Summaries of all articles

V.G. Popov

The themes review of the 4th All–Russian Young Scientist Conference on Micro- and Nanotechnologies and their Application

L.V. Bondarenko, D.A. Tsukanov, E.A. Borisenko, D.V. Gruznev, A.V. Matetskiy, A.V. Zotov, A.A. Saranin

Electrical conductivity of (Au, In) /Si (111) system

Using low energy electron diffraction, scanning tunneling microscopy and in situ four-probe method of electrical conductivity measurements, the (Au,In)/Si(111) structure is studied. It is shown that the deposition of the order of 0.7-0.8 monolayer of indium at room temperature on the reconstructed $Si(111)\sqrt{3} \times \sqrt{3} - (Au,In)$ surface leads to an approximately triple increase in sample conductivity, and further deposition of indium causes a drop in conductivity. When coverage of indium reaches about 2.5 monolayers, the short-term annealing of the surface results in the formation of the new reconstruction: $Si(111)2\sqrt{7} \times \sqrt{3} - (Au,In)$, which is not observed previously. The conductivity of gold films on the various indium reconstructions on Si(111) is studied. It is shown that changes in conductivity depend on the growth mechanism of the gold film.

Keywords: electric transport measurements, scanning tunneling microscopy, silicon, gold, indium, metallic films.

A.I. Dmitriev, A.D. Talantsev, S.V. Zaitsev, R.B. Morgunov

Bloch and percolation type of ferromagnetism in heterostructures InGaAs/GaAs/$\delta- < Mn >$

The effect of the orientation of GaAs substrates on magnetic properties, spin dynamics and the photoluminescence of heterostructues with InGaAs/GaAs quantum well and $\delta - \langle$Mn$\rangle$-layer is found. The temperature dependencies of magnetization, electron spin resonance spectra, and temperature dependencies of quantum well photoluminescence polarization are different for singular and vicinal InGaAs/GaAs/$\delta- < Mn >$ heterostructures.

Keywords: heterostructure, diluted magnetic semiconductor, quantum well, spin polarization.

V.G. Kohn, M.A. Orlov

Image adjustment in the Zernike method for hard x-ray radiation

The computer simulation of an experiment on imaging transparent (phase) microobjects using the Zernike phase contrast method under hard x-ray radiation is performed. The beam parameters typical of synchrotron radiation sources of the third generation are used in calculations. The x-ray refracting parabolic lens is considered as a focusing element. The phase shifting quarter-wave plate is located at a spot of the point source image. It is shown that the image could be corrected by dividing the intensity profile registered by a detector into the intensity profile formed just behind the lens due to absorption.

Keywords: computer simulation, hard x-ray radiation, Zernike phase contrast, refracting parabolic lens, phase shifting quarter-wave plate, image adjustment.

A.A. Konakov, V.A. Belyakov, V.A. Burdov

Optical gap of silicon nanocrystals doped with phosphorus

Electron and hole spectra and the optical gap of phosphorus-doped silicon nanocrystals embedded in an amorphous silica host matrix are calculated. The case of heavily doped silicon nanocrystals with impurities homogeneous distribution is investigated. It is shown that interaction with the short-range component of the impurity electric field leads to splitting the ground electron state into a singlet, doublet and triplet as is the case with bulk silicon. In the valence band, interaction with the impurity center leads only to the common shift of the degenerate energy levels. As a result, the optical gap decreases with increasing impurity concentration.

Keywords: silicon nanocrystal, doping, phosphorus, short-range potential, optical gap.

T.V. Krishtop, K.E. Nagaev

Quantum conductivity of a two-dimensional ballistic contact

We calculate the conductivity of a two-dimensional ballistic microcontact in the quantum case of the contact size much smaller than the Fermi wavelength of an electron.

Keywords: quantum contact, microcontact, ballistic conductivity.

P.A. Larionov, S.A. Ryabchun, M.I. Finkel, G.N. Gol'tsman

Air bridge superconducting detector of the terahertz range

We report on the fabrication process of air bridge superconducting hung detectors of the terahertz range based on MoRe films. A possible fabrication route is suggested and the material choice for this detector is explained.

