measurements were made in the vacuum-ultraviolet spectrometer of the SIBIR-1 facility under a vacuum of the order of 10^{-8} torr, luminescence being measured with an MDR-23 monochromator-analyzer in the photon-count mode and the electrical resistivity being measured at the same time at each temperature. The results reveal a correlation between luminescence intensity and location of the superconducting transition point, that the luminescence spectrum is the same for different excitation levels and thus represents the $YBa_2Cu_3O_{7-x}$ compound, and that deexcitation from its peak intensity occurs within a time at least 10^{-6} s. Luminescence at the 2.8 eV level and beginning of phonon multiplication within the 6-7 energy range indicate the existence of a forbidden band characteristic of dielectric materials. The relatively wide (at least 0.1 eV) luminescence peaks and the long (at least 10^{-6} s) luminescence excitation time indicate an exciton nature of this luminescence. The trend of its temperature dependence indicates a possible relation between its excitation by synchrotron radiation and the mechanism of high-temperature superconductivity. The authors thank Ch. B. Lushchik for helpful discussions. Figures 3; references 6: 2 russian, 4 Western.

Oxygen Surrounding of Iron Impurity Atoms in $YBa_2Cu_3O_{O7}$

18620125g Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 6, 25 Mar 88 (manuscript received 17 Feb 88) pp 324-326

[Article by A. I. Chumakov, R. S. Larina, and G. V. Smirnov, Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] An experimental study of three $YBa_2Cu_{3(1-x)}{}^{57}Fe_{3x}O_{7-d}$ ceramics with x equal to 0.01, 0.02, 0.10 respectively was made for an examination of the oxygen surrounding of the ^{57}Fe impurity atoms partially replacing Cu atoms. Three powder specimens of each kind and one special with 0.01 Fe were deposited on and glued to aluminum foil for Moessbauer spectroscopy before and after vacuum treatment for several days at room temperature. Only the spectrum of the special specimen was found to have changed as a result of such a treatment. An evaluation of the Moessbauer parameters for doublets D1,D2,D3,D4, namely their isomeric shift, quadrupole split, and line width, for their correlation with the known model of atomic lattice configuration reveals a change in the configuration of Fe atoms with increasing oxygen deficiency. The behavior of the special specimen indicates that oxygen atoms leave the surrounding of impurity atoms at a rate higher than the average rate at which they leave the host lattice so that the oxygen deficiency becomes higher in the "iron" component than in the "copper" component of the structure. Figures 2; tables 2; references 2: Western

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Thermoelectric Domain in Y-Ba-Cu-O Ceramic and Its Analogues

18620124b Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 5, 10 Mar 88 (manuscript received 4 Jan 88) pp 257-260

[Article by Yu. A. Osipyan, R. K. Nikolayev, N. S. Sidorov, V. S. Bobrov, and V. S. Tsoy, Institute of Solid-State Physics, USSR Academy of Sciences]

[Abstract] An experimental study of $YBa_2Cu_3O_{7-x}$ ceramic was made concerning formation and drift of a

thermal domain upon passage of direct electric current through a specimen with an approximately square cross-section. Specimens of this ceramic, 3x3 mm^2 in cross-section and 40 mm long, were produced by synthesis of Y_2O_3, $BACO_3$, CuO powders and subsequent compaction. They were tested first in air at a temperature of 300 K, then with the temperature varied and also in other atmospheres. Both voltage and current thresholds for formation of a thermal domain, known to depend on the specimen structure and dimensions, were found to rise during cooling and to drop during heating. For the given specimens in air, the typical ranges of these thresholds were 3-4 V and 8-10 A respectively. Thermal domains were drifting toward the anode at velocities of approximately 10 cm/h, the direction of their drift being repetitively reversible by reversal of the direction of current flow. In an oxygen atmosphere the drift velocity was up to 1.5 times higher. In a helium atmosphere the drift velocity was approximately one tenth as high as in air, with the domain itself being narrower and collapsing after several drift reversals. Similar trends were observed in specimens of the other ceramics in the high-temperature superconductor class: $HoBa_2Cu_3O_{7-x}$, $ErBa_2Cu_3O_{7-x}$, and $La_{1.6}Sr_{0.4}CuO_4$ with the superconducting transition temperature 96 K, 66 K, and 37 K respectively. The authors thank G. K. Baranov, O. V. Zharikov, M. V. Indenbom, B. G. Karepov, N. V. Klassen, V. V. Korshunov, V. Sh. Shekhtman, and I. M. Shmytko for collaboration and discussion, V. S. Lunev, B. A. Skakun, and S. S. Shevag for assistance. Figures 3; references 5: 2 Russian, 3 Western.

