Summaries of all articles

E.M. Gabidulin, N.I. Pilipchuk, A.I. Kolybel'nikov, A.V. Urivskiy, S.M. Vladimirov, A.A. Grigoriev

Network coding

An analytic review of fundamental works on network coding is presented. Network coding foundations are given, as well as the known methods for presenting and transmitting information in networks. Particular attention is given to a new approach, the so called coding by subspaces. This method is proposed by Koetter, Kschischang, and Silva. They essentially exploit Gabidulin's theory of rank codes. Network information security is also discussed. Models of distorting and breaking the information security service are described. It is shown that low density parity check codes allow one to solve important problems arising from the implementation of the network coding. The role of space-time coding in wireless relay networks with user cooperation diversity is shown.

Keywords: communication network, coding, decoding, information transmission, information security, cryptanalyst, finite field, space, subspace.

V.G. Dmitriev, Y.V. Poprigushin

The combined non-critical interactions and phase-matchings for optical harmonic generation in rhombic system nonlinear crystals by the example of a lithium triborate crystal

The combined noncritical interactions and phase matchings for SHG in nonlinear two-axis crystals by the example of an LBO-crystal are discussed. The possibilities of practical applications of such angle crystal orientations, for which the combined noncritical interactions and phase matchings occur, are considered (e.g., simultaneously for angles and temperature, simultaneously for angles and wavelength and so on). Some calculation results are given.

Keywords: harmonic generation, non-critical interactions, phase-matching, lithium triborate.

M.A. Dunaeva

Sensing Chain Parameters Mismatch Compensation Methods in Static Random Access Memory

Four types of SRAM sense amplifiers are presented. The impact of transistors channel lengths mismatch, threshold voltages mismatch and the variation of the RC bit lines parameter on the work of various sense amplifiers is compared. The voltage sense amplifier [1], the charge transfer sense amplifier [2], the new hybrid sense amplifier and the threshold voltage mismatch compensated sense amplifier [3] are theoretically and experimentally studied.

Keywords: sense amplifier, charge transfer sense amplifier, threshold voltage mismatch compensation, SRAM, memory.

B.V. Egorov, Y.E. Markachev

Transport dissipative coefficients of a clusterizing gas

The effect of the simplest clusters (water dimers) on the viscosity and heat conductivity of water vapor at modest pressures (1–25 bar) and temperatures (400–1100 K) is investigated by the quasichemical cluster gas model (QCCM).

Keywords: molecular clusters, dissipative transport coefficients, gas heat capacity.

A.A. Zaitsev

The compound nonlinear mode of operation of the pulse phase-locked-loop frequency control system

The structure chart of the pulse phase-locked-loop frequency control optimized-speed system is considered. There is a nonlinear correction unit in feedback and separate control at large and small mismatches. The parameters of the device intended for the synthesis of a signal at frequency 480MHz with values of reference frequency 12MHz are given. There are diagrams of modeling the behavior of the system during the power-up transient. To estimate the accuracy of the regulation regime the bar chart of the distribution of values of the instant periods of the target signal frequency in the steady state is shown. The obtained results con? rm the possibility to attain high speed in the structure system studied, with the acceptable accuracy preserved in most applications.

Keywords: pulse phase locked loop frequency generator, optimum nonlinear correction, variable structure, parabolic control.

A.S. Kryukovsky, D.S. Lukin, E.A. Palkin, D.V. Rastyagaev

The catastrophe theory and its application to focusing, diffraction and wave propagation

The basic principles of the wave theory of catastrophes are considered, viz. their classification, methods of the construction of uniform asymptotics used for the description of the structure of wave fields in these areas, analysis of the field structure. The general description of classes of special functions used for construction constructing the uniform asymptotic decomposition of wave fields, the properties of these functions and account methods is given. Examples of applied tasks are given, in which the application of wave catastrophes appears productive. The mathematical tools for solving the differential equations by the theory of the main, edge and corner catastrophes are described. The theory of the solution of the differential equations is constructed by the theory of the main, edge and corner uniform catastrophes.

Keywords: the main, edge, corner catastrophes, caustics, universal deformations, diffraction, focusing, propagation, wave fields, uniform asymptotics special functions.

V.M. Kuznetsov, V.I. Khromov

Fractal Phase Transition Description for Condensed Substances

The quantum continual model of fractal representation for macro- and nanostructures is developed. It may be used for studying heat and dynamic properties and also for phase transitions investigations

Keywords: quantum continual model, nanostructures, heat and dynamic properties, phase transitions investigations.

