Written by Administrator
Wednesday, 14 September 2011 12:06 - Last Updated Wednesday, 17 June 2020 21:25

"Interaction of spin waves and spin-polarized current with magnetic inhomogeneities in nanostructured ferromagnetic materials" (Faculty of Physics and Mathematics, supervisor SO Reshetnyak)

The theory of refraction of exchange spin waves in inhomogeneous ferromagnetic structures of spin lens type with inhomogeneous interfaces is constructed. The boundary conditions on the surfaces of spin lenses are determined taking into account the inhomogeneity of the exchange interaction within the thin interfaces in the model, when the thin interface is formed by superimposing crystal lattices of contacting materials taking into account all pairwise exchange interactions between lattice elements. The possibility of effective control of the spin wave intensity by spherical and cylindrical spin lenses is shown. The characteristics of the field and frequency dependences of the refractive indices of spin waves and focal lengths of spin lenses created on the basis of uniaxial ferromagnets in an external constant homogeneous magnetic field are obtained. The possibility of adjusting the transparency of such inhomogeneities is shown, which allows to use them both as lenses and as mirrors depending on the magnitude of the external field and the frequency of the wave. The existence of a narrow transition zone in the field and spectral dependences of the refractive indices and reflection coefficients was also revealed, in which there is a sharp jump in the amplitude of the wave reflected from the boundary of two homogeneous media. This feature makes it possible to use structures with a similar boundary as highly sensitive sensors of changes in the characteristics of magnetic media or the external conditions in which they are located. The comparative characteristics of the reflectivity of spherical and cylindrical surfaces of spin lenses are given, the existence of areas in which the influence of surface curvature significantly affects the transparency of lenses and areas in which the influence of interface curvature on their reflectivity when interacting with a spin wave can be neglected.

The work corresponds to the world level. The application of the obtained results in spin-wave electronics will make it possible to effectively control the processes of spin wave propagation in ferromagnetic materials.

According to the materials of the GDR, 10 articles were published, 2 of them in professional publications; in publications included in SCOPUS and Web of Science scientometric databases - 8. 5 reports were made at 5 international conferences, 5 abstracts were published, incl. 5 international. 1 doctoral dissertation was defended and 2 candidate dissertations were prepared for defense. The performance involved: 5 students, 2 graduate students. 4 master's theses are protected.

"Application of stochastic, statistical and functional methods for the analysis of asymptotic behavior of random fields" (Faculty of Physics and Mathematics, Department of Mathematical Analysis and Probability Theory, headed by Prof. OI Klesov).

A generalization of the classical Bass-Pike theorem is obtained, which establishes a uniform enhanced law of large numbers for normalized sums of multiindexed independent equally distributed random variables with indices belonging to a sequence of rescaled copies of some set;

A generalization of this theorem to the case of arbitrary random measures with a sign is proposed;

Uniform laws are established for multiple stochastic integrals according to the Brownian letter (another name is the random Wiener-Chentsov field);

Various classes of functions are considered, which generalize correctly variable functions, in particular functions with nondegenerate groups of regular points, regular log-periodic functions, ORV functions with index. For such functions, analogs of Karamati's theorem on the integral image are obtained, which are the criteria for belonging to the corresponding class;

A relationship is established between different classes of functions that generalize correctly variables, which is based on the integrated image of Karamaty;

Sequences with nondegenerate groups of regular points and their connection with correctly variable functions are considered;

The groups of regular points for the sequence were studied and it was found that the set of regular points of the sequence, in contrast to the function, is not always a multiplicative group;

Necessary and sufficient conditions are established for the set of regular points of the sequence

to be a multiplicative group;

The interpolation problem for functionals from periodically correlated sequences with omitted values ⬜⬜in the case of spectral uncertainty is investigated. The least favorable densities and minimax spectral characteristics of optimal estimates were found for given classes of spectral densities.

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The properties of boundary functions of ORV sequences with nondegenerate groups of regular points are investigated, and theorems on the representation of boundary functions and sequences are studied.

GDR 0113U004540 "Research of qualitative and spectral characteristics of dynamical systems" (Faculty of Physics and Mathematics, Department of Differential Equations - Head: Prof. Dudkin ME).