Size Effects in Exciton Spectra of Thin CdS and CdSe Single Crystal

18620124c Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 5, 10 Mar 88 (manuscript received 21 Jan 88) pp 263-265

[Article by G. V. Mikhaylov, A. G. Panfilov, and B. S. Razbirin, Institute of Engineering Physics imeni A. F. Ioffe, USSR Academy of Sciences]

[Abstract] A spectroscopic study of CdS and CdSe hexagonal single crystals in the form of wafers with the thickness varied over the 1000-100 nm range has revealed a dependence of the energy levels of A,n equal 1 and A,n equal 2 exciton absorption lines in their spectra at 1.16 K temperature on the crystal thickness. Noteworthy are a splitting of the A,n equal 2 $2P_{xy}$ exciton line and a shifting of the entire exciton spectrum toward higher energy levels with decreasing crystal thickness. The splitting is interpreted in terms of the hydrogen-like model of an exciton, which includes an electronic wave function representing a distribution of electron concentration near an exciton-hole "nucleus" and this interpretation is supported by the results of magnetooptical experiments involving CdSe crystals. The shifting of the spectrum is hypothetically attributed to a changing bandgap and related to a size effect in the phonon subsystem, which is however very difficult to confirm by x-ray structural analysis. The fast shift of the A_L-line following a decrease of the crystal thickness over the 1000-300 nm initial range of thickness variation cannot yet be explained. The authors thank I. N. Uraltsev, Ye. L. Ivchenko, Al. L. Efros, and V. A. Kiselev for many helpful discussions, G. O. Mueller and P. Flegel (Central Institute of Electrophysics (?, GDR) for supplying high-quality specimens. Figures 1; references 5: 3 Russian, 2 Western.

Microstructural Examination of Superconducting Ceramic by Method of Scanning Acoustic Microscopy

18620124d Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 5, 20 Mar 88 (manuscript received 26 Jan 88) pp 267-270

[Article by V. M. Levin, R. G. Mayev, and T. A. Senyushkina, Center for Acoustic Microscopy and Institute of Chemical Physics, USSR Academy of Sciences]

[Abstract] The microstructure of Y-Ba-Cu-O ceramic was examined under a scanning reflection acoustic microscope, with 0.007 mm resolution at a frequency of 0.2 GHz and with 0.001 mm resolution at a frequency within 1-1.3 GHz. Specimens with natural surface and specimens with surface polish were examined at room temperature, with water as acoustic medium characterized by a density of 1 g/cm_3 and an acoustic velocity of 1.5 km/s. Analysis and interpretation of the acoustic images, their contrasts being determined by singularities of local sound reflection and known acoustic properties of the ceramic material, have yielded not only the microstructural characteristics of this material including its intergranular "voids" as well as its grains but also relevant microscope performance characteristics in this application. The velocity of a Rayleigh wave on a grain surface has also been estimated on the basis of this data, an acoustic output signal from the grains being evidently generated by interference of specularly reflected ultrasonic waves and ultrasonic waves re-emitted from a plane grain surface by a Rayleigh wave. An acoustic output signal from a "void", generally much weaker, consists of random oscillations evidently generated by scattering of sound by inhomogeneities smaller than the wavelength. The authors thank L. A. Chernozatonskiy and V. A. Zayts for helpful discussion of the results. Figures 2; references 6: 1 Russian, 5 Western.

Indirect Exchange Interaction of Magnetic Moments of Rare-Earth Elements in RBa_2Cu_3O7 Superconductors

18620124e Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 5, 10 Mar 88 (manuscript received 1 Feb 88) pp 271-273

[Article by A. I. Buszdin and L. N. Bulayevskiy, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] The experimentally established fact that replacement of Y-atoms in $YBa_2Cu_3O_7$ superconducting

compounds with magnetic atoms of rare-earth elements R (Gd,Dy,Ho,Er) does not significantly influence the superconducting transition temperature, this temperature remaining 95 K according to measurements of small-angle neutron scattering, is explained not only by interaction of f-electrons in these atoms and conduction electrons in Cu-O layers but also by antiferromagnetic ordering of the magnetic moments of these elements by indirect exchange indirect exchange-interaction of magnetic moments and specifically by the role of its long-range component. The latter hypothesis is supported by theoretical calculation of the change in scattering upon superconducting transition and of the Knight shift. The authors thank D. A. Kuptsov for assisting in numerical calculations. Figures 1; references 10: 2 Russian, 8 Western (1 in Russian translation).

