2. MATHEMATICAL METHODS IN MECHANICS AND PHYSICS

Abstracts

Altsybeyev V.V., Ovsjannikov D.A. **Trajectory beams control in hybrid systems subject to the distribution density of charged particles**

The problem of dynamics optimization for charged particle beams in hybrid systems is considered. The variation of the quality functional is obtained. Parametric optimization of the accelerator with drift tubes is considered.

Andreeva T.A., Bedrina M.E. **Modeling the mechanism of the molecules interaction in the liquid crystal phase**

The method of density functional theory is used for analysis of the models with different molecular associates in the liquid crystal phase. The most probable spatial structures with the minimal total energy of the dimers and trimmers of CB5 molecules are found by variational method.

Belova O.A. **Flights to the collinear libration point L_1**

Within the mathematical model in the central gravity field the flight to the libration point is possible with no less then two impulses. Otherwise, according to the restricted three-body formalism the libration point L_1 becomes stationary and unstable, i. e. there is a manifold, that can be used for asymptotic approach to L_1. The purpose of the research is the construction of the one impulse trajectory of the space-craft from the earth orbit to the collinear libration point L_1. The numerical integration of motion equations for the space-craft is performed for the near earth space and for the collinear libration point neighborhood.

Bogdanov A.A., Golovkina A.G., Kudinovich I.V. **Optimization of the ADS characteristics**

Prospects and problems of ADS creation, which complitely excludes the opportunity of uncontrollable chain-reaction occurrence are considered. Calculations of neutron production in targets bombarded by protons with energies up to 1 GeV in framework of GEANT-4 are presented. Optimal geometry parameters of targets of different materials are outlined. Also the influence of neutron generation target localization in the active core and the obtained neutrons energy on the ADS power is shown.

Vasiliev A.A., Bedrina M.E. **The dependence of the calculations results obtained with DFT method on the representation of the wave function**

The calculations of fullerene S60 in different representations of basis functions using B3LYP method are obtained. The dependence of the calculations results based on the method on representation of the wave function is shown. The further application of basis functions is represented.

Vikulina Y.I., Grekov M.A., Kostyrko S.A. **Stress-strain state of an elastic**

body with a slightly curved surface in view of the surface stress

The 2D problem of elasticity for a half-space with a slightly curved surface is solved by means of the boundary perturbation technique. An existence of an extra surface stress typical for nanometer solids is assumed. Using Goursat-Kolosov's complex potentials and Muskhelishvili's representations leads the solution of the boundary value problem in each approximation to a solution of the same hypersingular integral equation, the right hand size of which depends on all previous approximations. In the case of the surface described by a periodic function, the solution of the equation is found in a form of Fourier series. The effect of the surface stress on the stress state of the boundary is analyzed on the base of the first-order perturbation solution.

Gaeva E.S., Krivovichev G.V. **Comparison of finite-difference schemes for solution of problems for a lattice kinetic equations system**

Four finite-difference schemes for solution of initial-boundary problems for a lattice kinetic equations system are considered. The comparison of these schemes is performed during the solution of two test problems of computational hydrodynamics. As a result of computations, it is shown, that the value of Courant number for the proposed in the work modified Lax finite-difference scheme is larger than its values for other schemes. The scheme has minimal value of mean-square deviation from well-known solutions of test problems.

Gromov A.O. **Stekel's isothermal models of galaxies**

In this paper a new family of the rotationally symmetric models of the mass distribution in models of stellar systems are proposed. The potential of such family refers to a type of Stekel's potential. For this potential there is a third quadratic integral of the velocity, which explains the observed triaxiality distribution of velocity. In this paper we consider the quasi-isothermal potential and we construct a self-gravitating model by the scheme, proposed by G.G. Kuzmin. In addition, the graphs of density distribution in the equatorial plane and the axis of symmetry are presented.

Yelaev E.V. **On the calculation of tolerances and their statistical verification**

In the work the problem of finding the tolerances in the accelerator of charged particles with drift tubes is considered.

Klimakov A.A., Vinogradova E.M. **Modeling of the diode system with a thin field tip**

In the paper the problem of electrostatic electron gun based on the field tip is considered. A mathematical model is presented to describe the diode system with a thin tip on a flat substrate as a field emission cathode. All system parameters may be various. The potential distribution is found for whole region of the electron gun.