Keywords: air bridge bolometer, terahertz frequencies, superconducting films.

A.V. Maslennikova, S.A. Ryabchun, M.I. Finkel, N.S. Kaurova, A.A. Isupova, B.M. Voronov, G.N. Goltsman

Wide-bandwidth hot-electron bolometer mixers based on NbN nanostructures

We report the results of gain bandwidth studies performed on hot-electron bolometer (HEB) mixers based on thin NbN films. The dependence of the gain bandwidth on the mixing element length is in excellent agreement with the results of the theoretical model of the HEB mixer in which the energy relaxation of electrons occurs simultaneously via two channels: phonon and diffusion.

Keywords: physics of nanostructures, millimeter and submillimeter waves, superconductors, superconducting NbN film, gain bandwidth, HEB mixers, terahertz frequencies, radio astronomy.

V.V. Medvedev, V.M. Krivtsun

Spectral filter for the new generation of projection nanolithography

We study the prospects for using free-standing inductive grid filters for suppression of infrared radiation in laser-produced-plasma EUV sources for high-volume manufacturing EUV lithography. Numerical modeling is performed to define the spectral response of filters.

Keywords: projection lithography, EUV lithography, CO_2 laser, infrared radiation, EUV radiation, metal-mesh filters, FDTD, scattering matrix technique.

I.V. Pentin, K.V. Smirnov, Y.B. Vachtomin, A.V. Smirnov, R.V. Ozhegov, A.V. Divochiy, G.N. Gol'tsman

Fast terahertz receiver and infrared single photons counter based on the hot-electron effect in thin film nanostructures

The development results of terahertz frequency- range (0,3 THz to 70 THz) record fast (50 ps) high sensitivity (to 5x 10^{-14} W / Hz $^{1/2}$) receiving systems as well as those of near -infrared single photon systems with quantum efficiency 25%, dark count level 10 s $^{-1}$, maximum counting rate ~ 100 MHz and time resolution up to 50 ps are presented.

Keywords: hot electron effect, thin film, superconductivity, bolometer, terahertz detector, IR single-photon counter.

A.O. Puchkova, P.A. Sokolov, K.G. Lopatko, N.A. Kasyanenko

DNA fixation on silicon surface for the creation of a nanowire template

The simple and effective method of DNA nanowires fabrication on the silicon surface is developed. It is based on the electrochemical reduction of Ag+ ions after their binding with a DNA molecule on the silicon surface. The absence of chemicals for the reduction of silver ions, and the application of n-type silicon as a source of electrons for the formation of metal clusters are the substantial features of the method under study. As a result, the extended nanowires with silver clusters about 30 nm in diameter are observed.

Keywords: dNA fixation, nanowires, reduction of silver ions, DNA-template, nanoelectronics, nanobiotechnology, silicon, DNA metallization.

I.N. Florya, Y.P. Korneeva, A.A. Korneev, G.N. Goltsman

Superconducting single-photon detector for the mid-infrared range based on narrow parallel strips

We present an ultrafast superconducting single-photon detector (SSPD). SSPD is a thin-film nanostructure - a very narrow and long strip of a superconductor bent to a meander made of NbN film with thickness of 4 nm, deposited on a sapphire substrate. SSPD is compatible with optical fibers and can easily be integrated into a fully prepared receiving system. In a wish to advance in the mid-IR, we develop SSPD in the form of strips connected in parallel with the strip width of 50 nm, with high superconducting properties preserved. These detectors show a tenfold greater sensitivity at a wavelength of 3.5 microns than meander SSPD. The results open the way for efficient mid-IR detectors having count rate above 1 GHz.

Keywords: superconducting single-photon detector, middle-IR, thin-film nanostructures.

