C 173(04)
C-73

International Conference

Computational Modelling and Computing in Physics

Dubna, September 16-21, 1996

CMCP 96

BOOK OF ABSTRACTS

JOINT INSTITUTE FOR NUCLEAR RESEARCH
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Organized by

Joint Institute for Nuclear Research

Co-organizer

Russian University of People's Friendship

Under the sponsorship of the

Ministry of Science and Technical Policy, Russia

Russian Foundation for Basic Research

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METHODS FOR SOLUTION OF SEVERAL SELF–ADJOINT MULTI–PARAMETER SPECTRAL PROBLEMS FOR ODE SYSTEMS [1]

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A short survey of results [1–6] is given.

Evaluation of the Lamé angle wave functions is an important example of the problem under consideration. In [1] the method allowing evaluation of these functions in a wide range of parameter variations is elaborated. The method is based on a globally converging iterative procedure, which provides the convergence to the solution specified by given function numbers. The method of [1] has been extended in [2] to the case of several non–linear two–parameter problems, and in [1, 3] to n–parameter problems arising, if the Fourier method is applied in its simplest form. Modifications of the method in [1] proposed in [4, 5] enable us to solve several tree–parameter problems, in particular, to carry out calculations of free acoustic oscillations inside a triaxial ellipsoid. In [6] a method for solution of n–parameter weakly connected systems of equations has been devised via introduction of a parameter.

In order to solve numerically most of the problems considered above, standard programs have been designed, in particular, for multi–processor computers.

The algorithm proposed in [1] is involved in the survey [7].

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ON NUMERICAL–ANALITIC INVESTIGATION OF SCALAR SCATTERING BY IDEAL PROLATE SPHEROIDS AND TRIAXIAL ELLIPSOIDS [1]

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The exterior Dirichlet and Neumann problems for the Helmholtz equation are considered for scatterers of a shape pointed out in the title. The problems are solved by the Fourier method via separation of variables either in the prolate spheroidal or in the ellipsoidal coordinate system respectively (see [1–3], and also literature cited therein). In so doing, complicated special functions arise, which are calculated by means of amplitude–phase methods proposed in [4–6]. The methods allow us to carry out calculations for the listed above classical scattering problems in a wide range of parameter variations (see [6]).

Calculations of distinct terms in the Fourier series are independent of each other, therefore they can be done in parallel. In [6] the calculations for a triaxial ellipsoid have been carried out on a multiprocessor computer, based on a net of trasputers.

The algorithms proposed in [4–6] are involved in the survey [7].

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[1] Supported by the Russian Fond of Fundamental Research (project No. 96-01-00951).

SOLVING LINEAR DIFFERENTIAL EQUATIONS IN SOME POWER SERIES CLASSES [1]

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The talk is mainly a survey of some results of [1, 2, 3].

Let a linear homogeneous ordinary differential equation $Ly = 0$ with polynomial coefficients be given. Our goal is to find all points a (ordinary or singular of the given equation) and all formal power series

$$y_a(x) = \sum_{n=0}^{\infty} a_n (x-a)^n$$

which satisfy $Ly_a(x) = 0$ and whose coefficients a_n have a "nice" explicit representation in terms of n. We consider the cases where a_n is a polynomial or a rational function of n, and where a_n is a hypergeometric term (i.e. a_{n+1}/a_n is a rational function of n). Hypergeometric series are in the latter class of power series.

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DYNAMICS OF CHERN-SIMONS FIELDS: COLLAPSE VERSUS TURBULENCE [1]

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Multiconnection of two-dimensional space, the definition space of field distributions is the essential feature of the $2+1$ D systems. The existence of topological peculiarities in spatial two-dimensional systems may be taken into account [1-3] by means of Chern-Simons (CS) action in the long-wave limit. The goal of the present paper is the study of the temporal evolution of C-S gauge fields as well as field distributions in the gauge nonlinear Schrödinger model

$$i(\partial_t + iA_0)\Psi = -\frac{1}{2}(\nabla - i\mathbf{A})^2\Psi - g|\Psi|^2\Psi \tag{1}$$

with the equation of motion (EM) for the C-S gauge fields

$$k\,\varepsilon^{\alpha\beta\gamma}\partial_\beta A_\gamma = j^\alpha\,. \tag{2}$$

Here $\mathbf{j} = Im\Psi^*(\nabla - i\mathbf{A})\Psi$, $j^0 = |\Psi|^2$. Let us write down the EM using dimensionless variables as follows

$$\begin{aligned}
\partial_x\beta - \partial_y\alpha &= -a^2\,,\\
\partial_t\alpha + \partial_x\gamma &= 2\beta a^2\,,\\
\partial_t\beta + \partial_y\gamma &= -2\alpha a^2\,,\\
\Delta a &= 2ca^3 + (\alpha^2 + \beta^2 + \gamma)a\,,
\end{aligned} \tag{3}$$

where $c = -k_t$ and the fields $\Psi = a\exp(i\varphi)$, $A_x = \alpha + \partial_x\varphi$, $A_y = \beta + \partial_y\varphi$, $A_0 = \gamma + \partial_t\varphi$. Numerical simulation of Eqs.(3) in the paper has been performed for two cases.