Effect of Isotopic Copper Substitution on Critical Superconducting Transition Temperature of $YBa_2Cu_3O_7$

18620124f Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47, No 5, 10 Mar 88 (manuscript received 5 Feb 88) pp 276-278

[Article by B. V. Vasilyev, V. I. Lushchikov, and V. V. Sikolenko, Joint Institute of Nuclear Research]

[Abstract] An experimental study of $YBa_2Cu_3O_7$ ceramic was made in search of an isotopic effect, relative to the mechanism of high-temperature superconductivity. Substitution of either yttrium or oxygen atoms with their respective isotopes already known to have a negligible effect on the superconducting transition temperature of $YBa_2Cu_3O_7$, measurements were in this study made with ^{63}Cu and ^{65}Cu copper isotopes. Two specimens were produced from thoroughly pulverized Y_2O_3 and BaO_2 with isotopic CuO by compaction, after synthesis, under a pressure of 10 kbars. One compact contained 99.7 pct ^{63}Cu and one specimen contained 99.0 pct ^{65}Cu. Both specimens, 1 mm thick bars 7x25 mm^2 in cross-section, were sintered at a temperature of 950 deg C in air for 3 h and then slowly cooled at a rate of approximately 1 K/min. The temperature dependence of their electrical resistance was measured by the voltage-current method under identical conditions for both and was found to correspond to metallic behavior in each case. The procedure was repeated twice, after both specimens were crushed each time for identical pressure and heat treatment. The range of superconducting transition temperature, equal to the difference between that temperature for the ceramic with ^{63}Cu and that for the ceramic with ^{65}Cu was found to be 0.2 K the first time, -0.1 K the second time, and zero the third time. Control tests with natural Cu only yielded a range of 0.1-0.2 K. Therefore, evidently, isotopic substitution of copper also does not influence the superconducting transition temperature of $YBa_2Cu_3O_7$ ceramic. References 7: all Western.

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UDC 537.312.62

Estimation of Upper Limit of Critical Temperature for Several Conventional Superconduction Mechanisms

18620115c Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 2, Feb 88 (manuscript received 15 Jul 87) pp 576-577

[Article by A. N. Kozlov]

[Abstract] The upper limit of the superconducting transition temperature is estimated on the basis of the Eliashberg equation, numerical integration of which for the model with one peak and for the model with two peaks having already revealed a dependence of the critical temperature on low-frequency phonon modes. Estimates are obtained for several mechanisms of superconduction especially relevant to new high-temperature superconductor materials, considering the case of a single mode without dispersion. Following analytical and numerical estimates for the phonon mechanism are estimates for scattering by vibrating defects with relaxation and scattering by a ferroelectric mode with attendant transition of the order-disorder kind. Figures 1; references 5: 1 Russian, 4 Western.

UDC 539.292

Mechanism of Intergranular Conduction in High-Temperature Superconductor Ceramic

18620115d Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 2, Feb 88 (manuscript received 28 Jul 87) pp 584-587

[Article by V. M. Svistunov, Yu. F. Revenko, O. V. Grigut, and V. Yu. Tarenkov, Donetsk Institute of Engineering Physics, UkSSR Academy of Sciences, Donetsk]

[Abstract] An experimental study of the $Y_{1.2}Ba_{0.8}CuO_4$ superconductor ceramic was made for an examination of its intergranular links and their electrical characteristics. Specimens of this material produced from Y_2O_3, $BaCO_3$, CuO powders by solid-phase reaction had an electrical resistivity of 0.11 ohm.cm at 300 K and a 50 K wide superconducting transition range with the critical temperature 45 K on the basis of zero resistance. The dependence of the resistance on three variables, namely ambient temperature over the 110-40 K range, external magnetic field over the 0-400 Oe range, and power of impinging microwave (2 GHz) electromagnetic radiation from below 0.2 mW to above 5 mW, was determined on the basis of the dynamic resistance dV/dI(V,I) as function of voltage or current measured by the modulation method at various levels of those variables. The specimens, approximately 8x1.5x1 mm^3 large with Ag-paste contact tabs, were placed in a cryostat with gaseous coolant. The temperature dependence of the electrical

