

# Soviet and Japanese Aerospace Literature

Throughout 1988 the *AIAA Journal* will carry selected abstracts on leading research topics from the Soviet aerospace literature and, as space permits, from similar Japanese literature. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features Optics from the USSR and Fluid Dynamics/Computational Fluid Dynamics from Japan.

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## Soviet Aerospace Literature This month: Optics

**A88-28368** Optically controlled transparencies based on structures consisting of a photoconductor and a polymer-encapsulated nematic liquid crystal (Opticheski upravliaemye transparenty na osnove struktur fotoprovodnik - kapsulirovannyi polimerom nematicheskii zhidkii kristall) O. A. AFONIN, V. F. NAZVANOV, and A. V. NOVIKOV, *Pis'ma v Zhurnal Tekhnicheskoi Fiziki* (ISSN 0320-0116), Vol. 14, Jan. 26, 1988, pp. 129-133.

A study is made of the characteristics of optically controlled transparencies (OCT) based on a photoconductor and a new electrooptic material consisting of a polymer-encapsulated nematic liquid crystal. The OCT samples studied have a layered structure consisting of a 5-10-micron-thick n-type ZnSe photoconductor layer and a 20-40-micron-thick layer of a polyvinyl-alcohol-encapsulated nematic liquid crystal, with both layers placed between glass substrates with transparent SnO<sub>2</sub> electrodes. The OCT structures have unipolar volt-contrast characteristics, a resolution of about 30 lines/mm, and a response of 5 ms or better.

**A88-28366** Refraction law for geometrical-optic rays in three-dimensionally inhomogeneous media (Zakon prelomleniia geometroopticheskikh lucheii v trekhmerno-neodnorodnykh sredakh) A. V. PROKOPOV, *Pis'ma v Zhurnal Tekhnicheskoi Fiziki* (ISSN 0320-0116), Vol. 14, Jan. 26, 1988, pp. 107-110. 6 Refs.

Refraction laws, which make it possible to trace the path of rays in an inhomogeneous medium, are known only for the particular cases of plane-stratified and spherically stratified media, which limits their practical applications. Here, an attempt is made to generalize the refraction laws to the case of arbitrary (three-dimensionally inhomogeneous) media, particularly for the earth atmosphere. The approach is based on the transition from the well-known differential form of ray equations to equations for quantities averaged along the rays.

**A88-28192** Giant impurity nonlinearities in the optics of fractal clusters (Gigantskie primesnye nelineinosti v optike fraktal'nykh klasterov) A. V. BUTENKO, V. M. SHALAEV, and M. I. SHTOKMAN, *Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki* (ISSN 0044-4510), Vol. 94, Jan. 1988, pp. 107-124. 10 Refs.

A theory describing the nonlinear optical properties of fractals is developed and a giant enhancement of the optical susceptibilities is predicted for the impurities bound to a fractal. The enhancement occurs if the exciting radiation frequency lies within the absorption band of the fractal. Coherent anti-Stokes Raman scattering and phase conjugation of light waves are enhanced to a much greater degree than the generation of

higher harmonics. It is predicted that a narrow resonant structure peculiar to an isolated fractal monomer should be observed in the coherent anti-Stokes Raman scattering spectra.

**A88-29943** The motion of space-charge waves in LiNbO<sub>3</sub>:Fe (Dvizhenie voln prostranstvennogo zariada v LiNbO<sub>3</sub>:Fe) O. V. KANDIDOVA, V. V. LEMANOV, B. V. SUKHAREV, and A. S. FURMAN, *Pis'ma v Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki* (ISSN 0370-274X), Vol. 46, Dec. 10, 1987, pp. 438-440. 5 Refs.

The dark relaxation of dynamic phase holograms recorded in electrooptical LiNbO<sub>3</sub>:Fe crystals was investigated experimentally. The spatial displacement of the holograms was observed, which is explained by the propagation of trap charge-exchange waves in the crystal. The dispersion law of these waves (omega approximately equal to the inverse of K) is in agreement with experimental data.

**A88-26082** Adaptive reconstruction of an undistorted image of an object observed through atmospheric turbulence (Adaptivnoe vosstanovlenie neiskazhennogo izobrazheniia ob'ekta, nabludaemogo cherez turbulentnuiu atmosferu) P. A. BAKUT, S. D. POL'SKIKH, and K. N. SVIRIDOV, *Radiotekhnika i Elektronika* (ISSN 0033-8494), Vol. 32, Dec. 1987, pp. 2548-2557. 11 Refs.