Krivosheev A.G., Kasikova P.V. **Solution of nonlinear dynamics equations**

using the method of polynomial transformation

One-dimensional nonlinear mechanical system is considered. Nonlinear terms of differential equations are represented in the form of power polynomials. Method of polynomial transformation is used to solve the problem. Analytical matrices of linear transformation are obtained in nonresonance and resonance cases.

Kuruch O.S., Vinogradova E.M. **The modeling of the field cathode as sphere on cone**

In the work the diode electron-optical system with dielectrics on the base of the field emission cathode (sphere - on – cone) and the anode (spherical segment) modeling is considered. The problem is to determine the Laplace's equation exact solution for electrostatic potential distribution function for the whole region of the considered emission system. To find the unknown coefficients in the expansion with the Legendre's functions the dual series equation method is employed. As a result of the research the solution of the initial value-boundary problem is reduced to the solution of Fredholm's integral equations of the second kind.

Larionov S.G., Vinogradova E.M. **The mathematical modeling of the electrostatic finite thickness aperture**

The mathematical model of the electrostatic lens with finite thickness aperture is presented. The potential distribution of the electron-optical system is found. Graphical outputs of the potential distribution of the electrostatic lens are presented.

Makarova M.A., Vinogradova E.M. **Modeling of the diode emission system subject to space charge**

The work is devoted to the problem of the influence of space charge on the field electron emission. The problem is to calculate the electrostatic potential distribution in diode cylindrical system subject to space charge. Poisson's equation with given boundary conditions is solved. The right-hand member of this equation is a function describing the space-charge density. It is approximated by a piecewise constant function. As a result the function of potential distribution is obtained; the results of calculations are presented and analyzed.

Malkov V.M., Stepanova V.A. **Large strains of a plane of harmonic material with interface crack loaded by pressure**

The nonlinear problem of plane strains of a bi-material plane with an interface crack loading normal pressure is considered. Mechanical properties of both materials half-planes are described by John's model harmonious material. Feature of the problem is the dependence of boundary conditions on the deformation of coasts. It was found out, that there is some critical pressure proportional to the shear module which excess conducts to physically doubtful results. It was discovered also, that nominal stresses in basis of the cartesian coordinates tends to infinity at approaches along of interface by the tips of a crack not only from the outside cracks, but also

from within.

Miasnikov R.I. **Numerical methods for particle beams long-time evolution**

In the paper the problems of a particle beams long evolution in cyclic accelerators are considered. Usually for this purpose some known numerical methods (usual and symplectic) are used for an enormous integration number (more than 106). It is known that usual methods don't lead to correct results for such great number of integration steps. In the work symplectic methods are compared with usual numerical methods.

Prikhod'ko A.A., Nesterov A.V., Nesterov S.V. **On systematization of stable Mathieu equation decision**

The results of gomogenius Mathieu equation research are presented in article. During the computing experiment associations of spectral characteristics of modulated named equation decisions on a relation of its coefficients are established. The specified associations are presented in graphic form which can serve for approximate decision estimations of Mathieu equation without its integration. The elementary classification of decisions is presented.

Raik A.V. **Approximation of intermolecular interaction potentials**

Potentials of intermolecular interaction of a molecule of water with MgO and ZnO crystals (100) surface were calculated using the method of quantum mechanics and approximated by the Buckingham analytic function. Gnuplot and Origin software packages were used for the approximation using the non-linear method of least squares. The data obtained by applying numerical and analytic approximation methods were compared.

Sedova O.S. **The plane problem of elasticity theory for a half-plane, a strip and a half-space**

In the paper the plain problem of finding an analytical solution of elasticity theory for a half-plane, a strip and a half-space is considered. Half-plain is loaded by normal and tangential force and concentrated moment is considered. The problem of acting of two concentrated forces, uniform normal load and concentrated moments on the strip borders, and the problem of acting of normal force on the half-space border are considered.