(i) The first three equations of the system (3) are equivalent to the EM for linked loops in two-dimensional ideal fluid. This is valid for the functions α and β containing only the vortex part of the phase dynamics.

(ii) Let the functions α and β have a potential part in addition to $\nabla\varphi$. This is essential for the description of collapse [3] of strongly correlated wave beams. The numerical simulation of the latter equation in Eqs.(3) describing the structure of a zero mode permits to find the critical power and the effective width of the field distribution. The simulation is based on the method of the stabilizing Petviashvili's multiplier [4] generalized in the present paper to the case of the polynomial type of nonlinearity.

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STABLE REGULARIZING NUMERICAL METHOD FOR SOLVING THE INVERSE PROBLEM OF QUANTUM SCATTERING THEORY [1]

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The problem of the numerical reconstruction of potential by scattering data is well known and important from the mathematical point of view and for such physical applications as the analysis of a nuclear interaction potential by experimental data. The main approaches to the theoretical investigations of the problem are well-known Gelfand-Levitan, Marchenko and Krein methods reducing the problem to the families of integral equations.

At the same time the development of the corresponding numerical methods is sufficiently complicated by the reason of the ill-posedness of the mentioned inverse problems. As it is known, their solutions are nonstable with respect to perturbations of input data. The nonstability of the problem strongly restricts the applications of the methods in the physical investigations and forced many authors to use the procedure of the substitution of a few parameters in the beforehand choised form of the solution instead of solving the problem. On the other hand the algorithms based on the Tikhonov method of regularization of incorrect problems are considerably more effective. There is a series of the papers devoted to the applications of the Tikhonov method to the numerical solving of the inverse problems.

In this report the rather different regularizing method for the inverse scattering problem in the matrix case is suggested. It is based on the Marchenko's and Krein's methods and on the analysis of the asymptotic behaviour of the phase shift and the module of the Jost function for high energies. As usually the regularization assumed some a priory information about the smoothness and integrability of an unknown potential and of corresponding phase shift.

In the frame of the suggested method the stable numerical algorithm is constructed and the theorem establishing the stability of the method is proved. The results of the numerical calculations shows the high accuracy of the algorithm as well as its stability with respect to perturbations of input data.

[1]This work was supported by the Russian Foundation for Fundamental Research, Grant No. 95-01-01467a.

SELF-EXCITED MULTIPETAL WAVES IN 2D OPTICAL SYSTEM WITH LARGE SCALE FEEDBACK INTERACTIONS [1]

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Recent advances in the potential to control light using light allow us to consider spatially distributed (2D) feedback optical systems as a promising tool for optical information processing. The significance of these nonlinear systems is that the external feedback configuration enables ready control of system dynamics through large scale interactions resulting in excitation of optical patterns, phase switching waves, rotating multipetal waves (reverberators), spiral waves etc.

Here we present a mathematical analysis of self-excited multipetal waves in the nonlinear Kerr slice - feedback mirror type optical system under diffraction and particular type of large scale feedback interactions - transverse coordinate rotation. Nonlinear phase modulation $u(r,t)$ in the system is governed by the equations [1]

$$\partial_t u + u = D\Delta u + K\left(|A(\mathbf{G}r, z=l; u)|^2 + A_0^2\right),\ \partial_r u|_{|r|=r_0} = 0,$$
$$\partial_t A + i\Delta A = 0,\ A|_{z=0} = A_0 \exp(iu(r,t)),\ \partial_r A|_{|r|=r_0} = 0,$$

where $\Omega = \{r = (x,y) \in R^2 : |r| < r_0\}$; Δ - Laplacian with respect to (x,y); D - diffusion coefficient; K - bifurcation parameter; $A_0 > 0$ - incident spatially homogeneous field; $A(z=l)$ - outgoing feedback field, l - feedback length. Transverse spatial coordinate rotation by the angle δ is accounted by means of the operator

$$\mathbf{G}r \equiv \mathbf{G}(x,y) = (x\cos\delta - y\sin\delta, x\sin\delta + y\cos\delta).$$