A.A. Neznanov, V.A. Kokhov

On the structure of stability subgroups of the automorphism group of graphs and the symmetry account in the solution of intractable structural analysis problems

The symmetry account as a universal method of increasing the effectiveness of hard structural analysis problems is discussed. We analyze a relationship between the structure of stability subgroups in the automorphism group of graphs and the exact symmetry account in algorithms for solving structural analysis problems. As an example, we consider the maximal general subgraph isomorphism algorithm and the interesting families of symmetric graphs.

Keywords: graph theory, group theory, efficient algorithms, symmetry, complexity.

N.N. Olyunin

Facet model in problems of electromagnetic scattering by impedance bodies

The method of the computation of a scattered field based on the physical optics method and the edge wave method is described. The facet representation of the body surface is used. The given method may be applied to large bodies on a wavelength scale which surface is perfectly or nonperfectly conducting or coated. A generalization of method of the edge waves to impedance bodies is described. The computational results are compared with the benchmark data for a sphere and a cylinder.

Keywords: scattering, facet model, impedance surface.

A.A. Ostroumov, S.A. Palatnaya

Monitoring the effect of ultrawide band electromagnetic emissions on the biosphere with spring crop seeds

Untrawide band electrmagnetic emissions will soon be used in wireless communications, radiolocation and global positioning systems. But a few papers found by the authors allow us to suppose that the effect of the ultrawide band pulse emissions on the biosphere is dramatic. In this study, the ultrawide band electromagnetic pulses with electric field peak intensity 115 kV/m, repetition frequency 100 Hz and longitude less than 1 ns were applied to spring crop seeds Triticum aestirum, grade Engelen, 2005-year harvest. Dry seeds were exposed for 30 and 45 minutes as indicator parameters of the plant condition. The main root growth was reduced to ($P < 0.05$) as compared to that of the unexposed seeds in both exposition times. The stalk growth was simulated by 30-minute exposition and reduced ($P < 0.01$) to 45-minute exposition. The conclusions of the crop seeds high sensitivity to ultrawide band emissions and the possibility to use the crop for monitoring the effects of ultrawide band emissions on the biosphere are made.

Keywords: ultra wide band emission of electromagnetic field, ecological monitoring, crop, seeds, bioassay methodology.

I.Y. Polishchuk, M.I. Gozman, T.A. Lomonosova

Optical modes in linear arrays of dielectric spherical particles. Numerical investigation

Low frequency guiding (bound) polariton modes in finite linear chains of spherical dielectric particles are investigated. The frequencies of these modes belong to the pass band, where free photon emission by the in? nite chain is impossible, and, therefore, the radiative loss is minimized. Using the multisphere Mie scattering formalism, the dependence of the quality factors of most bound modes on the number of particles and the refraction index n_r is found. It is shown that guiding modes exist for $n_r > 2$, and, as the number N of particles in the chain increases, the quality factor of these modes increases as $Q \sim N^3$ and their group velocity vanishes. It is also discovered that longitudinal guiding modes in particle chains possess a higher quality factor than the transverse ones.

Keywords: optical properties of arrays of nanoparticles, low-dimensional nanostructures, photonic crystals.

A.E. Polyakov, L.V. Strygin, P.I. Bobkovich

On the Effect of Additive to Phase Noise Conversion in the PLL Synthesizer

This paper covers methods and equations for phase noise spectral density at the output of the frequency divider, as a part of the RF-synthesizer, under an additive noise impact on the input periodical signal. Analysis of the additive to phase noise conversion at the output of the divider, as well as its spectral components at frequencies much greater than the detector reference frequency, is made. As a result of the analysis, the method of the spectral characteristics estimation of the phase noise at the divider's output and RF-synthesizer's output is developed. Some recommendations for synthesizer's design and debugging are given. It is supposed to be of some interest to designers dealing with high-frequency analog electronics, satellite communications systems, and test and measurement equipment.

Keywords: frequency synthesizer, RF-synthesizer, phase noise, additive noise conversion, frequency divider.

M.A. Samokhina

Modifications of Niederreiter cryptosystems, its cryptographically strong and practical applications

In this paper, various approaches to modifying the classical Niederreiter cryptosystem are considered. The most successful versions of attack on this kind of systems are analyzed. The results of the practical use of the modi? cations of Niederreiter cryptosystems based on the Frobeniusovsky type matrix are presented.

Keywords: cryptography, cryptology, cryptanalysis, public-key cryptosystems, Niederreiter cryptosystem, linear codes based cryptosystems, antinoise coding, error-correcting system, modeling.

M.A. Anisimov, A.A. Kolesnikov, V.I. Man'ko

Bell inequality in $m = 2, 3, 4$ — particle systems

In this paper, the possible violation of the Bell inequality dependent on the number of particles in the quantum oscillations superposition (inform $|\psi\rangle = 1/\sqrt{2}\,(|0\rangle_1 |0\rangle_2 + |n\rangle_1 |n\rangle_2)$) is investigated by a quantum tomographic approach.