The feasibility of reconstructing an undistorted image of an object observed through atmospheric turbulence using postdetector adaptive spatial filtering of the spectrum of its short-exposure image is assessed in the framework of the maximum likelihood (ML) criterion. Optimal and quasi-optimal functions of image 'sharpness' are examined. A numerical method for solving the ML equations is developed, and statistical simulation results are presented. The proposed method can be used to enhance the imaging quality of telescope systems.

**A88-26053** Transverse cavityless optical bistability in n-InP crystals (Poperechnaia bezrezonatornaia opticheskaia bistabil'nost' v kristallakh n-InP) I. P. ARESHEV, M. I. STEPANOVA, V. K. SUBASHIEV, and B. G. FARADZHEV, *Pis'ma v Zhurnal Tekhnicheskoi Fiziki* (ISSN 0320-0116), Vol. 13, Dec. 12, 1987, pp. 1431-1434. 7 Refs.

An n-InP cavityless bistable optical device has been constructed on the basis of the self-defocusing effect of Nd-laser radiation. The magnitude and the time lag of the self-defocusing effect for n-InP crystals are shown to depend strongly on the degree of their doping, which is connected with the dependence of the effective lifetime of two-photon-excited nonequilibrium carriers on the concentration of equilibrium electrons. Experimental

results indicate that the operation of the bistable device involves the shortening of laser pulses, with the duration of transmitted pulses decreasing with increases in the peak intensity of incident pulses.

**A88-30060** Radiation-frequency switching in a quadratically nonlinear medium and an optical transistor based on this effect (Perekliuchenie chastoty izlucheniia v kvadrachno-nelineinoy srede i opticheskii tranzistor na ego osnove) A. A. MAIER and K. I. SITARSKII, *Kvantovaya Elektronika (Moscow)* (ISSN 0368-7147), Vol. 14, Nov. 1987, pp. 2369-2371. 18 Refs.

It is predicted that radiation power can be converted 'sharply' from one frequency to another at the output of a quadratically nonlinear medium when a weak signal at the double frequency is fed to its input and the signal intensity is changed slightly both in the case of phase-matched interaction and in the case of divergence from the phase-matched condition. It is suggested that this effect can serve as the basis of an optical transistor and of the giant-amplification of a weak alternating signal.

**A88-28364** The use of profiled lithium niobate crystals to produce integrated-optic devices (Primenenie profilirovannykh kristallov niobata litia dlia sozdaniia integral'no-opticheskikh ustroistv) K. F. ESKIN, B. S. RED'KIN, V. M. KUZNETSOV, V. N. KURLOV, V. A. TATARCHENKO et al., *Zhurnal Tekhnicheskoi Fiziki* (ISSN 0044-4642), Vol. 57, Nov. 1987, pp. 2253, 2254. 5 Refs.

Experimental results are presented which indicate that the near-surface optical-physical properties of profiled LiNbO<sub>3</sub> single crystals make these materials suitable for use in integrated-optic devices. The geometrical dimensions of ribbon single crystals make it possible to fabricate large-scale devices with a high level of integration.

**A88-23373** Four-wave cross-scattering of light in lithium niobate crystals (Chetyrekhvolnovoe kross-rasseianie sveta v kristallakh niobata litia) V. V. LEMESHKO and V. V. OBUKHOVSKII, *Ukrainskii Fizicheskii Zhurnal* (ISSN 0503-1265), Vol. 32, Nov. 1987, pp. 1663-1668. 11 Refs.

The paper reports the observation of a new type of four-wave parametric light scattering, four-wave cross-scattering (FWCS), arising when two coherent bunches intersect in the lithium niobate. FWCS maxima are localized on the surface of a cone whose axis is directed perpendicular to the exit side of the crystal, the cone angle being defined by the pumping direction. Results of qualitative theory for this effect are found to be in agreement with experimental data. Attention is given to differences between FWCS and other types of four-wave light scattering, i.e., holographic-type parametric light scattering and photoinduced light scattering.

**A88-28377** Acoustooptic filtering of radiation with arbitrary polarization (Akustoopticheskaiia fil'tratsiia izlucheniia s proizvol'noi polarizatsiei) V. M. EPIKHIN, F. L. VIZEN, and L. L. PAL'TSEV, *Zhurnal Tekhnicheskoi Fiziki* (ISSN 0044-4642), Vol. 57, Oct. 1987, pp. 1910-1917. 13 Refs.

The paper describes a method for designing a wide-angle AO filter with simultaneous diffraction of the orthogonally polarized radiation components by a single sound beam. The main parameters of a bipolarization TeO<sub>2</sub>-crystal AO filter operating at wavelengths of 400-1000 nm are calculated, including the orientation of light and sound wave vectors in the crystal, the operating frequency range, the dependence of filter detuning on the beam incidence angle on the input face, the angular aperture, the M<sub>2</sub> AO quality coefficients, and the spectral characteristics. The calculation results agree well with experimental data at 1150 nm.

