Summaries of all Articles

N. D. Ageev

Numerical study of the airfoil nose radius and leading edge sweep combined effect on the wing aerodynamics at supersonic speeds

The airfoil nose radius and leading edge sweep combined effect on the wing performance at supersonic speeds is studied by RANS-based ANSYS CFX (customer number 607044, MIPT) product. An airfoil set with equal relative thickness and different nose radius is described. Calculation technique for the viscous turbulent flow model is presented. Analysis of the 2D and 3D results is carried out. Accuracy estimation is extracted.

Key words: CFD, airfoil nose radius, leading edge sweep, supersonic speed.

N. I. Amelkin, A. V. Sumarokov

On resonance rotations of a satellite with a two-degree-of-freedom powered gyroscope in a circular orbit

In this paper, the evolution of a satellite carrying a two-degree-of-freedom powered gyroscope with dissipation in axis framework in conditions of quite a central gravitational field is investigated. It is found that for a satellite initially remote from its relative equilibrium, the transitional process contains resonance rotations 2:1.

Key words: satellite, powered gyroscope, stability, asymptotic stability, resonance.

N. E. Zubov, E. A. Mikrin, S. S. Negodyayev, V. N. Ryabchenko, A. V. Bogachev, E. A. Vorobeva

Synthesis of the three-channel system unloading kinetic momentum of inertia actuators in a spacecraft in a circular orbit

The problem under study is the gravitational desaturation of the kinetic momentum of inertia actuators in a spacecraft in all three control channels for circular orbits using the method of precise location of the poles. The control laws for gravitational desaturation are synthesed in analytical form and uniquely defined by the object parameters and given roots of the characteristic equation.

Key words: inertial actuators, kinetic momentum unloading, state feedback, closed system, method of precise location of the poles, orthogonal divisor of zero.

G.V. Kalachev, A.B. Nuralieva, A.V. Chernov

Small oscillations of the space elevators tether

Small oscillations about a stable vertical equilibrium position of the space elevators tether are considered. The tether is flexible, superlong, inextensible, its linear density varies along the tether. Its lower end is fixed on the Earth in the vicinity of the equator and the upper end stretches beyond the geostationary orbit. Gravitational and centrifugal forces keep the system in equilibrium. The Sturm Liouville problem is solved for the linearized system with respect to transverse oscillation and eigenfrequencies and eigenforms of the linear oscillations are found. Asymptotic formulae are developed for high modes and an algorithm for finding them is described. Obtained forms are used for calculations of the movements in a numerical model.

Key words: tether systems, space elevator, small oscillations, Sturm Liouville problem.

A.A. Fomichev, P.V. Larionov, E.A. Polukeev, T.N. Vakhitov, A.B. Kolchev,
K.Yu. Schastlivets, V.B. Uspensky

Laser integrated inertial-satellite navigating system with the enhanced availability of satellite data

The results of the integrated inertial-satellite navigating system with the enhanced availability of satellite measuring design are presented. The system characteristics, description of the informational modes, software architecture are obtained. Filtering and correction problems of the nonuniform receipt of various configurations data are considered, structurally algorithmic solutions of these problems are offered. The results of mobile trials, software flight approbation and the results of seminatural flight trials are described.

Key words: laser gyro, integrated inertial-satellite navigating system, availability of satellite information, subintegrated mode.

A. D. Agaltsov

Characterisation and inversion theorems for the generalized Radon transform

In this paper, the generalized Radon transform over level hypersurfaces of CES-functions of measures supported in positive orthant $\mathbb{R}^n_+$ is studied. A characterisation of the generalized Radon transform of nonnegative measures is found. The explicit inversion formula for the generalized Radon transform of absolutely continuous measures is derived.

Key words: generalized Radon transform, theorem of characterisation, inversion formula, effect of substitution of production factors at the microlevel

M. Yu. Andreyev, N. P. Pilnik, I. N. Kalinin, I. G. Pospelov

Intertemporal equilibrium economy model of the Republic of Kazakhstan

In this paper, the general economic equilibrium model of the Republic of Kazakhstan is described. The model includes 8 macroagents. Optimization problems are formulated for 4 agents (household, producer, bank, owner). The behavior of other agents is determined by a scenario. The model is calibrated by quarter data from 2005 to 2010 and simulates trajectories of variables which characterize the situation in real and financial sectors of the economy.

