Research 2016

"Investigation of Asymptotic Properties of Pseudo Regular Functions and Generalized Recovery Processes" (Faculty of Physics and Mathematics, head Prof. OI Klesov).

A new class of complex-valued functions is investigated, which is connected with correctly-variables functions, namely the class of complex-valued functions with nondegenerate groups of regular points; The properties of complex-valued functions with non-degenerate groups of regular points are established, as well as their connection with correctly-variable functions. On the basis of the obtained results, the theorem on the representation of the classical theory of correctly-variables functions is proved; For the complex-valued functions with nondegenerate groups of regular points, analogues of the upper and lower boundary functions are introduced for a real valued case. Theorems on factorization images of these boundary functions for complex-valued OWRV functions with nondegenerate groups of regular points are proved. Also installed images for the OWRV and ORV functions themselves with non-degenerate groups of regular points; The complete convergence of the empirical analogues of the Sue-Robbins and Baum-Katz series was studied; Necessary and sufficient conditions for the existence of higher moments for empirical analogues are obtained; Asymptotic behavior of a non-autonomous stochastic differential equation with coefficients that is a product of functions depending on a spatial variable and a time variable, respectively, is investigated. Sufficient conditions are obtained that allow us to compare the behavior of the solution of a nonautonomous stochastic differential equation and the corresponding ordinary differential equation; Conditions of the correct solvability of a mixed problem for the second-order multidimensional linear parabolic equation in the 2-anisotropic Hermander spaces are found for an important boundary value of the numerical regularity index; New sufficient conditions for the classical generalized solutions of a mixed problem for a second order multidimensional linear parabolic equation are obtained; New sufficient conditions for the classical generalized solutions of initial boundary-value problems for parabolic equations of arbitrary order are obtained. The results of the work are implemented in the educational process: in part as separate units of the lecture courses "Theory of random processes", "Stochastic differential equations and their applications", "The application of correctly variable functions in the theory of probabilities". 1 candidate's dissertation is protected. In the year under review, using the results of the work, 1 monograph was transmitted abroad, 14 articles were published, 32 reports were made at conferences, including 26 at international conferences. Up to 12 students were involved. According to the results of scientific research students have defended 5 master's works and 1 work of a specialist.

"Spin Waves Spread in Non-uniform Modulated Ferromagnetic Structures with Complex Interfaces" (Faculty of Physics and Mathematics, Head Yu.I. Gorobets)

By means of the equation of the dynamics of the magnetization vector for a monovalent ferromagnet that looks similar to the quantum mechanical equation of Schrödinger, and also using the corresponding quantum mechanical formalism for determining the reflecting characteristics of the media, taking into account the finite thickness of the boundaries between ferromagnets with different magnetic characteristics in the external constant homogeneous magnetic Field in the framework of the exchange approximation, we obtain complex expressions for the amplitudes of the reflection and passing of spin waves This is a separate period of a multi-layer structure. In the presence of complex amplitudes of reflection and spin wavelength passing through a semi-infinite multi-layer ferromagnetic structure, an iterative procedure was used in which the amplitudes of reflection and passing through the entire structure are expressed through the amplitudes of reflection and spin wave passing through a separate period. Using the obtained amplitudes of reflection and spin wavelength transmission from an

unbounded multi-layer structure with finite-thickness interfaces, provided that the ferromagnet was located in an external constant homogeneous magnetic field, a correlation between the wave vector, the reflection amplitude from the semicontinuous multi-layer structure and the reflection amplitude from the structure was found within the framework of the exchange approximation A given number of layers with finite-thickness interfaces and alternating layer-by-layer parameters of a monovalent magne tion anisotropy exchange interactions and saturation magnetization. The dependences of the reflection coefficient on the spin-wave frequency, the magnitudes of the external constant homogeneous magnetic field, the exchange interaction constants, the univariate magnetic anisotropy, and the magnetization of saturation within the individual layers, the parameter of exchange between the individual layers, as well as the parameters characterizing the anisotropic properties of the finite-thickness interface, and the quantities Layers of multi-layer structure. The work corresponds to the world level. Application of the obtained results in microelectronics will allow to effectively manage behavior and intensity. In the reporting year, using the results of the performed work, published: 1 article in the professional edition, 4 articles in foreign publications, 1 of which is included in the scientific metric databases, 9 reports on International conferences. Up to 12 students were involved. According to the results of scientific research students have defended 4 master's works, 4 diploma works of specialists. With the participation of students, 1 article has been published in a professional edition and 1 report has been made at an international conference.