We have proved that under some conditions spatially homogeneous solution $u_s = 2K/A_0^2$ loses stability through Andronov-Hopf bifurcation then $K > K_*$, $K_* = K_*(\delta, D, l, r_0, A_0)$ is a critical value. Corresponding time-periodic solution is obtained in the form of small parameter $(K - K_*)^{1/2}$ expansion. The principal nonhomogeneous member appears in the form of multipetal rotating wave $J_n(\mu_{n,m}|r|/r_0)\cos(\omega_{n,m}t - n\theta + \theta_0)$ where θ - polar angle of r, θ_0 - arbitrary phase shift, J_n - Bessel functions, $J_n'(\mu_{n,m}) = 0$. The number n of petals and the temporal frequency $\omega_{n,m}$ are determined from bifurcation conditions as functions of angle δ as well as a Floquet stability conditions of the rotating wave.

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SOME APPLICATION OF THE CONTINUATION METHOD FOR THE NUMERICAL SOLVING OF THE THREE-DIMENSIONAL POLARON PROBLEM

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An iterative method for numerical investigation of the spherically-nonsymmetric polaron in the limit of strong coupling is proposed. An expansion in spherical harmonics is used for an approximation of the solution. An originality of the method consists in creating an iterative newtonian scheme with an additional parametrization of the initial equation, such that a transition from a simple linear problem to the initial nonlinear one is fulfilled. A classification for solutions of the problem is constructed in accordance with a numeration of the spherical harmonics. The testing calculations for various parameters of the problem and a comparison of obtained results with famous ones confirm the efficiency of the elaborated algorithms.

ON NEW NONLINEAR SYSTEMS WITH SUPERPOSITION PRINCIPALS [1]

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A new class of nonlinear ordinary differential equations with superposition principals is considered. In contrast to previous works, it describes the systems of N^2 ODEs associated with N linear equations. The latter (or more precisely, its fundamental set of solutions) can be used to derive the general solution of the related nonlinear systems. While the projective Riccati equations [1,2] can be obtained from them as some reduced cases and is of direct linearization.

The above systems arise and play an important role in chemical kinetics and plasma physics.

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BEHAVIOUR OF SOLUTIONS OF THE SINGULAR PERTURBED INFINITE DEGREE DIFFERENTIAL EQUATION

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We have the pleasure of bringing to your notice results of an investigat on of Kadyshevsky equation [1] of the form

$$[2c\sqrt{q^2 + m^2c^2} - H_0^{rad} - V(r)]\Phi_{ql}(r) = 0, \tag{4}$$

$$H_0^{rad} = 2mc^2\, ch\left(\frac{i\hbar}{mc}\frac{d}{dr}\right) + \frac{mc\hbar^2 l(l+1)}{m^2r^2c + i\hbar^2} exp\left(\frac{i\hbar}{mc}\frac{d}{dr}\right)$$

where $V(r)$ is a quasi-potential. It is the relativistical analog of Schrödinger equation because if $c \to \infty$ we obtain non-relativistical Schrödinger equation [2]. Let $l = 0$ and $\varepsilon = \frac{\hbar}{mc}$ then equation (1) has form

$$[ch\left(i\varepsilon\frac{r}{dr}\right) + V(r) - Q^2]\Phi_{ql}(r) = 0.$$

The availability of infinitely small values ε makes possoble to consider it as a singular perturbed differential equation [3]. In this case a special interest generates the asymptotic behaviour of solutions with the proviso that $\varepsilon << 1$.

We applied analytical and numerical methods solving of Kadyshevsky equation and examined asymptotic behaviour of solutions to the Cauchy problem and to the boundary value problem.

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NUMERICAL INVESTIGATION OF QUANTUMFIELD MODEL OF STRONG-COUPLING BINUCLEON [1]

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The quantumfield binucleon model [1] for the case of the nucleon spot interaction with the scalar and pseudoscalar mesons fields is considered. For the strong coupling limit the nonlinear equations describing two nucleons in the meson field are developed. It is shown that the model considered can be reduced to the following eigenvalue problem for nonlinear system of equations:

$$\begin{cases} \Delta\varphi - \lambda\varphi + (V_1 + BV_3)\varphi = 0, \\ \Delta V_1 - k_1^2 V_1 = -|\varphi|^2, \\ \Delta V_3 - k_2^2 V_3 = -(\sigma\nabla_r)^2|\varphi|^2. \end{cases} \tag{1}$$

Some alternatives for the statement of the boundary problem for the system (1) in the special case of axial symmetry, namely for the cylindrical and the spherical coordinates are discussed.

The algorithm suggested in [2] was used for solving the problem. This algorithm is based on the combination of continuous analogue of the Newton's method [3] and the continuation method and allows to reduce solving of the complicated system of nonlinear equations to the sequential solving of the relatively simple linear problems. The results of numerical investigation are presented.