conductivity obtained from the data reveals a range of zero-dimensional fluctuations and then a range of three-dimensional fluctuations preceding a range of Josephson fluctuations as the temperature drops, each range being describable by a different power-law relation in log-log coordinates with the power exponent equal to 2, 1/2, and 4 respectively. The zero-voltage resistance at 77 K, at which Josephson links already freeze, was found to increase first fast and then slowly with increasing magnetic field intensity, in accordance with an inverse proportionality between electrical conductivity and magnetic field intensity in weak magnetic fields and with the change of rate occurring at the 20 Oe level equivalent to a magnetic flux quantum. Already very weak impinging microwave electromagnetic radiation was found to suppress the anomaly in the voltage dependence of the dynamic resistance dV/dI(V), with an insignificant increase of the phonon resistance, and only very strong impinging microwave electromagnetic radiation was found to appreciably increase the total resistance as a result of heating. All this characterizes a superconductor material consisting of weak links. Figures 3; references 9: 5 Russian, 4 Western (1 in Russian translation).

UDC 541.44+537.312.62

Superconductivity of Molybdenum Hydride and Molybdenum Deuteride

18620115e Leningrad FIZIKA TVERDOGO TELA in a Russian Vol 30 No 2, Feb 88 (manuscript received 7 Aug 87) pp 598-600

[Article by V. Ye. Antonov, I. T. Belash, O. V. Sharikov, A. I. Latynin, and A. V. Palnichenko, Institute of Solid-State Physics, USSR Academy of Sciences, Czernogolovka (Moscow Oblast)]

[Abstract] An experimental study has revealed superconductivity of molybdenum hydride and molybdenum deuteride, molybdenum thus becoming the third known such d-element in addition to palladium and titanium. Molybdenum single crystals, electrolytically polished with aqueous H_2SO_4 solution, were cut into 3x3x0.2 mm^3 large slices for impregnation with hydrogen in an atmosphere of molecular deuterium at 325 deg C temperature under 60 kbar pressure for 24 h and subsequent "quenching" to -120 deg C under pressure. Four specimens of $MoH_{1.27}$ and two specimens of $MoD_{1.26}$ were produced by this method. Measurements were made at temperatures not exceeding 120 K so as to avoid desorption of hydrogen under atmospheric pressure. Superconducting transition was indicated by the drop of magnetic susceptance, the latter being measured by the induction method at temperatures down to 0.3 K in an apparatus with removal of ^3He vapor. The critical temperature was found to by 0.92 plus or minus 0.005 K for $MoH_{1.27}$ and 1.11 plus or minus 0.005 K for $MoD_{1.26}$. The critical magnetic field was found to be zero at the critical temperature and to increase linearly with decreasing temperature squared, according to the steps on isotherms of the field dependence of the magnetic susceptance. Estimates have yielded a critical magnetic field of 600 G and 300 G at zero temperature for $MoH_{1.27}$ and $MoD_{1.26}$ respectively. The specimens were also examined in a DRONE-2.0 X-ray diffractometer with a CuK_{alpha}-radiation source. The authors thank V. G. Glebovskiy for supplying Mo single crystals. Figures 2; tables 1; references 10: 4 Russian, 6 Western.

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Hysteresis Losses in Composite Superconductors With Hyperfine Strands

18620112f Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 1, 12 Jan 88 (manuscript received 31 Aug 87) pp 60-64

[Article by V. A. Altov, A. V. Ionov, V. V. Kurguzov, and V. V. Sychev, All-Union Scientific Research Institute of Metrological Services]

[Abstract] For an evaluation and minimization of hysteresis losses in stranded composite superconductors, a model of magnetic field penetration is proposed according to which the superconductor consists of N locally linked identical elements with an orthotropy of the critical current density. Analysis and calculations on the basis of field theory reveal that the effective penetration diameter, which is determined by both the skin effect and the proximity effect, decreases not only slower than the critical density of the proximity-effect current as the magnetic field intensity increases but also only when it is initially (at near-zero magnetic field intensity) less than the geometrical strand diameter, remaining independent of the magnetic field intensity when it is larger. These conclusions are confirmed by experimental data on Nb-Ti superconductors with micrometric-diameter strands. Figures 2; references 6: 1 Czechoslovak, 5 Western

