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Interaction of an ultrashort pulse of Gaussian form with the Morse oscillator

The article is devoted to the numerical analysis of excitation features of the classical Morse oscillator under the action of electrical pulses of Gaussian form. The spectral and time dependences of the absorbed energy by the Morse oscillator are investigated. Comparison is made with a harmonic oscillator case.

Key words: ultrashort pulse, Gaussian pulse, harmonic oscillator, Morse oscillator.

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Nonlinear excitation of Fano quantum resonance

The nonlinear formation of the asymmetric Fano profile in a resonant two-level system interacting with the levelband system is investigated. The dynamic description of resonance is presented and the population of the levelband system is calculated as a time function. The possibility to control the shape of the population quasicontinuum by changing the external field intensity is discussed.

Key words: Fano quantum resonance, two-level system, quasicontinuum, levelband system.

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Dust acoustic solitons on the surface of the Moon

The dusty plasma system at the near-surface layer of the illuminated part of the Moon is described. The dusty plasma system includes photoelectrons, electrons and the solar wind ions, as well as charged dust particles. Dust acoustic solitons are considered in the near-surface lunar plasma. It is shown that when describing the solitons, one should take into account the effect of electron trapping by potential wells which are due to the positive electrostatic soliton potential. The regions of possible Mach numbers and soliton amplitudes are determined. Soliton solutions are found for different altitudes over the lunar surface. It is shown that the solitons on the surface of the Moon can have rather large amplitudes, which enable us to observe them within the frames of the future lunar missions of «Luna-25» and «Luna-27».

Key words: dusty plasma, dust acoustic waves, trapped electrons, solitons, the Moon.

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High selective mass spectrometry analysis of nitro compounds by laser ionization under environmental conditions

A method for mass spectrometric detection of nitrocompounds vapor with pulsed-periodic laser ionization with pulses of nanosecond duration under atmospheric pressure is proposed. A pulsed-periodic laser with pulses of nanosecond duration and a corona discharge combined ion source is constructed. In the corona discharge ionization mode with a sufficiently high discharge current, the subsequent fragmentation is shown to be similar to ionization by classical electron impact in the medium vacuum conditions. Ionization with a diode-pumped laser (300 Hz) produces more ions with a less variety in the negative mode as compared to a lamp-pumped laser (10 Hz). TNT detection threshold does not exceed 10^{-13} g/cm^3. Thus, the method developed can be used to create a fast portable device for detection of explosives trace amounts in the atmospheric air with high sensitivity and reliability. The use of a laser with shoter pulses and higher friquncy pulses is demonstrated to increase the ionization efficiency, sensitivity and detection limit for nitrocompounds.

Key words: mass-spectrometry; ambient ionization; atmospheric pressure chemical ionization; laser ionization; nitrocompounds detection.

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Thermionic and field emission properties of nanostructured cathodes based on intercalated pyrolytic graphite

This work describes a technology for manufacturing a composite cathode containing an intercalated chemical compound of graphite and emission-active material. The research of such cathodes is presented, with temperature range 0-800 ℃and anode voltages between 1 and 10 kV. The paper gives the optimal pressing pressures, research results for thermionic and field emission cathode modes. High current densities are reported to be achieved.

Key words: vacuum electronics, nanostructured graphite materials, field emission, thermionic emission, composite cathode.

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A coordinate detector based on a matrix of silicon photomultipliers and scintillation LYSO crystals for charged particles registration

We propose to use a matrix detector based on silicon photomultipliers and LYSO scintillation crystals to register energy and determine the multiplicity of charged particles for study of quasibound nn-, pp- and np-states of the dinucleon system (E^s_{nn}, E^s_{pp}, E^s_{np}). Results of measuring the prototype parameters of the detector consisting of 4 detecting sections (with a full set of 16) are demonstrated in the article. A standard set of parameters is defined, viz. resolution (time, amplitude), relative efficiencies, intrinsic radiation spectrum, gain factors, etc. and their dependence on voltage and temperature. The results of the application of some variants for optical contact between crystals and a Si-photomultiplier are described. The use of such detectors in experiments for studying of the light nuclei interaction is discussed.

Key words: nuclear reaction, scintillation crystal, amplitude resolution, time resolution, own background, optical contact, dinucleon states.

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Comparison of turbulent closures in a one-dimensional lake model

The turbulence closures mostly used in one-dimensional lake models are $k-\varepsilon$ closure and Henderson–Sellers diffusivity. As these closures are very different in underlying physics and mathematical properties, they lead to contrasting numerical stability and computational efficiency of a lake model as a whole.This study presents the performance of the one-dimensional model LAKE using the abovementioned turbulence parameterizations in idealized vertical mixing scenarios and concrete lake simulations. Our results demonstrate that $k-\varepsilon$ closure allows for a smooth solution at timesteps $\Delta t < 450$ s, while the convergence of numerical scheme is attained at $\Delta t < 100$ s. In contrast, convergence of the lake model scheme using Henderson–Sellers diffusivity is achieved if $\Delta t < 3600$ s, resulting in drastic reduction of the lake model runtime as compared to using $k-\varepsilon$ parameterization. At the same time, the correctness of simulation results obtained by both schemes is very similar.