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[1] encouraged and supported by the RFBR Grant 94-01-01119

ON SOME PROBLEMS OF INVESTIGATION OF EIGENVALUE PROBLEMS IN MOMENTUM SPACE [1]

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Numerical investigations of the Schroedinger equation relativistic generalization in momentum space for some modifications of coulomb and linear potentials using continuous analogue of the Newton's method [1] are presented. The efficiency of method is demonstrated for one QCD model [2] computing. Codes SLIPH4 [3] and SYSINT(SYSINTM) [4] are applied for this investigation.

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[1] encouraged and supported by the RFBR Grant 94-01-01119

NONLINEAR DYNAMICS OF PARTICLE BEAMS WITH SPACE CHARGE

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This paper is devoted to modelling of nonlinear dynamics of particle beams with space charge. For some models of space charge distribution functions [?] the necessary motion equations are written. For solving of these equations the matrix formalism [?] for Lie algebraic tools is used. This approach permits to obtain solutions of the motion equations in symbolic forms. These solutions have forms of block-matrices (solution matrices) which can be created for advance for different control beam systems and the distribution functions. All symbolic information about model distribution functions and solution matrices form is involved to some base-dates. In this paper we suggest two methods of space charge descriptions: *the nonlinear rms-envelope matrices language* and *the distribution functions language* [?]. For modelling of beam dynamics it is more convenient to use the rms-envelope matrices approach as it requires more less computer resources than the second approach. But for some problems it is very important to calculate the time evolution of space charge distribution functions. An analytical technique using matrix forms for these distribution functions is described. This approach is one of direct methods of time evolution calculations. In particularly, the problem of making designed distribution functions (for example, the uniform distribution function) is solved as a nonlinear programming problem for some parameters which describe desired functions. The necessary symbolic computations are done with the help of computer algebra codes *REDUCE* and *MAPLE*.

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DYNAMIC MODELING PARADIGM AND COMPUTER ALGEBRA

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In this report we propose ideas and concepts of a new paradigm of computer simulation of particle beam dynamics – **dynamical modeling**, which accommodates the most of achievements of modern computer simulation: object-oriented programming, data and knowledge bases, computer algebra and expert systems. According to this paradigm one can by following way:

- – to define an initial set of decisions (preliminary judgements of a design problem);
- – to applicate one or more mathematical models of various properties of the dynamical system;
- – to analyse of the solution and then accept or reject corresponding model, and, in the later case, define a new set of decisions and return to the second step.

In the frame of this approach the mathematical models are regarded as objects, which have such very important characteristics as the inheritance and polymorphism. It is obviously that an assemblage of different effects, the problems of particles beam modelling and optimization require flexible and effective approaches. For the realization of dynamic modeling paradigm we suggest to create data–bases which contain sets of matrices which describe both dynamical equations (or Hamiltonians) and corresponding solutions. These matrices have to be calculated in symbolic forms. Such form of representation of necessary information guarantees more comfortable and effective process of modelling. An extraction from these data–bases corresponding matrices is carried out with the help of an oriented graph according to a desired structure of dynamical system nonlinearities. In another words in the frame of the dynamic modeling paradigm one can manipulate multiple models, each of them correspond a set of some matrices. The use of symbolic form of solution representation gives a possibility to set up the used matrices according to selected model. The use of group-theoretical methods and the methods of Lie algebras allows the compact codes (for example, on *REDUCE* or *MAPLE* codes) to be created. These codes can generate the numerical codes automatically after choosing the dynamical system under study. One of the main difficulties is the creating the semantic networks, rules, procedures, which maintain the necessary connections between dynamical characteristics of the particle beam control system and corresponding matrices. On this step the role of the experts has much significance. There are two principal assets of such approach: the uniformity of data bases elements (matrices) and the use of algebraic calculations only. These properties permit to fill up up the data–bases (and correspondingly the knowledge bases) step by step, including new effects in the form of corresponding matrices. At last, one of the part of any expert system – an appropriate human–machine interface – makes the system easily accessible to different researchers. Now the prototype of elements for the describing expert system is creating. The effectiveness of used matrix formalism for Lie algebraic tools is verified on some practical problems, including of space-charge problems, synthesis of transport and focusing systems with desired characteristics.

CALCULATIONS OF CONTRAST STRUCTURES IN SINGULARLY PERTURBED EQUATIONS AND SYSTEMS [1]

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This paper presents some techniques and examples of the numerical solution of nonlinear singularly perturbed equations with internal transitional layer, named contrast structure. These techniques are based on the combination of numerical and asymptotical methods. The latter ones allow us to make up the good qualitative comprehension of the solution being searched and to choose the most effective numerical method and suitable initial values.