The paper investigates various problems of optimal control, in particular for stochastic systems; systems of differential equations with a linearly transformed argument, in particular equations with delay and bias; equations generated by singularly perturbed rank one asymmetric operators and their spectral properties; block matrices of the Jacobi type correspond to multidimensional problems of moments; qualitative and spectral characteristics of dynamic systems,

The results of the work are implemented in the educational process. For 3rd year students, the courses "Mathematical Physics" for the specialties of the Department of Nuclear Power Plants and Engineering Thermophysics have been supplemented and improved.

According to the results of research, 2 candidate dissertations were defended, 1 monograph

was published, 2 reports were made at international conferences. 1 postgraduate student was involved.

GDR 0117U000192 "Application of the method of limit integral equations for a nonstationary problem of thermal conductivity for different areas" (Faculty of Physics and Mathematics, Department of Differential Equations - Head Assoc.

The application of optimization methods in the problems of designing mechanical devices with given optimal characteristics is investigated. The methods allow to significantly improve the functional characteristics of the control. The research considers the problem of determining the optimal amount and characteristics of forces acting on a hinged plate (places of application of forces, amplitudes and phases of oscillations, which provide with a given accuracy of approximation of given shapes and phases of oscillations of a plate in a given frequency range). The direct problem of determining oscillations with known excitation characteristics is solved by the Green's function method. For the inverse optimization problem, the optimality criterion is the method of least squares of integral deviations of the amplitude and phase of oscillations from the given ones. The analysis of the conditional problem of minimization of many extreme functional is carried out in length. A discrete equivalent is constructed, a numerical solution algorithm is formulated. The effectiveness of the proposed approach is demonstrated by numerical examples of determining the optimal excitation characteristics of given oscillations.

The results of the works are proposed to be implemented in the educational process. The program of a special course for specialties of an electric power cycle on discipline "the theory of optimum management" is prepared. In the reporting year, using the results of the work performed, the following were published: 1 - article, 1 - abstracts of the report at the conference.

GDR 0115U005199 "Statistical evaluation of characteristics and construction of mathematical models of random processes and fields", (Faculty of Physics and Mathematics, Department of Mathematical Analysis and Probability Theory - Head Klesov OI).

The interpolation problem for functionals from periodically correlated sequences with omitted values □□in the case of spectral uncertainty is investigated.

 The least favorable densities and minimax spectral characteristics of optimal estimates were

found for given classes of spectral densities.

Calculations and forecasting of nitrogen balance in agricultural production are carried out.

The results of the work are introduced into the educational process as new sections of special courses for masters of FMF: "Random wanderings in financial mathematics", "Elements of queuing theory", "Levy processes in models of financial mathematics". In the reporting year, 1 article was published in a journal included in the scientometric database, 1 report was made at an international conference.

New technologies and resource saving technologies in energy, industry and agriculture.

In this area faculty in 2010 carried out a research **"Theory of structural and parametric geometric modeling as a means of optimizing complex processes aided design and production" (Physics and Mathematics - head prof. Vanin VV)**

Identifying the most promising application areas of geometric modeling.

Generalized and systematized aided design and manufacturing of engineering products in terms of structural and para-metric approach.

Developed criteria, principles, methods and techniques of formalization of the design and construction machinery.

Developed criteria, principles, methods and techniques of formalization process production preparation and manufacturing of engineering products.

In 2010, using the results of the works published 12 articles in specialized collections. Published 12 articles. We took part in 3 students.

New substances and materials

In this area faculty in 2010, carried out five research

The results introduced in the educational process by teaching **"Modern problems of solid state physics", "Special sections of experimental physics", "Structure and dynamics of metal surfaces," "Methods of Surface Analysis", "Computational Methods in Physics", "Physics of Nanoparticles"** was extended partition "auto-oscillatory processes on the interfaces surface-electrolyte conductor in a magnetic field" course of physics of magnetic phenomena.

Main results of scientific research and scientific and technical developments in the priority areas.

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The results used in the institutions working in the field of semiconductor physics, solid state physics and microelectronics (Institute of Metal Physics NASU Institute of Magnetism NASU, Institute of Semiconductor Physics, National Academy of Sciences, Institute of Theoretical Physics, NASU).

In 2010, using the results of the works published 31 articles, made 37 presentations at conferences, including 24 on international with membership of 79 students. 4 PhD theses. Prepared by one of his doctoral thesis.

GDR, "Influence of magnetic field on self-oscillating processes on the interfaces surface conductor-electrolyte" (Physics and Mathematics - Science. Supervisor - prof. Gorobeetz YI).