Key words: one-dimensional lake model, turbulent closure, numerical experiments.

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Estimation of the heights of tidal waves during gliding a large satellite along the surface of spherical heavy liquid layer with a solid core

The motion of a large satellite around a model planet is considered. The planet is the thick spherical layer of a heavy ideal fluid with a relatively small solid inner core. The tidal perturbation caused by the satellite is propagated by long gravity waves. When the satellite glides along the surface of the layer, its energy and period of revolution decrease, while the height of the tide and the period of free gravity waves supporting the development of the tide increase. To maintain the tide the period of revolution of the satellite must not be less than the period of free long gravity waves. In this paper, the value of the static tide is estimated when the satellite revolution period and period of free gravity waves propagating over the surface of the spherical liquid layer coinside. When this condition is satisfied, the gliding of the satellite becomes impossible and the satellite rapidly penetrates the spherical layer.

Key words: asteroid, satellite, spherical layer, ideal fluid, gliding, long gravity waves, mantle of the Earth, tide, asteroid belt, biota.

Обсуждается движение спутника радиусом около 930 км вокруг некоторой модельной планеты, представляющей собой сферический слой тяжёлой идеальной жидкости внешним

A. S. Kozelkov[1,2], *D. Yu. Strelets*[3], *V. R. Efremov*[4], *Yu. G. Nechepurenko*[4], *V. V. Kurulin*[1], *E. S. Tyatyushkina*[1], *A. V. Kornev*[3]

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Investigation of the properties of discretization schemes for the volume fraction transfer equation in the calculation of multiphase flows by the VOF method

The paper summarizes the results of studying the properties of discretization schemes for the volume fraction transport equation in VOF (Volume of Fluid) multiphase flow simulations on arbitrary unstructured meshes. Surface shape preservation techniques are presented, the properties of the most popular ad hoc discretization schemes for the volume fraction transport equation are analyzed, and the effect of the Courant number on front transport is examined. The obtained results provide the limiting value of the Courant number using different schemes and types of a computational mesh required to preserve the shape of the scalar field after its transport.

Key words: Navier–Stokes equations, numerical vodeling, multiphase flows, free surface, unstructured meshes, front transport, LOGOS.

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Disturbances propagation in the boundary layer on a rotating cone in a supersonic flow

The problem of disturbances propagation in the boundary layer on a rotating cone in a supersonic flow is studied. Boundary layer computation is carried out assuming a nongradient external flow. The velocity direction diagram is obtained.

Key words: boundary layer, disturbances propagation, supersonic flow, weak interaction, cone.

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Resources of inductive drag diminution of the aircraft wing

In this paper, we propose to use for aircraft designing the favorable interference phenomena of its elements. It is A. Ferry who first mentions on it. The formula for calculating the lifting surface inductive drag is obtained. This surface is presented by piecewise constant vortex distribution over its span. The problem of optimal circulation distribution over the wingspan that generates the inductive drag minimum for the given lifting force is solved. There are given some calculation examples. We obtain the estimation of the inductive drag losses that may arise during lifting accommodation and no lifting elements of the combination. The problem of ways of the inductive drag decreasing at tip winglet installation is solved. The analytical dependence of the winglet influence on the wing bending moment is obtained too. The effect of wing flexing on the inductive drag is investigated on an example of Boeng-787 aircraft.

Key words: subsonic flight mode, inductive drag, vortex wing model, circulation, bending moment

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Dynamics of rotational motion of satellite with damper in the central gravitational field

To study the effect of internal dissipative forces on the rotational motion of a satellite in the central gravitational field M.A. Lavrentev's model (the satellite is modeled by solid shell and a spherical damper) is used. The results of numerical analysis of the evolution of rotational motion of a dynamically symmetric and asymmetric satellite moving on the Kepler circular orbit, depending on the values of the coefficient of damping and initial conditions, are presented.

Key words: evolution of rotational motion, satellite with a damper, circular orbit, steady rotation.

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Optimization of the shape of the Pareto set in multicriterial programming problems

A scheme of usage of the smooth penalty method is concidered. This scheme is appied to parametric multicriterial programming problems. A suitable algorithm for solving parametric reference-point problems is suggested. Solutions of the problem describe the optimal shape of the Patero set.

Key words: parametric multiobjective programming problem, Pareto-set, penalty functions method, parametric optomization.

N. I. Zhukova

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Strong transverse equivalence of complete transverselly affine foliations

Complete transverselly affine foliations are studied. The strong transverse equivalence of complete affine foliations is investigated, which is a more refined notion than the transverse equivalence of foliations in Molino sense. A global holonomy group of complete affine foliations is determined and it is proved that this group is the complete invariant of the foliation of relatively strong transverse equivalence. A representative of an arbitrary equivalence class is constructed on its complete invariant. This representative is the two-dimensional complete transverselly affine foliation (M, F), where M is the Elenberg-McLane space of the type $K(\pi, 1)$.