Following problems are considered.

I. The parabolic equation

$$\varepsilon u_t - \varepsilon^2 u_{xx} = f(u, x, t)$$

is investigated on $D = \{(0 < x < 1) \times (t > 0)\}$ with initial value $u|_{t=0} = \sin \pi x$ and boundary conditions $u|_{x=0} = u|_{x=1} = 0$. Here $\varepsilon > 0$ is the small parameter and $f(u, x, t)$ is periodic on t.

The calculation results of so-called variable structure solutions are given for $\varepsilon = 10^{-2}$ and $f(u, x, t) = (1 - u^2)(u - 0.5 \sin \pi x + 0.73 \sin at + 0.25)$. Solutions $u(x, t, \varepsilon)$, which are settled on the big values of t, are described too.

II. For several systems of type

$$\begin{aligned} \varepsilon^2 u'' &= F(u, v, x, \varepsilon) \\ \varepsilon^2 v'' &= G(u, v, x, \varepsilon) \end{aligned}$$

with boundary conditions of first or second kind the calculations of contrast structures are made as in the case when their existence is proved, so when it is not done. Results are represented by graphs.

[1] supported in part by the RFFI (grant N96-01-00694)

TAKING INTO ACCOUNT THE FINITE STATISTICS OF MONTE CARLO SIMULATION FOR PARAMETERS ESTIMATION FROM EXPERIMENTAL DATA [1]

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One of the most important problems in modern high energy physics experiments on measuring cross sections is the problem of parametric analysis, which includes testing the hypothesis about agreement between some parametric model and experimental data. In this problem we must take into account statistical fluctuations in Monte-Carlo sample, that is used for correcting experimental data by limited acceptance and finite resolution of the detector. These fluctuations lead to the distortions of the final distribution used in χ^2 criterion (because of these fluctuations, the final distribution, used in the criterion, differs from the χ^2 distribution). In this report we propose the method to take into account these fluctuations and, as a consequence, correction of the final distribution, that allows to use the χ^2 criterion correctly in the problem of the hypothesis testing. Our numerical experiments show that this method provides significant improvement of the final distribution and it's proximity to the corresponding true χ^2 distribution.

[1] supported by the RFFI grant 96-02-16495-a

МЕТОД УЧЕТА СИЛЬНОЙ АНИЗОТРОПИИ РАССЕЯНИЯ В УРАВНЕНИИ ПЕРЕНОСА.

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Во многих задачах переноса излучения или частиц важную роль играет учет анизотропии рассеяния. Стационарное уравнение переноса в одномерной плоской геометрии для одной группы с учетом анизотропии рассеяния в стандартных обозначениях имеет вид:

$$\mu\frac{\partial\varphi}{\partial z}+\sigma\varphi=\frac{\sigma_s}{2\pi}\int\limits_{-1}^{1}\int\limits_{0}^{2\pi}w(\mu_0)d\chi\,\varphi(z,\mu')d\mu'+q(z,\mu), \qquad (1)$$

где косинус угла между направлениями падающих и рассеянных частиц

$$\mu_0=\mu\mu'+\sqrt{(1-\mu^2)(1-\mu'^2)}\cos\chi. \qquad (2)$$

Индикатрисы рассеяния $w(\mu_0)$ известны или из эксперимента, или из достаточно трудоемких расчетов. При сильной анизотропии рассеяния $w(\mu_0)$ может иметь особенность, близкую к δ-функции при $\mu_0\to 1$, а также может быть почти разрывной функцией. Эти обстоятельства затрудняют вычисление интеграла в правой части (1), кроме того, сильно усложняется итерационный процесс решения интегро-дифференциального уравнения (1). Применение квазидиффузионного метода вкупе с частичным разложением индикатрисы рассеяния по полиномам Лежандра решает проблему сходимости итераций при сильной анизотропии [1, 2]. Однако прямое интегрирование остатка от разложения индикатрисы рассеяния по полиномам Лежандра остается дорогим в вычислительном отношении за счет наличия разрывов и δ-особенности.

1) Предлагается замена переменных в интеграле рассеяния, упрощающая задачу вычисления интеграла от остатка разложения индикатрисы: от переменных χ,μ' сделан переход к переменным χ,μ_0.

2) Эта замена переменных позволяет корректно выделить и учесть δ-образную особенность индикатрисы рассеяния в окрестности значения $\mu_0=1$.

3) Интеграл рассеяния от остатка разложения индикатрисы сводится к интегралу Стильтьеса, который более пригоден для фактических расчетов при наличии больших градиентов (почти разрывов) индикатрисы рассеяния.