**A88-28161** Anisotropic light scattering in an inhomogeneous atmosphere - The radiation field for nearly conservative scattering (Anizotropnoe rasseianie sveta v neodnorodnoi atmosfere. Pole izlucheniia pri pochti konservativnom rasseianii) N. N. FOMIN and E. G. IANOVITSKII, *Astronomicheskii Zhurnal* (ISSN 0004-6299), Vol. 64, Sept.-Oct. 1987, pp. 992-1003. 11 Refs.

The determination of the radiation field in an inhomogeneous semiinfinite atmosphere and in an optically thick inhomogeneous layer is considered for nearly conservative scattering. Asymptotic formulas describing the intensity in the case of nearly conservative scattering at any optical depth are derived through corresponding magnitudes for conservative scattering. A solution to the characteristic equation is presented for the case of isotropic scattering when the particle albedo  $\lambda(\tau) = \exp(-m\tau)$ .

**A88-27198** Adaptive compensation for atmospheric phase distortions using a spatial image spectrum (Adaptivnaia kompensatsiia atmosferykh fazovykh iskazhenii s ispol'zovaniem prostranstvennogo spektra izobrazhenii) A. V. ANUFRIEV, I. A. ZIMIN, and A. I. TOLMACHEV, *Kvantovaya Elektronika (Moscow)* (ISSN 0368-7147), Vol. 14, Oct. 1987, pp. 2116-2123. 9 Refs.

An algorithm permitting adaptive compensation for atmospheric phase distortions using a spatial image spectrum is theoretically investigated. The algorithm can be used to reconstruct images of coherently illuminated objects of arbitrary shape. It is noted that the energy possibilities of this algorithm are limited by the quantum nature of the radiation.

**A88-27195** Nonlinear processes in the formation of three-dimensional dynamic holographic gratings (Nelineinye protsessy pri formirovani ob'emnykh dinamicheskikh golograficheskikh reshetok) V. G. GORSHKOV, I. K. DANILEIKO, T. P. LEBEDEV, and D. A. NESTEROV, *Kvantovaya Elektronika (Moscow)* (ISSN 0368-7147), Vol. 14, Oct. 1987, pp. 2089-2097. 14 Refs.

Wave equations are solved to develop new concepts on the dynamics of the diffraction efficiency of a three-dimensional light-induced grating in media with a nonlinear index of refraction (or absorption). The effect of the radial distribution of the exciting beam intensity on the observed diffraction efficiency variation is considered. The role of the nonlinear refraction of the beam as a whole as a significant factor in the spatial-temporal dynamics of the diffracted radiation in the far field is predicted and experimentally confirmed.

**A88-27191** Self-oscillations, single pulses, and transient processes in multistable interferometers with competing nonlinearities (Avtokolebaniia, odinochnye impul'sy i perekhodnye protsessy v mul'tistabil'nykh interferometrach s konkuriruiushchimi nelineinostiami) A. V. GRIGOR'ANTS, I. A. RZHANOV, I. I. BALKAREI, and M. I. ELINSON, *Kvantovaya Elektronika (Moscow)* (ISSN 0368-7147), Vol. 14, Oct. 1987, pp. 2047-2050. 13 Refs.

The paper presents a mathematical model which describes the dynamics of a semiconducting Fabry-Perot interferometer characterized by competing concentration and thermal mechanisms of nonlinear refraction and enhanced absorption with increasing temperature. The transmission self-oscillations near various equilibrium positions are studied as well as switching from one limiting cycle to another, lasing of single pulses in response to faint additional illumination in the one-shot optical multivibrator regime and nonmonotonic transient processes with switchings.

**A88-27188** The influence of second-order diffraction on linear and nonlinear optical effects at a surface with periodic relief (Vliianie difraktsii vtorogo poriadka na lineinye i nelineinye opticheskie efekty vblizi poverkhnosti s periodicheskim rel'efom) V. I. EMEL'IANOV, V. N. SEMINOGOV, and V. I. SOKOLOV, *Kvantovaya Elektronika (Moscow)* (ISSN 0368-7147), Vol. 14, Oct. 1987, pp. 2028-2037. 23 Refs.

An analytical theory of light diffraction by a surface with sinusoidal relief is developed with the zero, first, and second orders of diffraction taken into account. The surface relief can either be prescribed or generated upon exposure to laser radiation. Allowance for the second order of diffraction leads to a change in the dispersion law of the diffracted waves; this makes it possible to qualitatively explain the displacement of dips in the angular dependence of the surface reflection efficiency as well as the shortening of the period of surface gratings generated by the laser radiation as their amplitude increases.