The process of etching of steel under the influence of constant magnetic field in a solution of nitric acid, taking into account the presence of different distribution of magnetostatic fields in magnetic field orientation perpendicular to the metal surface and perpendicular to the direction of unwinding the sample. The influence of gravitation on the nature of digestion in a magnetic field. Shown that the fluctuations are quasi-periodic nature, which depend in particular on the complex configuration of the electrolyte flows arising during the process of digestion, as well as the geometry of the sample location. The obtained time dependence of mass corrode substance in a magnetic field at the respective orientations of the magnetic field relative to the metal surface and to the direction of unwinding the sample at various concentrations in solution.

"Theoretical and experimental studies of morphology and optical properties of photochemically / thermally synthesized nanoscale particles with characteristic spectra of surface plasmon resonance" (Physics and Mathematics - head prof. Gorshkov VM).

These samples meso-porous silica with the introduction of nanoparticles of silver and gold. Experimentally determined temperature and consantration regimes for the formation of negative curvature. Programs are developed to calculate the local field of nano-particles of complex shape. Experimentally investigated the characteristics of materials.

"Research on the impact of the statistical characteristics of partially coherent beams when used in optical communication systems" (Physics and Mathematics - head prof. Hermash LP).

A study of the process of distribution in the Earth's turbulent atmosphere partially coherent laser beams, formed as a result of artificial phase modulation in the plane of the beam aperture. The developed algorithms for modeling of partially coherent laser beams in turbulent atmosphere of the Earth. Established pattern of distribution of partially coherent laser radiation through the turbulent atmosphere in two-cone model. The methods of optimizing the parameters of the phase modulator to minimize.

"Electronic processes in probiynyh electric fields in silicon carbide polytypes" (Physics - Mathematics Department - Head LP Hermash.).

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A program and the results of calculations of the band structure of cubic SiC by using an empirical pseudopotential. Established methods and assembled laboratory stand for anodization surface of silicon carbide crystals. Retrieved characteristic size and structure of the nanopore. Summarized information on the impact of technological methods on the structure surface.

Developed and manufactured test machine for research gas sensitivity semiconductor sensors. Experimental data on the impact of gas environment on the electrical properties of porous layers of SiC.

"Development of optical methods and means of multiparameter process control basic parameters of strip material (Physics - Mathematics Department - Chief S.O Voronov.)

Developed optical system of continuous process control basic settings (brightness, thickness, moisture) belt and sheet materials that are produced in the pulp and paper, woodworking and other industries.

An effective method of measuring brightness, the technological control. Proved feasibility of joint measurement shine and color of the material. For the first time a method of simultaneous measurement of brightness and color paper and cellulose materials in the processing stream. Defined and calculated measurement error parameters arising in the process of movement material. The method of their elimination or reduction to values that are within the main errors: 1% for measuring brightness, 0.5% for thickness and 0.5% for humidity. A standard samples - simulators humidity substances to construct nominal gradei characteristics of infrared moisture meters. This enabled us to improve the accuracy of measuring humidity at 40%. Proposed the use of simulators as a matter of humidity standards. Were tested in the industry, confirmed the need for their widespread use. Developed, manufactured and has been tested three parametric measurement system, which has the following advantages over existing: high precision control, high efficiency, low power consumption, a significant increase of employment with the device, a low cost. Tested measuring system in terms of industrial production at OJSC "Koryakovska estate market" by setting shine, OAO "Troitskaya Paper Mill" (Russia) by setting the humidity, Inc. "Ukrplastyk" parameter in thickness. The results confirmed the suitability of devices for process control on the specified parameters.

GDR "Investigation of electrophysical parameters of ferroelectric materials and nanostructures thermal sensors' (head Voronov SA)

Study many-particle system for problems that arise in nanomehanichnyh devices and appliances. The algorithm of the computer experiment method of molecular dynamics. A layout of laboratory sample to form shyrokoaperturnyh beams of neutral atoms of metals and nonmetals. An optimal algorithm MD - calculations. A calculation of the effective force field in MD - modeling. A study of electro-dynamic method of ferroelectric layers. A node magnetron system for creating nanoshariv. A thumbnail of the design documentation device selection and grouping of neutral atoms from the 5% range of deviation from the mean speed.