Предварительные расчеты показали эффективность метода при очень сильной анизотропии рассеяния [3].

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AUTOMATIC PROCESSING OF FILM INFORMATION.

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Hardware and software system for real time processing of film information is described. The system is based on upgraded flying spot digitizer PSP-2 on-line to E 60 computer which controls the hardware and stories the measured coordinates in its memory. E-60 is memory mapped into the memory of PC AT-286 which filters, checks, compresses and writes done the information. The PC finds fiducial marks, sparks, dashed indicators etc. Used algorithms and real implementations is discussed. Special attention have been paid to opted friendly interface.The high level automatization have been reached, the intervention of operator was really needed only for initialization or to change films.

The system was disined for measurement of films from 3-meter spectrometer with optical spark chambers which is used for experiments in intermediate energy physics on ITEP 10 GeV synchrotron. The measurement started in may 1993. 700000 events measured to the end of the year.

SPLINE APPROXIMATION AND SMOOTHING USING ADAPTIVE PROJECTIV FILTERS

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A new algorithm for determining the adaptive cubic spline (ACS) which approximates or smoothes a function on a given interval, is proposed. The *automatic search of the spline nodes* is realized in this algorithm. To search the spline nodes, the local one-parameter three-point cubic splines [1] are constructed and fitted tc a given function using the adaptive projective filters [2]. The boundary points of the i ntervals, on which the function is approximated sufficiently well by the local splines, are chosen as the nodes of the global spline, which is further determined by the two- or three-point model. The first version of the library in C++ for working with (ACS) is presented. The examples of the treatment of model and experimental data are given.

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COMPUTER ALGEBRA APPLICATIONS IN QUADRATIC GRAVITATIONAL THEORIES

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It is well-known that one of the usual technical problems in the theory of gravity is the calculation of the various geometrical and physical quantities and equations. The task may be simplified by using the suitable system of the computer symbolic algebra. We have experience of application of the computer algebra to the investigation in the theory of gravitation with the Lagrangians which are quadratic in the irreducible pieces of the curvature and torsion in a Riemann-Cartan space-time, in particular, to the investigation of the solutions for the plain general pp-waves [1] and the generalized conformal invariance in the gauge theory of gravity [2]. The field equations of such theories contain operations of dualization, covariant exterior differentiation, etc. The algorithm of testing is well defined but numerous indices, components and contractions make these calculations very tedious that may lead to mistakes. Computer algebra system GRG [3] can perform these calculations. Although GRG has not the built-in mechanism for the solution of field equations but it can help to transform them to the more simple form. The main steps of user to solve the problem with the help of GRG are :

1) to set the coordinates, tetrads, metric;
2) to set the components of torsion as arbitrary functions of coordinates;
3) to set the field equations.

GRG calculates the components of all necessary geometrical objects, substitutes them into the field equations and gives the answer in the form suitable for further analysis. The same instruction for GRG may be used for the search of exact solutions of field equations in the quadratic theory of gravitation. When the field equations in the quadratic gravitational theory are obtained, one can investigate different types of exact solutions without wasting time for the intervening calculations. The only modification that the user must do is to change the metric and tetrads in the GRG task. It is clear that such computational approach can play an important role in the progress in this area.

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COMPUTER-AIDED INSTRUCTION UROK/MPGU WITH SYMBOLIC COMPUTING

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Computer-aided instruction (CAI) UROK/MPGU is intended for a development, debugging and production run of the computer controlled teaching lessons for a wide range of physical and mathematical branches of science. It consists of the data base (text of lessons) and the softwear allowing to create the structure of teaching lessons and then to realize the educational process and perform the statistical data collection . Both the creating of the computer controlled lessons and the educational process have an interactive character and are realized on menus, which provide the user with total control over the way the program proceeds. CAI UROK/MPGU users need not to use any programming or author languages. At the same time CAI permits to use some educational modules created with the help of the appropriate programming languages, in particular, graphic modules.

CAI realizes the adapted educational strategy that permits the education to be individual and at the same time standardized. For this purpose CAI includes the spacial educational modules, which realize the "standart methodical situation" created by the sophisticated teachers.

CAI realizes the analysis of the pupil answers in the form of a number, symbol expression, key word, set of symbol expression, set of key words, mathematical expression. Besides, CAI contains the special module "Task Solver" which can solve the mathematical problems with the help of the symbolic computing and compares the results with the pupil answers.

CAI lets to teachers the powerfull and comfortable instrument for the realization of the verious educational purposes and can be applied both in secondary school and in university.