M.S. Dolgonosov, I.V. Kuzichev, L.M. Zelenyi

Evolution of an electrostatic wave propagating perpendicular to the uniform magnetic field in plasma

In this paper, we numerically study the Landau damping of the Langmuir wave propagating perpendicular to the constant magnetic field. To solve this problem we use a splitting scheme as a model. in simulation. It is shown that the wave evolution could be studied as a bifurcational problem relative to a set of the initial parameters. In particular, the magnetic field prevents wave damping in the Landau regime with some set of initial parameters. In the O'Neil regime the effect of the magnetic field is quite different. A weak magnetic field slightly decreases the oscillation amplitude of the wave energy envelope. If the value of the magnetic field exceeds some threshold, the initially undamped Langmuir wave damps approximately in one gyroperiod. A further increase in the magnetic field value again stops the wave damping and results in generating Bernstein modes.

Keywords: langmuir wave, Landau damping, magnetized plasma, Bernstein modes, modeling of Vlasov equation, nonlinear wave-particle interaction, Bernstein–Landau paradox.

A.A. Ivanov

Radiation from an end face of a planar dielectric waveguide

In this paper, the problem of radiation from an abruptly ended waveguide is considered. The problem is solved in strict electrodynamic statement. The radiation patterns, the energy of the field radiated from an abruptly ended waveguide and loss for a reflected directed wave are calculated in several approximations. A comparison of two modes of the solution to this problem is made.

Keywords: dielectric waveguide, radiation from an abruptly ended waveguide, strict statement of a problem, radiation patterns.

S.M. Vladimirov

New time decreasing method for modeling of iterative decoding

The goal is to decrease time of modeling an iterative decoding process for binary low density parity check codes. We propose a new method based on partial byte-code generation using the code check matrix data. Oracle Java Virtual Machine is used as execution environment, the Javassist library is used for byte-code generation.

Keywords: modeling, time optimization, java, byte-code, byte-code generation, binary LDPC-codes.

O.G. Golichenko, A.A. Malkova

Analysis of human resources in research and development in Russia and worldwide

This research is directed to the analysis of models of human resources engaged in research and development. We specifically consider the human resources employed in the research and development (R&D) of institutional sectors, and also the level of financing of the personnel and its structure in Russia and worldwide. Interaction comparisons of institutional sectors in Russia and worldwide allow revealing the strengths and weaknesses of the Russian system of new knowledge production.

Keywords: human resources in research and development (R&D), personnel structure in R&D, financial support of the personnel in R&D, work security of researcher in R&D by other personnel, international comparisons of systems of new knowledge production.

A.A. Domunian

Cortical Scanner

The paper discusses a hardware-based cortical scanner used for feature extraction on image preprocessing stages of pattern recognition. This device attempts to model boundary extraction processes that take place in the primary visual area of cerebral cortex. The flexible programmable gate array (FPGA)-based scanner is coupled to a video camera.

Keywords: machine neural cortex, cortex scanner, image recognition, machine intelligence.

F.A. Druzhinin, V.V. Tokarev

Financial performance of innovation projects in a game situation

The problem of the common solution of innovation engineering design is considered. The game model of innovation project participants coordination is developed. Its features due to the availability of management restrictions which unite the participants are analysed.

Keywords: investor, creditor, downstream, net effective discount income, index profitability, Nech balance, cooperative solution.

V.E. Zyamalov, S.S. Studnikov

Investment portfolio allocation allowing for investor's psychologic peculiarities

The expected utility hypothesis is a tool widely used to describe the behavior of economic agents in case of uncertainty. But there are evidences that this theory barely depicts the behavior of real investors. In this article, the model describing the investment portfolio allocation allowing for this inconsistency is constructed.

Keywords: investments, uncertainty, irrationality, expected utility hypothesis, regret theory.

O.S. Pigareva

Basis for management of higher education institute interaction with business structure: concept, index, rating

In the present situation, institutes of higher education in Russia face with numerous and diverse problems. The authors offer a new approach to the estimation and management interaction of innovation institutes of higher education with affiliated business structure. The described instruments include Coefficient of Stakeholders Involvement in IHE Development Extent and Rating of Business Oriented Innovation Kernel of IHE Participants. The latter consists of the sub- Rating of Education Activity, Scientific and Innovation Activity and Financial Stability. All groundworks as a whole correspond to the decision-making system for IHE management. The approach is put through tests at MIPT.