Keywords: Bell inequality, quantum tomography, entanglement.

P.Y. Dobrachev

The Dynamics subsystem for the storage and statistical analysis of consumption of computational resources of University Cluster software

The Dynamics subsystem is intended for the structuring, storage and statistical analysis of consumption of computational resources by users. This subsystem is written on Python and PL/pgSQL and uses PostgreSQL as data storage. The software analyzes the log of qserver query server and stores the collected and structured data in database. The subsystem contains various applications to analyze task exit code statistics, average latency time depending on the number of requested processing units, average latency time on different task types, processing units' utilization statistics.

Keywords: dynamics subsystem, statistical analysis, computational resources, log, query server, database.

O.V. Zamanova, R.S. Terlekchi

One of the methods of the study of water relations

There is the problem of water deficit Worldwide. A great number of natural recourses are involved in the industry cycle. Water is used for energy production, building, agriculture industry, and for other demands. In the past 70 years during which the consumptive use was intensive nationwide, the large storage of fresh water has been decreasing. Water becomes dangerous for lives not only as a storm. All of these examples are a demonstration of problems in the management system. There are some ideas of the adequate management of water relations in this article.

Keywords: management of the water relations, types of water, the dynamics of water states, subject, subject-subjective relations, systems theory.

S.I. Zingirevich, V.E. Krivtsov

On the construction of the computer system of support of the educational process at the institute of higher education based on principles of open architecture with the use of middleware technology

We discuss the requirements which the modern competitive computer system of support of the educational process at the institute of higher education must meet. The method for constructing the computer system of support of the educational process at the institute of higher education, which is based on principles of open architecture with the use of middleware technology, is discussed. The structure of this system is also discussed; all the main parts are described. The evidence that the system meets the necessary requirements is given.

Keywords: the computer system, open architecture, middleware technology, support of the educational process.

A.A. Kalenkova

Workflow performance optimization based on redundant control flow elimination

A novel formal workflow language is presented. It incorporates complete workflow language basic constructs to translate programs of well-known workflow languages into programs written in the proposed language and vice versa. A new technique for the performance optimization of workflows, which is written in the formal workflow language, is presented. During the optimization process the initial workflow is transformed so that sequential activities, which are not data dependent, are executed in parallel.

Keywords: workflow, workflow languages, data flow analysis, program parallelization, workflow optimization, distributed image processing, equivalent transformations of programs.

B.G. Kukharenko

The Prony method study of system dynamics based on time-series

The local-transient time series of dynamic system variables is studied. A method for determining the spectral characteristics of local-transient time series is described to provide similarity search of the time-series segments. As shown, the nonlinear time series describes the chaotic dynamics of the stochastic resonance, Rossler, and Lorenz are local-transient time series. Similarity search of nonlinear time-series segments gives an opportunity to study the local-time dynamics of chaotic systems.

Keywords: system dynamics, time-series, spectral analysis, singular values decomposition, similarity search in time-series, stochastic resonance, Rossler model, Lorenz model.

V.G. Napreenko, E.P. Smirnov

Development of Tools for Planning and Managing Sophisticated Pioneer Research Design and Experimental Works

The study is aimed at creating practical tools for optimal planning and managing sophisticated pioneer research works and R&D. These tools that have no analogues in the national or international science are based on the joint use of advanced information technologies, mathematical modeling and expert appraisal.

Keywords: optimal planning and management, mathematical modeling of economy, underdetermined calculations, expert appraisal.

S.A. Smirnov

Development of a Grid-service based on the Ice middleware for a computer algebra system Maxima.

The paper concerns the problem of the transformation of the computer algebra system Maxima (open source) into a Grid-service by Ice (Internet Communications Engine) middleware. The service provides: the remote execution of Maxima commands and the remote management of Maxima's processes instances (creation/destruction). The article contains an overview of possible approaches to programmatic interactions with the Maxima process. The article also covers some details of the service implementation.

Keywords: Maxima, grid-service, symbolic computation, computer algebra system, CAS, ZeroC Ice.

E.A. Tsvetkov, V.V. Shahovsky

The substantiation of DXTAN-modification of Monte Carlo method on basis of a reciprocity relation for discriminating systems

In this paper, the DXTRAN-modification of the Monte Carlo method used in MCNP program is described. It is applied to the calculation of the distribution of ionizing radiation fluxes integral quantities in localized regions. The intuitive proof via the particles weights balance adduced in the manual of this program is given for understanding the method. The substantiation by a reciprocity relation for discriminating systems is suggested.

Keywords: radiation transport simulation, Monte Carlo, variance reduction techniques, reciprocity relation, DXTRAN, MCNP.