ELASTIC ARM APPROACH FOR DRIFT TUBE IN MAGNETIC FIELD [1]

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The detection system based on the drift tubes working in a uniform magnetic field is widely used in high energy physics experiments. In this work an algorithm for recognition of tracks, detected by drift tubes system, is developed.

Measurements corresponding to each event look as a set of anode wire (x_i, y_i)-coordinates of tubes hitted by particles, noise signals and r_i–drift distances between the particle track and the anode wire. In this case conventional methods of track recognition are not efficient enough.

The suggested algorithm consists of two stages.

At the beginning we have to divide the set of measurements into subsets $S_j = \{x_i, y_i; r_i, i = \overline{1, N}\}$ which are collections of coordinates and drift distances probably belonging to the same track of the event. With this aim the method of serial histogramming – our modification of the Hough–transformation method [?], have been applied.

At the second stage, we to find a track in the form of a second–order curve, in particular, a circle $(a, b; R)$, which is tangent to as much as possible circles $(x_i, y_i; r_i)$ of the subset S_j. Let us define the degree of tangency of two circles on the plane as a minimal distance between intersect on points of these circles with the straight line connecting the centres of circles. It is clear, that if two circles are tangent to each other then a degree of tangency is equal to zero. Thus, we must find a circle $(a, b; R)$, which minimizes a sum of the degree of tangency of this circle with all circles from the subset $S_j = \{x_i, y_i; r_i, i = \overline{1, N}\}$. In other words, the problem is reduced to searching the global minimum of corresponding functional. We propose our modification of the Deformable Template Method [?] applied for solving this problem and, therefore, for solving the problem of track recognition and track parameter determination.

The efficiency of this algorithm tested on Monte–Carlo events is 96%.

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МЕТОД ФИКТИВНЫХ ОБЛАСТЕЙ РЕШЕНИЯ НЕСТАЦИОНАРНЫХ ЗАДАЧ [1]

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При решении нестационарных задач в областях сложной формы может использоваться следующий метод. Система уравнений, возникающая при решении проблемы с помощью неявной разностной схемы, продолжается в большую область простой формы так, чтобы решение некоторой краевой задачи для продолженной системы было близко к решению исходной задачи. Под "простотой" формы области понимается возможность быстрого решения краевой задачи для системы уравнений с постоянными коэффициентами.

Далее применяется итерационный метод решения новой задачи со скоростью сходимости не зависящей от временного шага и параметров продолжения.

Последние годы такие методы были предложены и обоснованы для нестационарных задач диффузии, упругости и системы уравнений Стокса в случае граничных условий первого рода или в случае граничных условий второго рода при постоянных коэффициентах в исходной задаче.

В настоящее время предложена модификация этого метода для случая граничных условий второго рода при переменных коэффициентах в исходной задаче.

Существо метода состоит в том, что исходная система уравнений записывается в виде системы уравнений относительно "псевдопотоков" – значений производных решения и произведения решения на некоторый большой параметр, и далее строится итерационный метод решения получившейся системы уравнений.

Обоснование равномерной сходимости по указанным выше параметрам потребовало доказательства новых теорем о продолжении функций через границу области.

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ЭФФЕКТИВНЫЕ СВОЙСТВА КОНСТРУКЦИЙ С ТОНКОСТЕННЫМИ ВКЛЮЧЕНИЯМИ [1]

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В работе выводятся явные приближенные формулы для эффективных коэффициентов теплопроводности конструкций и материалов с включениями в виде периодической системы взаимно перпендикулярных стен и стержней, отношения толщин которых и коэффициентов теплопроводности удовлетворяют некоторым условиям.

Для примера рассмотрим процесс передачи тепла в конструкции периодической структуры с ячейкой периодичности в виде трехмерного куба со стороной ϵ со стенками толщиной $\mu\epsilon$. Пусть коэффициент теплопроводности внутренности куба равен a_0, стенок — a_1.

Областью периодичности относительно переменных $y_j = x_j/\epsilon$ будет являться единичный куб $\Pi : 0 \le y_1, \dots, y_3 \le 1$. После такой замены переменных толщина "стенок" будет равняться μ.

В [1], получены оценки для эффективного значения коэффициента теплопроводности $\bar{a}$

$$a^- \le \bar{a} \le a^+,$$

$$a^- = <<< a^{-1} >_1^{-1} >_2 >_3, \qquad a^+ = <<< a >_2 >_3^{-1} >_1^{-1};$$

здесь $< . >_j$ обозначает интегрирование по y_j в пределах $[0, 1]$.