**A88-18018** Amplification and oscillation due to vectorial forward four-wave mixing in crystals with diffusive nonlinearity (Usilenie i generatsiia pri vektornom poputnom chetyrekhvolnovom vzaimodeistvii v kristallakh s diffuzionnoi nelineinost'iu) A. D. NOVIKOV and S. G. ODULOV, *Ukrainskii Fizicheskii Zhurnal* (ISSN 0503-1265), Vol. 32, Oct. 1987, pp. 1514-1520. 15 Refs.

The possibility of the amplification of plane-wavefront light beams in a four-wave mixing scheme with the diffusive mechanism of photorefractive nonlinearity is demonstrated. The characteristics of amplifiers and oscillators are calculated for arbitrary ratios of the signal (oscillation) and pumping wave intensities. The amplification and oscillation scheme proposed here can be implemented using such crystals as BaTiO<sub>3</sub>, Ba<sub>2</sub>Nb<sub>5</sub>O<sub>15</sub>, LiNbO<sub>3</sub>, and KNbO<sub>3</sub>.

**A88-18017** Autocorrelation wavefront transformation at the exit of multimode fiber-optic waveguides (Avtokorrelatsionnoe preobrazovanie volnovykh frontov na vykhode mnogomodovykh volokonnykh svetovodov) A. M. BYKOV, A. V. GNATOVSKII, and A. B. OPMAN, *Ukrainskii Fizicheskii Zhurnal* (ISSN 0503-1265), Vol. 32, Oct. 1987, pp. 1472-1477. 5 Refs.

The possibility of the holographic correction of wavefronts at the exit of multimode waveguides using various types of spatial amplitude-phase modulators is investigated theoretically and experimentally. It is shown that holographic wavefront correction makes it possible to obtain light beams with specified spatial-angular characteristics at the exit of the multimode waveguide-corrector system. The form of the light field at the exit of the system is largely determined by the type of the spatial wavefront modulator.

**A88-15795** Optical hysteresis and multistability in a double resonator system with an additional feedback G. P. GOLUBEV, D. G. LUCHINSKII, A. L. VELIKOVICH, and M. A. LIBERMAN, *Optics Communications* (ISSN 0030-4018), Vol. 64, Oct. 15, 1987, pp. 181-185. 9 Refs.

An experimental and theoretical study of optical multistability in a double resonator system formed by a thin single crystal of GaSe and an air gas separating it from a dielectric mirror is reported. The system allows one to observe various types of optical hysteresis, bi- and multistability with microsecond switching time at room temperature and submilliwatt threshold of first switching. Five stable output states are reported for a given input. A nonmonotonic input/output characteristic of the double resonator system is used to demonstrate doubling of the incident laser modulation frequency as a new example of an all-optical signal processing.

**A88-25537** Effect of the Goos-Haenchen shift on the amount of loss in electroabsorption waveguide modulators (Vliianie sdviga Gusa-Khenkhena na velichinu poter' v volnovodnykh modulatorakh na elektropogloshchenii) S. A. SUKHOTIN and V. V. GOLUBEV, *Zhurnal Tekhnicheskoi Fiziki* (ISSN 0044-4642), Vol. 57, Sept. 1987, pp. 1776-1781. 8 Refs.

Losses in electroabsorption waveguide modulators are calculated by the numerical integration method on the basis of a model of zigzag waves. Calculations carried out for a GaAs modulator for the TE<sub>0</sub> mode show that nonuniform distribution of the absorption coefficient in the direction normal to the optical axis of the waveguide is responsible for the distortion of the mode shape. It is also shown that there is an optimum waveguide thickness for which TE<sub>0</sub> mode attenuation is minimum for a given modulating voltage.

**A88-14653** A study of the diffraction of optical emission by a thermally stimulated grating in a planar microwaveguide (Issledovanie difraktsii opticheskogo izlucheniia na termostimulirovannoi reshetke v planarnom mikrovolnovode) L. M. ANDRUSHKO, V. A. VOZNESENSKII, G. T. TARIELASHVILI, and G. S. FELINSKII, *Ukrainskii Fizicheskii Zhurnal* (ISSN 0503-1265), Vol. 32, Sept. 1987, pp. 1345-1349. 5 Refs.

The diffraction of waveguide modes by a thermally stimulated phase grating in planar waveguides based on LiNbO<sub>3</sub> is investigated analytically and experimentally. Empirical expressions are obtained which relate the efficiency of diffraction and three-dimensional scanning of diffraction orders to the potential at the resistive structures. The diffraction process investigated here is compared with diffraction by an electrooptic phase grating in a waveguide. The possibility of using this effect in integrated optics devices is discussed.