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UDC 537.312

Collapse of Relaxation: Possible Analogy Between Narrowing of Spectral Lines

18620111e Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 64 No 1, Jan 88 (manuscript received 10 Aug 87) pp 5-7

[Article by V. Yu. Dmitriyev, A. A. Kiselev, A. D. Kiselev, A. L. Kitanin, and G. P. Miroshnichenko]

[Abstract] Experimentally detected deceleration or complete cessation of relaxation in quantum systems interacting with both a thermostat and an external electromagnetic field is given a concise theoretical interpretation, considering first a four-level quantum system whose density matrix satisfies corresponding the

Liouville kinetic equation where this matrix appears with a Hamiltonian in one term and multiplied by the relaxation matrix in another term. Next a symmetric linear array of two-level quantum systems interacting with a thermostat and responding to external action in the form of transfer effects is considered. A solution of the Liouville equation in the secular approximation according to the first-order perturbation theory taking into account that elements of the relaxation matrix are temperature-dependent, yields the condition for collapse of relaxation. Attendant widening of one spectral line and narrowing of another is analogous to a nonattenuating transfer process and, in the case of charge transfer, a state described by the density matrix can be regarded as a superconducting one. Figures 2; references 9: 2 Russian, 7 Western (one in Russian translation).

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Application of Muon Method of Type-2 Superconductors

18620108c Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 1, 10 Jan 88 (manuscript received 19 Nov 87) pp 34-36

[Article by S. A. Gordyunin, V. P. Smilga, and V. I. Fesenko, Moscow Institute of Engineering Physics]

[Abstract] Application of the muon method to new high-temperature type-2 superconductors for identifying the kind of Abrikosov two-dimensional vortex lattice is considered, this method having already been applied on a numerical basis to superconductors with triangular or square lattices in magnetic fields of intensity below but near the upper critical level. Taking into account the high values of the Ginzburg-Landau parameter, it is demonstrated that this method yields all characteristics of a vortex structure with all necessary information contained in the Fourier spectrum of transverse muon polarization. This transverse polarization is "rectified" by ignoring its slow relaxation which does occur in the normal phase as a result of muon interaction with nuclear spins, considering also that no diffusion of muons in the superconducting phase has been found to occur. Figures 1; references 8: 1 Russian, 7 Western (3 in Russian translation).

Domain Structure and Density of State in Superconductors With 'Heavy Fermions'

18620108d Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 1, 10 Jan 88 (manuscript received 4 Nov 87) pp 40-43

[Article by L. I. Burlachkov and N. B. Kopnin, Institute of Theoretical Physics imeni L. D. Landau, USSR Academy of Sciences]

[Abstract] Evidence that the electronic part of the thermal capacity of axial superconductors with "heavy fermions" such as UBe_{13} and UPt_3 is in the low-temperature range now simply proportional to the squared or cubed temperature but includes an additive linearly temperature-dependent component which corresponds to a low but finite density of states N(O) is explained by existence of anomalous excitation spectrum branches with a domain structure of the superconducting phase at temperatures near zero, rather than by presence of impurities, so as to avoid the problem of critical defect concentration associated with the Born approximation and resonant scattering. Analysis of this model with an appropriate description of the order parameter is based on assuming a triplet superconductivity in a crystal with either tetragonal or hexagonal symmetry. The authors thank L. P. Gorkov for formulating the problem and for steady attentiveness, also G. Ye. Volovik and A. V. Balatskiy for helpful discussions. References 16: 5 Russian, 11 Western.