Theoretical and experimental studies of electronic, magnetic and optical properties of nanosized carbon-containing materials" (Faculty of Physics and Mathematics, Head Gorshkov VM)

Experimental samples of a-SiO2 films: C / Si, a-SiOC: H / Si and a-SiO2: C nanopowders with different thermal processing were made. It was found that an increase in the content of isolated C in a-SiOC: H films results in an increase in the wide band of visible photoluminescence (PL). The influence of target material (Si and SiC), discharge power and composition of the working combustible gas mixture on the properties of a-SiOC: H films was studied, and it was found that the use of Si-C target allows the introduction of Si-C bonds to the a-SiOC matrix , Which improves the mechanical and chemical stability of the films. It has been established that the introduction of C to the a-SiO2 matrix leads to the appearance of a broad PL band that covers the entire visible spectral range. The growth of the content C with the annealing temperature of SiO2 nanopowders: C causes an increase in the intensity of the PL and the shift of the signal to the infrared region, which is accompanied by the growth of the spin concentration of C-bound radicals. The transport of charge carriers in the graphene layers on SiO2 and their low-frequency (20-1 × 106 Hz) conductivity and capacitance were investigated. It is shown that scattering of charge carriers in graphene at elevated temperatures (300-400 K) is determined by the phonon component. The working formula for the contact capacitance metal-graphene film is obtained, which demonstrates the logarithmic decrease of the capacity with increasing frequency of measurement, which is confirmed by the experiment. The peculiarities of the transport of atoms in the near-surface layer of metallic nanoparticles are investigated and the mechanisms of formation of contacts between nanoparticles during sintering are due to the so-called By combined transport due to the extremely intense exchange of atoms between whole clusters and surrounding "steam" from free atoms. The Monte Carlo kinetic method was developed to study the processes of growing and evaporation of nanoparticles on / from nanotubes, in particular, it was shown that this method can reproduce the properties of the process that are not included in the phenomenological thermodynamic modeling, as well as provide a picture of the morphology of growing and evaporation processes. The transport of free atoms in near-surface layers that cover the nanoparticles, during sublimation and sintering in a nanoparticle system under different external conditions, is theoretically investigated: variations in the average size and degree of polydispersity of nanoparticles, the temperature regime,

and the density of their initial packaging at sintering. According to the research papers, 2 papers were published, 1 work was submitted to the editorial staff, and 3 works were prepared for the editions included in the Scopus and Web of Science science-centered databases, 7 theses and 1 work in the works of the international conference, one dissertation was defended for the degree of scientific degree Doctor of Physics and Mathematics.

"Physical principles for the creation of new elements of optical-electronic devices based on mono- and nanocrystalline silicon carbide". (Faculty of Physics and Mathematics, Head Voronov S.O.)