**A88-19396** A study of an integrated-optics Mach-Zehnder interferometer with coupled waveguides (Issledovanie integral'no-opticheskogo interferometra Makha-Tsendera so svyazannymi volnovodami) E. M. ZOLOTOV and R. F. TAVLYKAEV, *Kvantovaya Elektronika (Moscow)* (ISSN 0368-7147), Vol. 14, Aug. 1987, pp. 1625-1627. 6 Refs.

The modulation characteristics of an integrated-optics Mach-Zehnder interferometer with coupled waveguides are calculated as a function of the coupling coefficient and phase mismatches due to waveguide manufacturing imprecision. Conditions for achieving maximum modulation depth are determined, and ways of achieving deep modulation are discussed.

**A88-19379** Crystals for nonlinear optics (Kristally dlia nelineinoi optiki) D. N. NIKOGOSIAN and G. G. GURZADIAN, *Kvantovaya Elektronika (Moscow)* (ISSN 0368-7147), Vol. 14, Aug. 1987, pp. 1529-1541. 90 Refs.

The nonlinear optical properties of seven commonly used biaxial crystals, KB5, DKB5, LFM, Ba<sub>2</sub>NaNb<sub>5</sub>O<sub>15</sub>, KTP, alpha-HIO<sub>3</sub>, and KNbO<sub>3</sub>, are reviewed. Formulas are proposed for calculating the phase-matching angle of biaxial crystals for emission propagation in two main planes; data are presented on the dispersion and nonlinear properties of the crystals, optical breakdown thresholds, linear absorption characteristics, crystal lengths, pumping densities, and conversion coefficients. Typical applications of the crystals are discussed.

**A88-14719** Image differentiation in terms of time using optically controlled MOS-liquid crystal transparencies (Differentsirovanie izobrazhenii po vremeni opticheski upravliaemyi transparentami so strukturoi MDP-ZhK) I. U. D. DUMAREVSKII, N. F. KOVTONIUK, G. A. PETROVICHEVA, and A. I. SAVIN, *Avtometriia* (ISSN 0320-7102), July-Aug. 1987, pp. 60-65.

The effect of the time differentiation of images by MOS-liquid crystal transparencies is described. Experimental results obtained by this method for optical and TV images are presented. The physical mechanism underlying this effect is examined. The similarity between the image differentiation effect realized with MOS-liquid crystal structures and the effect used in PRIZ image converters is noted.

**A88-13706** Structure of an optical field inside spheres and thermal explosion of particles (Struktura opticheskogo polia vnutri sfer i teplovoi vzryv chastits) N. N. BELOV, *Fizika Goreniia i Vzryva* (ISSN 0430-6228), Vol. 23, July-Aug. 1987, pp. 44-48. 10 Refs.

The structure of the laser-wavelength field of a corundum particle suspended in air is investigated analytically. It is shown that the energy input in the region of the main maximum of the particle's optical field is sufficient for the explosive destruction of the particle resulting from a cumulative increase in temperature. This effect is essential for the understanding of the explosion, fractionation, and acceleration of aerosol particles in a laser beam and optical breakdown.

**A88-12090** Electrooptic effect in a photopolymer with a dispersed liquid crystal (Elektroopticheskiy effekt v fotopolimere s dispergirovannym zhidkim kristallom) L. G. GRECHKO, T. I. A. MARUSII, I. U. A. REZNIKOV, V. I. U. RESHETNIK, and A. I. KHIZHNIK, *Ukrainskii Fizicheskii Zhurnal* (ISSN 0503-1265), Vol. 32, Aug. 1987, pp. 1213-1216.

An experimental observation of the electrooptic effect of brightening in a system consisting of nematic droplets in a photopolymer matrix is reported. The effect consists of the matching of the refraction index of the crystal and that of the photopolymer achieved through reorientation of the director in the electric field. The response of the system is approximately 100 microseconds.

**A88-11288** The nonlinear resonance optics of thin films - The inverse problem technique (Nelineinaia rezonansnaia optika tonkikh plenok: Metod obratnoi zadachi) V. I. RUPASOV and V. I. IUDSON, *Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki* (ISSN 0044-4510), Vol. 93, Aug. 1987, pp. 494-499. 10 Refs.

It is shown that the interaction of light with a thin film of a nonlinear resonant medium situated at the interface between linear media can be described by a set of nonlinear differential Bloch-Maxwell equations which effectively allow for the presence of a reflected wave. The equation set is entirely integrable. The present approach is used to solve the problem of the passage of a solitonlike light pulse through a film with an arbitrary profile of the nonuniform broadening line. It can also be used to study photon echo and the radiative decay of the excited atoms of the film.