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"Asymptotic and qualitative methods of Evolutionary Systems" (Head Samoilenko AM)

A study of the structure of sets of solutions of systems of linear differential-functional equations with linear deviations.

"Magnetic and transport properties of ordered nanostructures in porous matrices" (head Hermash LP)

A technology of ordered nanostructures in porous matrices of anodized aluminum oxide.

"Magnetoelastic effects in semiclassical and quantum magnets" (head Loktev VM)

The models and the analysis of properties of magnetic materials of various types (weak ferromagnets, quantum magnets, antiferromagnets) with strong magnetoelastic interaction.

"Architectural organization of software operational analysis of information resources of digital libraries" (head Kotovsky VI)

A statement of the problem and its solution methods. The structure of expert systems for organizing electronic resources of libraries. The developed algorithms of expert systems for organizing electronic resources of libraries.

Creating a multi-domestic meter natural gas consumption based on passive sensors on surface acoustic waves. To explore the possibilities of remote control passive sensors "(head Kolomeyko AV)

Conduct optimization and testing of passive sensors to improve their metrological parameters and measuring the whole system that supports multi-channel algorithm for contactless reading of data and interfaces for communication with service equipment.

"Investigation of parameters of working construction and modernization of the field of earth-moving machines ETC-200m" (head Yurchuk VP)

Upgrading the existing structures of the field of earth-moving machines ETC-200m (working drawings Trench chain). Development of construction of the Trench chain with new work surfaces and plant layout including Novelty designs.

Faculty initiative activities

Departments of Physics and Solid State Physics

- Theoretical and experimental studies of optical, electrical properties and surface phenomen of semiconductor materials, modeling of self-organization of nanoscale particles;

- Development of theoretical foundations and a series of optoelectronic devices based on semiconductor materials;

- High technology training, distance learning.

Department of Theoretical Physics

- Physics of superconductivity, physics of magnetic phenomen;

- Physics nonideal crystals;

- Physics composite media;

- The theory of complex systems;

- Development of diagnostic sensors for aircraft systems

It is proved that the new physical environment of the relativistic-like spectrum of quasiparticles in the presence of impurities also demonstrates the ability to form recent localized states that have recently considered impossible and greatly affects the electrical system.

Loktev VM: In the educational process in the know "macroscopic quantum phenomen" used and taught specialist and master FMF information on the latest scientific achievements in physics of high-temperature superconductivity and the properties of new materials - graphene in which the electronic spectrum is described by the Schrodinger equation, and the Dirac equation.

It is proved that the new physical environment of the relativistic-like spectrum of quasiparticles in the presence of impurities also demonstrates the ability to form recent localized states that have recently considered impossible and greatly affects the electrical system.

Sus BA: I work on the staging of the experiment to detect absorption of gravitons (the initiative work).

Brodin AM, Art. Off. Initiative Projects: Experimental and theoretical studies of molecular ordering in the polar molecular liquids.

Kornienko EG: In 2010, two initiatives carried out applied research work in the field of "nanotechnology, microelectronics, information technology, telecommunications."

 In 2010, using the results of the works published a professional article, made a report at the conference, published a thesis reports.

1) "Nano-torsion resonator with the inclusion of antiferromagnetic"

The dynamics sandwiched nano-plate with a thin inclusion AFM. Found eigenmodes and frequencies of magneto-torsialnyh fluctuations in this system. Shown that fluctuations torsialni

considered nano-plate can induction applying an external magnetic field or spin-polarized current to the antiferromagnetic layer.

The results can be used to develop nano-devices, in particular for the creation of nano-motors.

2) "Domain structure in multyferoyik Sr2Cu3O4Cl2: competition and demagnetization and under factors"

We construct a phenomenological model that describes the domain structure in multyferoyiku simultaneously ferromagnetic and antiferromagnetic ordering (for example multyferoyiku Sr2Cu3O4Cl2). Shown that in multyferoyik simultaneously ferromagnetic and antiferromagnetic ordering, under certain conditions, possible competition domains with magnetization directed parallel to the external magnetic field and magnetization directed perpendicular to the external field, which leads to spontaneous emergence of perpendicular to the external field components of magnetization at overmagnetization sample of large (greater than field   monomagnetization) field values. Theoretically explained by atypical behavior of magnetization in Sr2Cu3O4Cl2

The results can be used in specialized training courses of solid state physics, in "Magnetism."