Anisotropy of Electrical Resistivity in $YBa_2Cu_3O_{7-x}$ Single Crystals

18620108e Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 1, 10 Jan 88 (manuscript received 25 Oct 87) pp 50-52

[Article by L. Ya. Vinnikov, G. A. Yemelchenko, P. A. Kononovich, Yu. A. Osipyan, and I. F. Shchegolev, Institute of Solid-State Physics, L. I. Buravov and V. N. Laukhin, Institute of Chemical Physics, USSR Academy of Sciences]

[Abstract] An experimental study of $YBa_2Cu_3O_{7-x}$ single crystals was made, for the purpose of determining the temperature dependence of their anisotropic d.c. electrical resistivity: longitudinal in the (ab) plane and transverse along the c-axis over the 300-80 K temperature range. Single crystals were grown from solution in the melt. Each electrical resistivity was determined on the basis of crystal geometry and voltage readings at a certain current level according to the Montgomery method, taking into account the width of Pt contact tabs with graphite paste and their distances from the crystal edges. The superconducting transition temperature based on drop of the transverse electrical resistivity to zero was found to be lower, evidently owing to finiteness of the measuring current. The transverse critical current was also measured, at temperatures from 80 K to below 70 K, and found to increase linearly with decreasing temperature. The critical current density appeared to be much lower than when based on measurement of the maximum diamagnetic moment. The transverse-to-longitudinal electrical resistivity ratio was found to decrease with decreasing temperature, but differently in each crystal owing to a wide variance of crystal properties. Figures 3; references 8: 1 Russian, 7 Western.

Anisotropy of Electrical Resistivity in Single Crystals of $YBa_2Cu_3O_x$ High-Temperature Superconductor Material

18620108f Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 47 No 1, 10 Jan 88 (manuscript received 25 Nov 87) pp 52-56

[Article by I. N. Makarenko, D. V. Nikiforov, A. B. Bykov, O. K. Melnikov, and S. M. Stishov, Institute of Crystallography, USSR Academy of Sciences]

[Abstract] An experimental study of $Y(TR)Ba_2Cu_3O_x$ single crystals (TR- trace of La,Nd,Yb) was made concerning the anisotropy of their electrical resistivity. Two different batches of single crystals were grown from nonstoichiometric melts in Pt crucibles at a 900-1000 deg C temperature and then annealed in an O_2 stream at 700 deg C. Annealing of the crystals with $Y_{0.92}(TR)_{0.03}Ba_{2.95}O_x$ composition caused a transformation of their structure from tetragonal to rhombic. The crystals with $Y_{0.94}(TR)_{0.02}Ba_2Cu_{2.88}O_x$ composition retained their tetragonal structure upon annealing, probably owing to their Cu deficiency. Regular crystal chips were used for electrical resistance measurement by the voltage-current method, with d.c. current of 0.5-1 mA fed through low-resistance Ag contact tabs and using a digital microvoltmeter. Measurements were made at temperatures from 300 K to 80 K, for identification of the superconducting transition. The results indicate an increase of the resistivity anisotropy as superconducting transition is approached, the transverse resistance first peaking before dropping at the temperature at which the longitudinal resistance vanishes. The data on transverse and longitudinal resistivity at room temperature and at critical temperature, including the transverse-to-longitudinal resistivity as measure of anisotropy and the derivative of longitudinal resistivity with respect to temperature, reveal that the anisotropy and its temperature dependence are largely determined by the degree of crystal imperfection. No conclusions can, however, be drawn on this basis regarding anisotropy in perfect crystal. The authors thank I. V. Aleksandrov for determining the lattice parameters and G. I. Shamanenkova for chemical analysis of the crystal specimens. Figures 3; tables 2; references 2: 1 Russian, 1 Western.

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Formation and Evolution of Fractal Structures in Diffusion Layer

18620119a Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 84 No 1, Jan 88 (manuscript received 12 Jun 87) pp 318-214

[Article by V. B. Sapozhnikov and M. G. Goldiner, Automation Center for Scientific Research and Metrology, MSSR Academy of Sciences]

[Abstract] Interdiffusion occurring by the vacancy mechanism and resulting in a substitutional solid solution with fractal geometry is analyzed microscopically on the basis of numerical simulation with application of the Monte Carlo method, using a rectangular grid of 100x200 atoms divided into two halves with 50x200 atoms of kind A and 50x200 atoms of kind B respectively. The computer experiment and analytical evaluation of the data reveal formation of two geometrically correlated stochastic structures evolving in time, a diffusional percolation front and an overall cluster boundary. Evolution of the former determines the growth of phases, constituting their boundary, and is accompanied by changes in electrical properties. It is found to be a fluctuational process describable with a set of critical power exponent. The authors thank V. L. Pokrovskiy, S. P. Obukhov, V. N. Nikor, V. I. Medvedik, and I. E. Verbitskiy for very helpful comments. Figures 3; references 8: 1 Russian, 7 Western (1 in Russian translation).

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