**A88-11287** Quasi-resonant Stark broadening of the optical spectra of quantum systems in a noisy Gaussian field (Kvazirezonansnoe Shtarkovskoe ushirenie opticheskikh spektrov kvantovykh sistem v shumovom Gaussovskom pole) N. F. PEREL'MAN, I. SH. AVERBUKH, and V. A. KOVARSKII, *Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki* (ISSN 0044-4510), Vol. 93, Aug. 1987, pp. 483-493. 21 Refs.

A theory is constructed for the Stark broadening of the light absorption line of a quantum system upon excitation of a transition adjacent to the sounding transition. The excitation is caused by a quasi-resonant noisy electromagnetic field having the form of a complex Gaussian random process. The evolution of the shape of the line is traced upon variation of the spectral width of the field from low values (the quasi-static limit) to asymptotically large values when efficient 'switching-off' of the field occurs.

**A88-17677** Optical waveguide processors (Opticheskie volnovodnye protsessory) A. S. SEMENOV, V. L. SMIRNOV, and A. V. SHMAL'KO, *Kvantovaya Elektronika (Moscow)* (ISSN 0368-7147), Vol. 14, July 1987, pp. 1319-1360. 157 Refs.

The basic principles and methods involved in the design of optical integrated circuits (OICs) for information processing are considered. OICs having different functions are studied, including spectral analyzers and correlators, analog-to-digital converters, circuits for data set identification and signal coding, threshold and multistable circuits, and logic and arithmetic units. Optically controlled OICs for information processing such as bistable and purely optical logic circuits, multivibrators, flip-flops, and an optical transistor are also examined.

**A88-10206** Coherent Raman transformation of light in a two-level medium (Kogerentnoe kombinatsionnoe preobrazovanie sveta v dvukhurovnevoi srede) A. A. ZABOLOTSKII, *Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki* (ISSN 0044-4510), Vol. 93, July 1987, pp. 84-94. 31 Refs.

Raman scattering for periods of time which are much less than the relaxation times of the medium is studied using the inverse scattering method. Consideration is given to cases in which energy transfer in a Stokes field is induced by polarization fluctuations and the momentum of a Stokes field of small area. Fluctuations of the pumping field are taken into account, and it is shown that the combined effect of the fluctuations of the pumping intensity and polarization leads to a spike in the solution describing the shape of the transmitted pulse of the pumping field. Compression of the Stokes field fluctuations in the strongly nonlinear stage of Raman scattering is explained on the basis of the quasi-self-similar solution obtained.

**A88-13677** Extension of holography to multifrequency fields (Rasshirenie golografii na mnogochastotnye polia) N. B. BARANOVA and B. I. A. ZEL'DOVICH, *Pis'ma v Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki* (ISSN 0370-274X), Vol. 45, June 25, 1987, pp. 562-565. 10 Refs.

Experiments are described which demonstrate the possibility of extending holographic processes to the cases of (1) recording of the interference patterns of mutually coherent fields of several different frequencies and (2) recording of the perturbations of higher-order optical susceptibilities. These processes are examined in relation to second harmonic generation in waveguides.

**A88-12218** Reduction of images distorted by atmospheric turbulence (Reduktsiia izobrazhenii, iskazhennykh turbulentnoi atmosferoi) I. U. P. PYTEV, A. I. CHULICHIKOV, and N. M. CHULICHKOVA, *Moskovskii Universitet, Vestnik, Seriya 3 - Fizika, Astronomiia* (ISSN 0579-9392), Vol. 28, May-June 1987, pp. 21-26. 5 Refs.

The reduction method is applied to the processing of images recorded during observation through a layer of atmospheric turbulence. The aim of the processing is to represent the images in the form they would have if they were recorded by a nearly perfect instrument in the absence of the atmosphere. The effect of the statistical characteristics of the medium on the processing is analyzed, and information requirements for attaining a given reduction quality are formulated.

**A88-10796** The nonlinear susceptibility of InSb at a wavelength of 10.6 microns (Nelineinaia vospriimchivost' InSb na dline volny 10,6 mkm) A. I. EROKHIN, V. I. KOVALEV, and A. K. SHMELEV, *Kvantovaya Elektronika (Moscow)* (ISSN 0368-7147), Vol. 14, June 1987, pp. 1170-1174. 9 Refs.

The nonlinear susceptibilities in InSb at 10.6 microns were measured and their relaxation times were determined. When both the signal and

reference waves are incoherent, the third-order nonlinear susceptibility (10 to the -7th esu with a relaxation time of about 10 to the -11 s) makes a dominant contribution to the reflection under the four-wave interaction. In the case of the coherent interaction, the fifth-order nonlinear susceptibility (10 to the -8th esu with a relaxation time of 10 to the -8th s) plays a leading role in the reflection.