In work examining the properties of macroscopic objects that can be used in spintronitsi and touch technology. Based on these studies can be controlled by such macroscopic properties of the sample as a domain structure that includes the domains of different nature. The results can be useful in the design of multilayer devices spintronics, in particular, memory elements based on multyferoyikiv and the design of controllers.

Department of Experimental Physics

- Magnetic properties of ferromagnets and antiferromagnets;

- Electrochemical and hydrodynamic processes in a magnetic field;

- Study the behavior of domain structures in an external magnetic field;

- Thermomagnetic phenomena in ferromagnetic bodies;

- The study of processes of spin waves in magnetic media;

- The study of surface characteristics of solids by means of scanning electron microscopy, and tunneling and atomic force microscopy.

Research Laboratory acoustoelectronics

- Development of instruments frequency, spatial and temporal filtering of surface acoustic wave (SAW);

- Development of various SAW sensors for monitoring the environment, including completely

passive, remote removal of information;

- Development, production and research of electronic instruments measuring physical quantities based on passive SAW sensors, remote elite media.

Department of Mathematical Analysis and Probability

In 2010, the department of mathematical analysis and probability theory performed research "Investigation of current problems of the theory of random processes, mathematical analysis and boundary value problems of mathematical physics" (Physics and Mathematics, supervisor prof. Buldyhin VV)

In 2010, using the results of the works published 23 articles, 22 of the report made at conferences, among them 21 of the report at international conferences. 12 students participated in the state budget project, 6 of them took part in scientific projects of the Department in defending the diploma and masters.

The main area of research is the research and development of new mathematical methods for analyzing linear and nonlinear stochastic systems, statistical procedures, further develop the theory of special functions and its applications to problems of mathematical physics.

During the period in 2010 received the following scientific results:

Developed new methods for solving integral equations with special functions in nucley.

Investigated the properties of integral functions with nondegenerate groups of regular points.

Theorem Karamaty of integrals of regular functions on the function is not degenerate groups of regular points.

We consider stochastic approach to the problem of assessing the impact of the unknown pulse function unstable linear systems subject to Voltaire's internal system noise. Using the theory of multidimensional singular integrals with cyclic kernel, set new conditions for asymptotic normality of the relevant assessments and proved the convergence of functional assessments.

Established new relations for composite operators of fractional integro-differentiation.

Contemporary Issues of linear and nonlinear stochastic systems and mathematical physics;

study of actual problems of probability theory and mathematical statistics, stochastic processes and stochastic analysis theory of functions and functional analysis, differential equations and mathematical physics;

advanced learning technologies, distance learning.

Department of Differential Equations

- Asymptotic and qualitative research methods of evolutionary systems;

- Study problems of optimal control for stochastic systems;

- Solutions of systems of linear differential equations with the fundamental argument of linear transformations.

Department of Mathematical Physics

- Construction, research and application of various Green's matrices of boundary value problems and the fundamental solution of the Cauchy problem;

- Development of methods and algorithms of asymptotic-solution "adhesion agent operators;

- Deterministic chaos in the nonideal dynamical systems and systems with limited excitation;

- Nonlinear Dynamics of inhomogeneous distribution of magnetization in magnetically polysublattice crystals in external alternating fields, structural phase transitions and perturbation methods.

Under the initiative of department subjects received the following main results:

 1) constructed methods and algorithms for solving multidimensional problems of optimal control graph-operator systems with the use of asymptotically-solving operators to the construction of optimal management strategies under conditions of incomplete data (Bejko IV);

 2) set the correct solvability of parabolic initial-Eydelmana Solonnikov problems in generalized Sobolev spaces (Ivasyshen SD);

 3) by means of perturbation theory for solitons theoretically proved the possibility of drift motion of magnetic domain boundaries in the oscillating electric field (Gerasimchuk VS);

 4) discovered and described new scenarios of transition to deterministic chaos in the nonideal hydrodynamic systems, installed by Feigenbaum universality class of dynamical systems "pendulum-motor", revealed the existence hiperhaosu in some dynamical systems (Shvets OY).

Departments of descriptive geometry, engineering and computer graphics

- Geometric design surface modeling products, processes, and snap-in aircraft construction and engineering;

- Geometric modeling multicriteria problems of science and technology;

- Modeling of agricultural production to optimize the design of agricultural tools and equipment;

- High technology training, distance learning.

Main results of scientific research and scientific and technical developments in the priority areas.

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