Key words: general economic equilibrium, mathematical simulation, rational expectations, bank system, economic crisis.

M.A. Burnusuzyan

Analysis of the impact of the main macroeconomic indicators on exchange rate in the Republic of Armenia

The purpose of this paper is to examine the influence of the main macroeconomic indicators on the exchange rate of the Republic of Armenia (RA). The theoretical and methodological basis of the study includes the working papers of Armenian, Russian and foreign economists related to macroeconomics, statistics and econometric instruments. In this work, we quantitively estimate the impact of the main factors on the exchange rate of RA. It is shown that transfers are of great significance for the process of exchange rate determination.

Key words: exchange rate, national currency, transfers, gross domestic product (GDP), import, export, foreign direct investments, money supply, foreign exchange market intervention, inflation.

E. G. Molchanov

Rhomboidal tiling's modifications in the recourse distribution problem

We study the combinatorial properties of plane cuts associated with the moment's problem arising in the evaluation of substitutability of domestic and foreign factors on the microlevel.

Key words: rhombical tilings, flips, generalized Hauthakker-Johansen model.

A. V. Vasiliev

Java enterprise design pattern for adaptive object models that provides scalability of such type systems

In some areas such as telecommunication, medicine, education, there are a lot of changes in the data structure and system requirements. Therefore, companies try to implement adaptive data structures for costs reduction to build such systems. Initial spending for development is high, but all other changes are very cheap. In practice, instead, a code that works with adaptive models is not automatically testable, the system is not scalable because it works with relational databases directly. The paper suggests an approach to the design of such type systems, which allows us to make the tests easier and change data the access level without any difficulties when the data volume is grown.

Key words: Java, adaptive object model, scalable systems, automatic testing, enterprise design patters.

K. K. Gluharev, A. M. Valuev, I. N. Kalinin, N. M. Ulyukov

On modeling of traffic flows on the major city transport network

The comprehensive model development problem for traffic flow on a city network is studied. The discrete traffic safety distance flow model is created and its properties are studied, viz. queue dynamics and stable modes. Flow properties in closed loops are considered. Road intersections are decomposed into primitive elements (uniform lane segments and join nodes) and the discrete flow model is applied, with the initial and boundary conditions constructed and model parameters determined. The major city transport network notion is introduced. Topological types of this network are studied as well as routing for certain topological types. The computational model for traffic simulation network is presented as well as some simulation results and qualitative conclusions.

Key words: traffic flows, microscopic traffic model, queue dynamics, arterial network, network topology, traffic network routing, traffic simulation, computational model.

K. O. Zheleznov, M. V. Khlebnikov

Applying invariant ellipsoids' technique to a linear tracking problem

This paper is devoted to a linear tracking problem and its solution based on an invariant ellipsoid technique. It is required to track the input signal (discussed below) and system control to make the system output as close to the input signal as possible. The method efficiency is demonstrated on an example of a two-mass system.

Key words: linear control systems, tracking problem, linear matrix inequality, invariant ellipsoid, bounding ellipsoid.

E. V. Burnaev, P. V. Prikhodko

Methodology of building surrogate models for inhomogenous functions

We propose a general methodology for building surrogate models. The application of proposed methodology is given on an example of building surrogate models for constraints in the problem of optimizing the aircraft fuselage skin weight. Results obtained show the effectiveness of the proposed methodology.

Key words: surrogate modeling, regression, approximation, optimization, mixture of experts.

J. I. Skalko, M. A. Mendel

Application of generalized functions tools for construction of an approximate solution of the radiation transfer equation

The application of generalized function tools to constructing an approximate solution of the radiation transfer equation is considered. A number of approaches using an approximate solution of the Cauchy problem or boundary problem for mathematics physics equations, which use the generalized solution concept, are known. In the approach presented below we replace the original problem by the equivalent generalized function problem. Then we find an approximate solution to piecewise polynomial generalized functions.