Semenov S.A., Krivovichev G.V. **Numerical research of approaches to the boundary condition realization in lattice Boltzmann method**

Various approaches to the no-slip boundary condition realization in lattice Boltzmann method are considered. In the case of the problem for flow in the cavern the numerical solutions for different approaches to no-slip condition are compared. Numerical simulations are realized on different grids with different Reynolds numbers. It is shown, that Coupanec boundary condition is optimal for some criteria.

Suspitsin K.S. **Solution of the Henon-Heiles problem using symplectic methods**

In the paper, a comparison of symplectic and nonsymplectic numerical methods for the Henon-Heiles problem is made. Developed applied software allows us to study the dynamical systems described by ordinary differential equations.

Syrov E.V. **The development of numerical-analytical model of the process of dry magnetic separation to create a dynamic control system of the process**

The widespread use and a variety of dressing material properties determine the relevance of the development of automatic dry magnetic separation control systems with integrated physical-theoretical model. The questions related to the development of such models is considered. Among them are the use of numerical-analytical and numerical methods, the use of simulation packages, the integration of models in the automatic control system. Mathematical model of the magnetic field pattern in the vertical section of the magnetic separator is designed.

Televnyi D.S., Vinogradova E.M. **Calculation of triode-type system with a field tip**

The modeling of the triode electro-optical system with a field tip is considered in the work. The problem is to find function of potential distribution in the field of the system, which filled with two different dielectrics, value of potential on the electrodes is given. There is tip on axis of system, this tip is modeled by charged thread. The method of overlapping of areas was used. The density function was represented as a linear function. In the result there are the functions of potential distribution in system and the results of numerical computation are presented.

Timkina V.E. **On a problem of stabilization of the orbital motion of the spacecraft in the vicinity L_1**

The orbital motion of the spacecraft in the vicinity of collinear libration point L_1 is discussed. The mathematical model of the restricted three-body problem modified by the Hill method is used to describe the motion of the spacecraft. In this work the computational investigation of the controlled path of the motion, which shows the Lyapunov stability with a special choice of the control action in the position and momentum spaces, is treated.

Trofimov V.V., Nikiforov K.A., Antonova L.I. **Study of field emission arrays of cathodes**

Non-gated NbN field emission arrays are studied. The I-V measurements and emission characteristics of edge-shaped cathodes for vacuum high-voltage and atmosphere low-voltage regimes are considered. Mathematical model is presented and electrostatic field magnification at edges of n-type silicon wafer is discussed.

Ulanov E.A., Uteshev A.Ju. **Three attracting centers: stationary points for**

two potentials

The mass m_j is located at the fixed point $\mathcal{P}_j$ in the plane. The problem is to find stationary points of the potential $f(\mathcal{P}) = \sum_{j=1}^{3} m\_j \, |\mathcal{P}\mathcal{P}_j|^s$ lying inside the triangle $\mathcal{P}_1\mathcal{P}_2\mathcal{P}_3$. The solution for this problem for the case $s = +1$ (generalized Fermat – Torricelli problem) and the one for the case $s = -1$ (Euler fixed centers problem) are compared. An extension of the obtained results for the case of four points in space is also discussed.

Khisamiev A.R. **Evaluation of the prolate spheroidal functions**

Schrodinger equation for a particle in the prolate spheroidal coordinates is considered. The separation of variables equations leads to prolate spheroidal functions. Algorithms for computing eigenvalues of the problem, decomposition of the solution with systems of orthogonal functions and numerical integration of the equation with explicit Runge-Kutta method of order 8 are investigated. A comparative analysis of algorithms' computing power is completed. Recommendations for the calculation of angular and radial spheroidal functions are made.

Shirokolobov A.Y., Ovsyannikov A.D. **Mathematical optimization model of parameters of travelling-wave accelerator**

Mathematical model of optimization of parameters of accelerator with traveling wave is suggested. Numerical optimization results are presented.

Yakushev E.A. **Fundamentals of mechanics of discrete solid body**

Mechanics of discrete body uses theoretical models that reflect all the main characteristics of real structure of various materials. Deflection mode of objects under the force and temperature influence is investigated from the standpoint of interaction between structural elements. New unknown laws were discovered which couldn't be revealed within the boundaries of traditional model of continuous medium. The practical realization of theoretical innovations in the metallurgy industry has shown its high efficiency.