Keywords: stakeholder, rating, management, IHE, business structure, interaction, interests.

D.I. Ponomarev, B.G. Kukharenko

Expectation-maximization algorithm in the continuous profile model for control signals synchronization of a hand-held computer manipulator

The problem of the control signals synchronization of a hand-held computer manipulator is studied. The manipulator has two independent MEMS-accelerometers. Because of the inaccurate calibration of sensors, electrical noise and the mistiming of clock signals, the data of the sensors recording is different. The continuous profile model is used for the signal alignment. The model parameters are estimated by the expectation-maximization algorithm. The results of the synchronization of two control signals of the manipulator are presented.

Keywords: hand-held computer manipulator, accelerometer, control signal, continuous profile model, expectation-maximization algorithm.

K.E. Smirnov, V.G. Napreenko

Development and usability research of network software tools based on subdefinite computations for economic processes modeling with insurance activities case study

The results of the development of multiuser software that extends economic and mathematical modeling possibilities are given. The multiuser modeling mode with the use of subdefinite computations is a specific feature of the system. The research is performed by way of insurance activities example.

Keywords: subdefinite computations, web technologies, economic and mathematical modeling, insurance activities.

I.E. Smirnov

Interactive cartographical modeling with the use of interval data based on constraint programming

The application of the subdefinite models method in GIS is studied. Its use makes it possible to display an extended class of data on a map and use this data in calculations with interactive display of results.

Keywords: GIS, subdefinite models method, visualization.

I.G. Ushanov

Strategic management accounting customer profitability based on CAP-analysis

We consider the possibility of applying the elements of CAP-analysis to strategic management accounting profitability of customers, in particular, the problems of cost allocation to customers depending on their level of grouping, the sequence of CAP-analysis in strategic management accounting, the major strategic initiatives of the organization on key customer groups and indicators such as customer value (LTV) and customer profitability (LTP).

Keywords: strategic management accounting, CAP-analysis, customer, relevant costs, customer value, customer profitability.

V.S. Filimonov, O.I. Dranko

Reseach of the business cost model: a measure of approaching perfect competition

The aim of the paper is a quantitative approach development of assessing the degree of competition in the market and the level of its proximity to perfect competition. The method is based on a discounted cash flow model and suggests the use of such measurable indicators as enterprise value, the weighted average cost of capital and return on invested capital. Based on obtained results, it is possible to assume that the real situation on the world market is far from perfect competition.

Keywords: discounted cash flow, perfect competition, continuing value, risk rate, credit rating.

V.I. Golubev, D.N. Mikhailov

Simulation of the dynamics of bimodal suspension filtration through porous media

The filtration of bimodal suspension through porous media is considered. Particles in suspension are different in size or other physical properties. A model based on fluid and particles mass conservation laws and local equations of trapping is proposed. Unlike the conventional unimodal model, the new bimodal model takes into account differences in the physical properties of particles. The numerical simulations show that the suggested model is able to qualitatively reproduce the experimental data which can hardly be reproduced by the conventional model.

Keywords: mathematical modeling, filtration, suspension, porous media, particles retention, permeability damage.

S.A. Mirer, I.V. Prilepskiy

Optimal parameters of a satellite with model damping

The optimal damping problem of the angular velocity of a rigid body is considered. Model damping implies that three damping devices installed along three axes («damping axes» fixed in a body) are producing control torques proportional to angular velocity projections on corresponding axes. This paper aims to determine the system parameters resulting in the maximum damping rate. Optimization is performed with respect to the damping coefficients and the attitude of damping axes. It is demonstrated that optimum is achieved when the damping axes are parallel to the principal inertia axes of a body. In addition, several extremal properties of the inertia tensor of a rigid body are obtained.

Keywords: model damping, degree of stability, inertia tensor.