Key words: approximate solution of radiation transfer equation, generalized functions.

I. A. Garagash, A. V. Dubovskaya

Application of a geomechanical model of the Caspian Region crust estimating oil and gas content

Numerical simulation based on a three-dimensional model of the Caspian Region crust including the main geomechanical parameters is carried out. The main factors which have an effect on the stress-stain state of earth crust such as the unbalanced weight of rock mass, horizontal and vertical tectonic movement, density variation and variable heating are also taken into account. As a result, new information on stress and strain invariants and temperature distributions is obtained. It is established that parameters including the temperature gradient, bulk strain and energy saturation in the earth crust correlate with known hydrocarbon clusters in the area studied.

Key words: geomechanical model, stress-strain state, decompression zones, energy saturation, numerical simulation.

N. A. Markitantova, A. P. Chernyaev

Filtration with a power law in the case of asymmetrical wellsite

The model of stationary incompressible fluid filtration under the power law for the horizontal nonsymmetrical well is considered. The map onto a hodograph plane is used. Expressions for a stream function are obtained.

Key words: stationary filtration, nonlinear filtration, power law, incompressible liquid, nonsymmetrical well.

N. I. Ryzhikov, D. N. Mikhailov, V. V. Shako

Method for calculation of the porosity and volume fraction in porous media using X-ray computed microtomography

We propose a new method for porosity and material concentration profiling in porous media, based on analysis of the image histogram single section of 3-D image of X-ray micro Computed Tomography. In contrast to commonly-used thresholding segmentation, now the number of different materials inside the sample is calculated without any additional a priori data for segmentation (e.g. porosity data, etc.). The results of porosity and volume fraction profiling for different artificial porous samples are presented. The obtained data is in agreement with the macroscopic parameters of samples studied and the calculation made by commercial software CTAn. The given samples after the injection of low concentrated clay solution show that this method is applicable to working with material in low concentration.

Key words: X-ray computed tomography, thresholding, colmatation of rock sample, image histogram.

M. R. Arifullin, V. L. Berdinsky

Spin state entanglement in the four fermion system

Multispin density matrices of an indistinguishable fermion system described by the antisymmetric wave function $\Psi(r_i, s_i)$ are constructed. On reducing spatial variables, multispin density matrices are independent of spatial single-particle wave functions and are "universal" in this sense. For any even number of fermions in the ground state, the density matrix can be uniquely presented as a sum of nonorthogonal projection operators. The four fermion system is investigated in detail and is shown to be entangled, contains the entangled three spin subsystem, but the two spin subsystems are not entangled. The entanglement of fermion spin subsystems is the consequence of the indistinguishability principle and Pauli's principle.

Key words: quantum entanglement, density matrix, Pauli's principle, quantum correlations.

B. I. Vasil'ev, D. P. Korenev, V. M. Kunin, V. V. Ouskov

Laser spectroscope in 9–11 um region based on CO_2 laser and its lasing spectrum

The simple laser spectroscope in the 9-11 um region, based on CW laser LG-23 is described. The semitransparent mirror is replaced by a diffraction grate. PC control helps us increase the resolution. Using the metal diffraction grate leads to abnormal trough of the lasing spectrum in the area of 10P branch (Wood anomaly).

Key words: CO_2 laser, frequency tuning, rotating-vibrating transition, diffracting grate, selective resonator, Wood anomaly.

V. V. Gorin

Solution of the equations of nonlocal kinetics in the diffuse scattering of ionizing electrons

We obtain general formulae for the solution of the kinetic equation for ionizing electrons in a glow discharge of arbitrary configuration in the approach of ergodicity of an electron motion along the constant energy hypersurface. In this approach an ionization source appears to be a function of one scalar variable - an electric potential. The electron distribution function also appears to be a function of one scalar variable - the total mechanical energy of an electron.

Key words: electron distribution function, ergodicity, glow discharge, hollow cathode, nonlocal ionization, nonlocal kinetics.