The influence of technological regimes for the creation of alloyed p-n structures on the basis of the most common silicon carbide polystyrenes, the degree of doping of the initial crystals and the state of their surface on the microplasm localization is determined. Methods of obtaining p-n-transitions with a homogeneous breakdown have been worked out, as well as methods for reducing the influence of self-absorption of UV radiation upon its removal beyond the structure. The latter is necessary for the creation of effective UV radiators in the range up to 250 nm. Methods and non-standard equipment for measuring the spectral distribution of the degree of linear polarization of weak radiation sources in a wide range of wavelengths are developed. For the first time, the spectral dependence of the degree of linear polarization of electroluminescence, which is accompanied by an electrical breakdown of p-n structures constructed on the basis of SiC-4H, 6H, 15R polyposites and silicon cubic carbide in the range 1.4-3.8 eV, was obtained. The structures were placed on the faces of crystals parallel and perpendicular to the crystallographic axis C. The radiation was deduced from the side of the thin p region perpendicularly and at an acute angle to the working face of the crystal. The components of radiation with linear polarization in a plane parallel to and perpendicular to the C (E || C, E ^ C) axis and parallel to the vector F of the electric field strength in the p-n-junction (E || F) were found. The energy situation and the intensity of the components related to the direction of the C axis have significant differences in the various polips, which indicates the significant impact of the nanosized polypositive structure. The general feature of all politicians is the presence of polarization (with a degree of 0.3-0.4) In the plane E || C in the region of fundamental absorption and the adjoining region. Correspondence of the polarization characteristics of radiation with data on optical absorption occurs only in some cases. The polarization E || F reaches a degree 0.5 and tends to increase towards the high photon energies. The modern requirements for gauge sources of pulsed radiation for use in large-scale nuclear-physical experiments have been analyzed. The main of these requirements are as follows: the spectrum of radiation - blue-blue 350-500 nm; The range of change in the amplitude of light pulses - from dozens of photons to 1010 or more photons in one pulse; Pulse duration - from tenths of nanosecond to microseconds; High temperature and temporal stability of the amplitude and shape of light pulses. It is found that such parameters can be realized by using silicon carbide breakthrough emitters and some types of modern imported light-emitting diode based on gallium and aluminum nitrides as an emitter. Using the time correction method of individual photons, the dynamic characteristics of breakdown LEDs based on silicon carbide and some high-performance imported light-emitting diodes with short-wave radiation were investigated. The clock differentiation of the installation was 0.25 ns. The amplitude range exceeded four orders. The radiation was recorded in different spectral intervals. Several designs of scintillation simulators were developed, model designs were made and their characteristics were studied. Long-term testing of the stability of these devices in the process of their long-term work is underway. The fulfillment of the GDR helps to organize a cycle of laboratory work for students of the FMF "Methods of determining the characteristics of weak sources of optical radiation" according to the course "Optics": In the reporting year, using the results of the work performed: 3 special articles were published, 3 reports were made at the conferences. II The most important results of applied research, competitive application development and the latest technology in the priority areas of science and

technology, it is mandatory to specify the enterprises and organizations that tested, tested and likely to be interested in their use. As a result of the implementation of the doctoral dissertation prepared for defense. Published 2 articles in professional journals, 4 papers at international scientific and technical conferences. Two students and 2 postgraduate students were involved in the implementation of scientific research, preparing to defend theses.

"Development of methods and algorithms for optimization of complex systems and the construction of optimal control in the conditions of complex phase constraints "(Faculty of Physics and Mathematics, Head of IV Beyko).

Within the framework of this research, methods and algorithms are developed for constructing optimal control of complex processes with lumped and distributed parameters described by controlled systems of differential equations and equations with partial derivatives and incompletely set functional parameters in the presence of phase constraints. The increase in the efficiency of the implementation of new algorithms is based on the use of methods of asymptotic-solving operators and algorithms based on their calculation of optimal controls in the presence of phase constraints. The algorithms for the approximation of the optimality criterion are realized in the class of solvers and asymptotic-solversing operators, which are defined on the spaces of control functions. The efficiency of the new methods is further enhanced by reducing the dimension of the simplified optimization task of minimizing the decoupling operator and by simplifying the calculation of gradients / quasi-gradients without the required previous calculation of phase trajectories.

The obtained results were reported at 3 international scientific conferences, reflected in the materials of these conferences, published in two articles and four abstracts of reports at international conferences. Doctoral dissertation prepared for defense. Up to carrying out scientific research on the subject of GDR involved 2 students and 2 graduate students of the Department of Mathematical Physics, preparing to defend the thesis.