**A88-29838 Polarized light transfer in a medium containing perfectly oriented elongated particles: General theory—'Rayleigh' scattering** (Perenos polarizovannogo izlucheniia v srede, sostoiashchei iz polnost'iu orientirovannykh sil'no vytiannykh chastits. Obshchaia

teoriia. 'Relevskoe' rasseianiia) M. I. MISHCHENKO and E. G. IANOVIT-SKII, *Kinematika i Fizika Nebesnykh Tel* (ISSN 0233-7665), Vol. 4, Jan.-Feb. 1988, pp. 19-29. 11 Refs.

Transfer of polarized light is studied in a plane parallel medium containing perfectly oriented elongated particles (infinite cylinders). External linearly polarized radiation is assumed to fall perpendicularly to the direction of particles orientation. The Sobolev method is applied in order to determine polarized radiation field in a semiinfinite homogeneous medium. Numerical results are represented for the case of very thin cylinders ('Rayleigh' scattering) which are compared with corresponding results for purely gaseous planetary atmosphere.

## Japanese Aerospace Literature

### This month: *Fluid Dynamics/Computational Fluid Dynamics*

**A88-29718 Numerical simulation of vortex-induced flow fields in a turbine cascade** (Numerische Simulation durch Wirbel zu bestimmender Strömungsfelder im Schaufelgitter) H. NISHIMURA, *Zeitschrift fuer angewandte Mathematik und Physik* (ISSN 0044-2275), Vol. 39, Jan. 1988, pp. 50-64. 7 Refs.

Vortex-induced flow fields in (1) a parallelogram-shaped zone enclosed by four nonporous walls; (2) a channel enclosed by upper and lower walls; and (3) a half-open region enclosed by upper, lower, and left-side walls are investigated by means of numerical simulations based on the potential-vortex model of Lakshminarayana (1970). The derivation of the governing equations is discussed, and the results are presented graphically and characterized in detail. The effectiveness of the present approach in describing secondary cascade flows with vortices is demonstrated.

**A88-29465 Analytical study of the structure of radiation controlled flame** YOSHIO YOSHIZAWA, KIYOSHI SASAKI, and RYOZO ECHIGO, *International Journal of Heat and Mass Transfer* (ISSN 0017-9310), Vol. 31, Feb. 1988, pp. 311-319. 16 Refs.

This study is aimed at clarifying the effects of radiative heat transfer on the flame structure and burning velocity in gas-solid two-phase systems. Based on a strict treatment of radiation, a detailed numerical analysis has been performed for a one-dimensional model of premixed combustion in a porous medium, and the effects of the absorption coefficient and total optical thickness of the porous medium, as well as the position of the reaction zone within the porous medium on the flame structures and burning velocity have been elucidated.

**A88-29375 Effects of wind distribution over aircraft on the longitudinal equations of motion in wind shear conditions** HARUO KIMURA and HAMID BASSIRI, *Kyushu University, Faculty of Engineering, Memoirs* (ISSN 0023-6160), Vol. 47, Sept. 1987, pp. 193-205. 8 Refs.

This paper derives the longitudinal equations of motion for an aircraft incorporating the wind shear terms in which the effect of wind distribution over the aircraft is taken into account. The aerodynamic forces and moment being dependent on the motion relative to the atmosphere, pertinent use of wing and tail relative velocities is emphasized. For simplicity, only the variation of horizontal atmospheric winds with altitude is considered. It is shown by a simple numerical example that - depending on the severity of atmospheric movement - the wind distribution over the aircraft has a distinguishable effect on the moment, and therefore the stability.

**A88-29275 On the Kolmogorov's spectrum for turbulence - A review of the statistical mechanical theory of turbulence** NORIO OHTOMO, TADASHI SEIDOU, and YUKIO TANAKA, *Hokkaido University, Faculty of Engineering, Bulletin* (ISSN 0385-602X), Feb. 1988, pp. 69-75. 23 Refs.

Several contributions to the recent development of a statistical mechanical theory of turbulence are briefly reviewed. The first group of these is represented by Wyld's theory, which adopts a perturbation method for solving the Navier-Stokes equation, analogous to the perturbation theory using Feynman's diagrams of quantum field theory. The Kolmogorov '-5/3' spectrum is derived by Shut'ko on the basis of Wyld's theory. The next is Hopf's theory based on the functional formulation, in which the so-called Hopf equation is derived. The Hopf equation is formally identical to the Tomonaga-Schwinger equation of quantum field theory. The Kolmogorov '-5/3' spectrum is derived by Edwards and McComb using the maximum-entropy principle.

