Issue of the magazine „Optics and Spectroscopy“ in memory of Vladimir Moiseyevich Agranovich

On April 19, 2024, Vladimir Moiseevich Agranovich — a world-famous theoretical physicist, Dr. Sci. in Physics and Mathematics, professor, chief researcher at the theoretical department of the Institute of Spectroscopy of the Russian Academy of Sciences, passed away at the age of 95.

We hope that the memory of Vladimir Moiseevich as a remarkable person and outstanding scientist will be held dear to the hearts of his friends, students and collaborators, and his ideas will inspire new students and graduate students,

The present issue of the „Optics and Spectroscopy“ is a tribute to Vladimir Agranovich and all articles are written by his students, collaborators and friends especially for this issue.

The article by V.E. Anikeeva, N.Yu. Boldyrev, O.I. Semenova, K.N. Boldyrev and M.N. Popova „Optical spectroscopy of single crystals of inorganic lead-halide perovskite $CsPbBr_3$“ presents the results of the study of temperature dependences of luminescence spectra of (3.6−120 K) under excitation with 405 nm wavelength light and non-contact measured photoconductivity (3.6−300 K) of single crystal $CsPbBr_3$. In the low-temperature photoluminescence (PL) spectrum, in addition to the autolocalized exciton line (2.318 eV at 10 K), a rich structure, possibly related to exciton-impurity complexes, and a broad band with a maximum around 2.24 eV, which may be the PL of impurity or defect centers, are observed. In the photoconductivity (PC) spectrum, there are two narrow peaks at the frequencies of intense exciton PL lines and a broad continuum corresponding to band-band absorption. While the PL is quenched as the temperature increases, the PC increases. Based on the analysis of the temperature dependences of the integral intensities of the exciton peak in PL and PC, the activation energies 12 ± 3 meV and 77 ± 10 meV of the processes leading to the decay of the autolocalized exciton, accompanied by the quenching of PL and the appearance of charge carriers, have been found. We have obtained an estimate of the exciton binding energy in the single crystal $CsPbBr_3$:Eb $= 65 \pm 13$ meV.

In the paper by V.A. Yakovlev, N.N. Novikova, and S.A. Klimin, „The Phonon Resonance of a Thin Film with the Surface Polariton of a Substrate“ the optical effects in layered structures, which are usually linear in film thicknesses (at small thicknesses), are considered. Therefore, the root dependence of the surface polariton (SP) splitting on thickness predicted theoretically by V.M. Agranovich is unique. In the paper the splitting of the SP dispersion curve of a sapphire after depositing a magnesium oxide film on its surface was shown. The magnitude of this splitting is directly proportional to the square root of the transitional layer thickness, as predicted by the theory. Other experiments confirming the theoretical conclusions are reviewed.

The study by E.S. Sedov, M.M. Glazov, and A.V. Kavokin „The ”Trembling” Motion of Tamm Polaritons in a Magnetic Field“ theoretically investigated the effect of trembling motion (zitterbewegung) of Tamm polariton states on the boundary of two multilayer binary heterostructures with overlapping bandgaps belonging to the point symmetry group C_{3v} and supporting exciton resonance. The effect involves oscillations of the trajectory of the Tamm state as it propagates in the interface plane. The possibility to control the characteristics of the trembling motion, including the period and amplitude of the oscillations, by means of an external magnetic field applied in Faraday geometry is shown.

In the article by B.A. Malomed „Null-, one-, and two-dimensional structures in the Lugiato-Lefever model with focused supporting radiation“ (brief review), the theoretical results showing the creation of stable spatially confined 0D (null-dimensional), 1D, and 2D modes in the framework of the Lugiato-Lefever (LL) equations, which are fundamental models of nonlinear passive optical resonators with external excitation, are reviewed.

The article by V.N. Konopsky, A.A. Melnikov, E.V. Alieva, and S.V. Chekalin, „The Second Harmonic Generation by Excitation of Surface Modes of a One-Dimensional Photonic Crystal“ experimentally studied a multilayer structure supporting the propagation of surface optical waves both at the frequency of excitation light and at twice the frequency, and with the same effective refractive indices at both frequencies. The phase synchronism of these two surface waves and the localization of field maxima at the boundaries of the layers allows observing the second harmonic generation, despite the fact that the structure is composed of centrosymmetric materials, the second-order nonlinear susceptibility of which is zero in the electrodipole approximation.