Key words: foliation, Serre fibration, strong transverse equivalence of foliations, transverselly affine foliation, global holonomy group, Ehresmann connection for foliations.

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Shift-invariant measures on sequence spaces

We consider countably-additive measures on the Banach space l_∞ and the linear topological space R^∞ that are shift-invariant to arbitrary vectors from the spaces under study. In this paper we give an example of an analogue of the Lebesgue measure – a nonnegative countably additive measure defined on a certain sigma algebra of subsets of the above infinite-dimensional sequence spaces which contains all stationary infinite-dimensional rectangles (whose length of sides is equal to one from some moment) and is invariant to shifts on an arbitrary vector in these spaces. An essential difference between the measure obtained in this paper and the standard Lebesgue measure on the finite-dimensional space is the absence of sigma-finiteness. It is shown that the measure constructed in the paper satisfies the condition of invariance to permutations of coordinates including infinite ones, and the condition of invariance to reflections replacing the signs of some coordinates by opposite ones.

Key words: sequence spaces, Caratheodory's extension theorem, shift-invariant measures, invariance with respect to permutations, invariance to reflections.

E. A. Umnov, A. E. Umnov

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Mathematical programming problem for a complex of mathematical models

In this paper the feedback functions method is concidered. This method is used for solving the mathematical programming problems. The first-order method is used for solving parametric linkage problem. A numerical example of the procedure is given.

Key words: system of mathematical programming problems, feedback functions, problem of optimal distribution of resources.

I. A. Akolzin

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Equitable colorings of simple hypergraphs

The work deals with a problem of equitable colorings of hypergraphs, which is connected with the Hajnal-Szemeredi theorem. We obtain a new bound for the maximal vertex degree of a simple uniform hypergraph that provides the existence of an equitable coloring with two colors.

Key words: equitable colorings, simple hypergraphs.

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Optimal voting procedures in multiexpert binary systems

Two approaches for constructing an optimal multiexpert binary voting system are considered. In the first case, the solution is obtained with known values of conditional probabilities of decision making by individual experts. In the second case, optimization is performed with unknown values of conditional probabilities in the statistical test mode. Optimization is based on the choice of the optimal number of experts accepting this or that hypothesis. It is shown that the solution of the system in the statistical tests mode asymptotically approaches the exact solution when the values of conditional probabilities of experts are known.

Key words: optimal multiexpert binary voting system, conditional probability, decision making, statistical test mode, program, Delphi.

A. V. Dvorkovich, A. P. Zaretskiy, K. S. Mityagin, D. E. Koposov

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Algorithms of thermal image processing for analysis of hemodynamic parameters of facial arteries

The problem of automating of medical infrared image processing arises in analysis and monitoring of hemodynamic parameters of facial arteries. In this paper, we give a comparison overview of algorithms for segmentation regions of interest (ROI) in face's thermal images. The simulation results allow us to identify a number of key algorithms, whcih implemetation is necessary for the analysis of hemodynamic parameters of facial arteries.

Key words: medical infared imaging, hemodynamic analysis, thermal image processing, segmentation, ROI detection.

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Method for determining cepstral markers of speech signals under psychogenic disorders

At present, various remote experimental and statistical methods are used for detection of psychogenic disorders, the most adaptive of which are methods based on the analysis of speech signals. Low detection accuracy is one of the main problems for practical implementation of remote monitoring systems of psychogenic disorders. The main reason for the low accuracy and large errors is associated with the use of inefficient and nonadaptive methods for processing of nonstationary speech signals. This article proposes an automated method for detection of cepstral markers of speech signals under psychogenic disorders based on the method of improved complete ensemble empirical mode decomposition with adaptive noise (CEEMDAN). The method consists in decomposition of a speech signal with the help of the improved CEEMDAN into frequency components with the subsequent formation of a set of informative components (concentration of information on psychogenic disorders), and the determination of their cepstral markers. A block diagram for the developed method and a detailed mathematical description are presented. The research is conducted using the generated verified signal base of healthy male and female patients, and patients with psychogenic disorders, aged 18 to 60 years. It follows in accordance with the results of the study that the psychogenic disorders affect the vocalized characteristics of the vocal tract and are sufficiently fully displayed in cepstral markers. The proposed automated method can be used in remote monitoring systems of psychogenic disorders, and introduced in clinical practice of a psychiatrist to accelerate the treatment process.

Key words: speech signal, psychogenic disorders, cepstral characteristics, mel-frequency cepstral coefficients (MFCC), improved complete ensemble empirical mode decomposition with adaptive noise.

E. A. Yulyugin

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Implementation of direct time stamp counter access execution technique in a software simulator

The goal of this research is to improve the performance of software simulation workloads frequently accessing TSC (Time Stamp Counter), while running on Intel® 64 platforms. To achieve the goal a new direct TSC access execution approach is developed, implemented and tested by the full-platform software simulator Wind River® Simics®.

Key words: Simics, TSC, VT-x, simulation, hypervisor, direct execution.