**A88-28931 Mean-field magnetohydrodynamics associated with random Alfvén waves in a plasma with weak magnetic diffusion** HIROMITSU HAMABATA and TOMIKAZU NAMIKAWA, *Journal of Plasma Physics* (ISSN 0022-3778), Vol. 39, Feb. 1988, pp. 139-149. 7 Refs.

Using first-order smoothing theory, Fourier analysis and perturbation methods, a new equation is derived governing the evolution of the spectrum tensor (including the energy and helicity spectrum functions) of the random velocity field as well as the ponderomotive and mean electromotive forces generated by random Alfvén waves in a plasma with weak magnetic diffusion. The ponderomotive and mean electromotive forces are expressed as series involving spatial derivatives of mean magnetic and velocity fields whose coefficients are associated with the helicity spectrum function of the random velocity field. The effect of

microscale random Alfvén waves, through ponderomotive and mean electromotive forces generated by them, on the propagation of large-scale Alfvén waves is also investigated by solving the mean-field equations, including the transport equation of the helicity spectrum function.

**A88-24847 Pressure losses and flow field distortion induced by tip clearance of centrifugal and axial compressors** YASUTOSHI SENO, *Kyushu University, Research Institute of Industrial Science, Reports* (ISSN 0368-6841), no. 82, 1987, pp. 1-13. 40 Refs.

The flow field near the tip of compressor rotor blades is distorted by leakage through the tip clearance, and the performance of the compressor deteriorates. Empirical equations expressing the pressure loss and the efficiency drop are varied. They are related to the lift coefficient in different ways such as proportional to  $C(L)$ ,  $C(L) \exp 1.5$ ,  $C(L) \text{ sq.}$  or the sum of two terms, depending upon the ways of understanding the mechanics of pressure losses. These methods are examined and compared. Also included is a brief discussion on the optimum value of the tip clearance.

**A88-24508 Shock wave/turbulent boundary-layer interactions induced by a semicone** NOBUMI SAIDA and TOMONARI OOKA, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 30, Nov. 1987, pp. 173-185. 12 Refs.

This paper presents an experimental study of shock wave/turbulent boundary-layer interactions induced by a semicone placed on the floor of a wind tunnel. The experiments were carried out in an 8 x 10 sq cm supersonic wind tunnel at free-stream Mach numbers of 1.98 and 2.48. Corresponding unit Reynolds numbers at the test section were in both cases  $3.8 \times 10$  to the 7th/m. Semicone models with half angles varying from 20 to 90 deg were used in this study. Surface static pressure measurements, oil flow studies, and Schlieren photographs of the flow field were made. It was found that, on a flat plate, the shape of the separation line is insensitive to the cone angle of over 40 deg. Furthermore, a secondary separation region embedded in the shock-induced primary separated flow exists along the semicone and plate junction.

**A88-24507 Theoretical and experimental studies of a turbulent wall jet along a highly convex surface** NOBUYUKI FUJISAWA and HIROYUKI SHIRAI, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 30, Nov. 1987, pp. 162-172. 22 Refs.

Mean flow and turbulence characteristics of a two-dimensional wall jet along a highly convex surface of constant radius are studied theoretically and experimentally. The calculations are based on a Reynolds stress model of turbulence with modifications of streamline curvature and velocity acceleration. The transport equations for the turbulence energy, Reynolds shear stress and dissipation rate, coupled with the fluid dynamical conservation equations, are solved by a parabolic numerical method. Streamwise pressure gradients needed for the calculations are evaluated from the experiment. Main features observed in the present experiments such as streamwise variations of half width of the jet, mean velocity profiles, turbulence energy, and Reynolds shear stress are fairly well reproduced in the calculated results.

**A88-23321 Estimate of constants in the k-epsilon model of turbulence by using large eddy simulation** FUJIIHIRO HAMBA, *Physical Society of Japan, Journal* (ISSN 0031-9015), Vol. 56, Oct. 1987, pp. 3405-3408. 7 Refs.

Constants in the k-epsilon model are estimated using the statistics obtained from a large eddy simulation of a turbulent mixing layer. Estimated values are compared with those usually adopted in the k-epsilon model and those derived by statistical analysis. It is shown that the estimate using large eddy simulation can give an important clue to the optimization of the constants and improvement of the model.

**A88-23272 Research in computational fluid dynamics at National Aerospace Laboratory, Japan** H. NAGASU, *Computer applications in aircraft design and operation—Proceedings of the First International Conference on Computer Aided Design, Manufacture and Operation in the Aeronautics and Space Industries*, Paris, France, June 16-18, 1987, Computational Mechanics Publications, 1987, pp. 195-208. 7 Refs.

The development of computational fluid dynamics (CFD) software and its applications at the Japanese National Aerospace Laboratory (NAL) are discussed. Two-dimensional and three-dimensional CFD codes for design-