In the paper by M. Artoni, S.A.R. Horsley, and J.C. La Rocca entitled „Weak Disorder in Photonic Crystals“ finite one-dimensional photonic crystals with geometric and compositional disorder are studied using a perturbative approach in the limit of weak effective disorder. Expressions are obtained which, when used to calculate the disorder-averaged reflection spectra around the photonic bandgap, give accurate results and are much more efficient than those obtained by direct numerical averaging over the disorder implementation. The method is well suited to work with atomic photonic crystals with a low level of disorder and a significant number of periods.

In the paper by D.V. Bykova and A.M. Kamchatnov „Dynamics of Solitons in a Light Conduit in the Gerdzhikov-

Ivanov Model “ the dynamics of a soliton moving in a light conduit along an inhomogeneous and time-dependent background is considered within the framework of the Gerdzhikov-Ivanov model. The equations describing the soliton motion are derived. The theory is illustrated by an example of soliton motion along a simple wave.

In the paper by V.I. Rupasov and V.I. Yudson, „Multiphoton Scattering by Resonant Atoms as a Problem of the Theory of Integrable Quantum Systems“ the problem of multiphoton scattering of a multiphoton state of an electromagnetic field of arbitrary statistics on a resonant atom is considered. Using a set of exact eigenstates of the integrable model „quantum field+two-level atom“ an expression for the multiparticle wave function of scattered photons is obtained. The general formalism is shown using a particular example when the colliding field is in a stationary coherent state — although the results known for this case (spectrum and correlation function of the second order) are derived without involving the Lindblad approach and the regression theorem. The developed formalism is applicable to arbitrary, including non-classical (incoherent) states of colliding photons.

In the paper by N.N. Rozanov „Influence of the Short Electromagnetic Pulse Shape on the Probability of Quantum Transitions“ the probability of quantum transitions of microobjects under the action of extremely short electromagnetic pulses was analyzed in the framework of the first-order perturbation theory without using the electric dipole approximation. The selection rules are discussed and the dependence of the transition probability on the pulse parameters is determined.

The study by D.I. Dominsky and D.Yu. Parashchuk „Multiresonant Phosphors Based on the Effect of Thermally Activated Delayed Fluorescence for Organic LEDs of the 3rd and 4th Generation“ presents an overview of recent advances in the field of the most promising phosphors that exhibit the effect of delayed fluorescence for organic LEDs — multiresonant phosphors, which differ from other types of organic phosphors narrow emission bandwidth. A brief overview of generations of organic light-emitting diodes is given, principles of operation of multiresonant phosphors, the specific features of their structure and their photophysical and luminescent properties are outlined. Advances and problems in the field of multiresonant phosphors are analyzed and approaches to their molecular design are discussed.

In the article by D.M. Basko „On the Theory of Tip-Enhanced Raman Scattering (TERS) in Two-Dimensional Materials“ Raman scattering on phonons in two-dimensional materials such as graphene or transition metal dichalcogenides is considered. The focus is on the problem of what kind of information about phonons on nonzero wave vectors can be extracted from the dependence of the Raman spectrum on the tip position with respect to the sample. It is shown that for single-phonon nonresonant scattering the measurable quantity is the wave vector convolution of the phonon spectral function with an integral kernel, which is determined by the geometry and dielectric properties of the whole structure.

The article by D.S. Smirnov and E.L. Ivchenko, „The Role of Superfine and Anisotropic Exchange Interactions in Exciton Luminescence of Quantum Dots“ theoretically investigated optical orientation and exciton alignment in semiconductor indirect-gap quantum dots. A special mode in which the energy of the superfine interaction between the electron and the lattice nuclei is low compared to the exchange splitting between light and dark exciton levels, but comparable to the anisotropic exchange splitting of the radiation doublet was analyzed. The dependences of the degrees of circular and linear polarization on the external magnetic field at resonance excitation of excitons by polarized light were calculated.

V.N. Zadkov, N.N. Rozanov,
editors of the tribute issue