Оказывается, что в случае малых μ величины a^- и a^+ совпадают с точностью до членов высшего порядка, а именно

$$a^- = \frac{a_0 + 2a_1\mu}{a_1 + a_0\mu}(1 + O(\mu)), \quad a^+ = \frac{b_0 + 2a_1\mu}{b_1 + a_0\mu}(1 + O(\mu)).$$

Отсюда следует равенство $\bar{a} = \dfrac{a_0 + 2a_1\mu}{a_1 + a_0\mu}(1 + O(\mu))$.

Точно также в двумерном случае имеем $\bar{a} = \dfrac{a_0 + a_1\mu}{a_1 + a_0\mu}(1 + O(\mu))$.

Аналогичные соотношения выводятся в случае разных толщин стенок по различным направлениям и различных коэффициентов теплопроводности в различных стенках и их сочленениях.

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НЕЛИНЕЙНАЯ МОНТЕ-КАРЛОВСКАЯ МОДЕЛЬ ЭЛЕКТРОЯДЕРНОГО РЕАКТОРА

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В ЛВТА ОИЯИ создан программный комплекс, моделирующий в едином цикле межядерный транспорт частиц и внутриядерные каскады, инициируемые первичной высокоэнергетической частицей (протоном, нейтроном, мезоном или тяжелым ионом) в гетерогенной делящейся среде с неделящимися конструктивными элементами. Алгоритм учитывает нелинейные эффекты, обусловленные изменением свойств среды (накоплением легкоделящихся элементов, зашлаковыванием) под действием распространяющихся в ней излучений. Разработанная математическая модель позволяет шаг за шагом просмотреть "анатомию" происходящих в среде процессов, рассчитать полный выход нейтронов, интенсивность потоков других частиц, их энергетические и пространственные распределения. Модель позволяет также рассчитать пространственное распределение тепла, выделяющегося в результате ионизационных потерь заряженных частиц и актов деления, и распределения образующихся в среде нуклидов. Выполнены математические эксперименты по сравнению урановых и ториевых электроядерных систем, по выбору типа и энергии пучка бомбардирующих частиц. Особое внимание уделено математическому моделированию управляемых ускорителем подкритических электроядерных реакторов и секционированных (вентильных) систем, являющихся наиболее безопасными в эксплуатации и позволяющих, как показывают математические эксперименты, получить значительно больший выход нейтронов и, соответственно, большее количество энергии, чем действующие атомные электростанции. Созданный программный комплекс может служить основой для математического моделирования трансмутации (выжигания) долгоживущих радиоактивных отходов атомных электростанций и переработке накопленного оружейного плутония.

INFORMATION SYSTEM "SPACECRAFTS AND FIELDS IN THE NEAR-EARTH SPACE"

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The information system (IS) has been developed, which includes database on spacecrafts (SC) trajectories, set of models for converting SC coordinates and physical models for several of near-Earth's space (NES).

The IS includes:

- available and regularly updated data on trajectory parameters of active SC;
- program for calculations of SC geographical coordinates in arbitrary time period, which accounts for orbit elements precession and upper atmosphere drag;
- program for geographical coordinates transformation to physical (L, B) coordinate system, which accounts for Earth inner magnetic field sources;
- programs to estimate fluxes of charged particles in the Earth's radiation belts as on of important factors in SC environment. Programs use empirical NASA trapped radiation models AP8/AE8 and models, developed in the Institute of Nuclear Physics Moscow State University.

The results of the calculations can be presented as plots of SC trajectories in geographical and physical coordinates as well as particles spectra (protons and electrons) averaged along the SC trajectory during given orbit. These spectra can be used for comparison with experimental data (direct measurements of particle fluxes) during new modelling and to estimate radiation environment on the SC trajectory. Trajectory data can be also used to select SC, which are located in a given regions of NES (magnetotail, South-Atlantic anomaly) in a given period of time.

The method of user-defined orbit selection has been implemented to perform fluxes and fluences modelling for future missions, and allows to perform calculations for arbitrary region of the near-Earth space.

Program modules from IS are also used in SC DB for coordinate calculations.

Program interface was developed as hypertext forms, conforming to Hyper Text Markup Language (HTML). IS can be accessed via Internet as hypertext document

http://www.npi.msu.su/wheresat/wheresat

Developed IS was used to calculate time dependence of particle fluxes for "MIR" orbital station and "Coronas-I" satellite. the comparison with measured fluxes values shows that calculated data were in reasonable agreement with observations.

ENERGETIC PARTICLE FLUXES DATA BASE OF THE SPACECRAFT

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The data base of primary spacephysical data obtaining on spacecrafts (SC DB) oriented on archiving and primary analysis of large sets of data containing information about particle fluxes in the near Earth space. SC DB software is used to perform detail scientific analysis and interpretation. The system is integrated with UNIX based software "Model SC and Physical Fields in the NES DB" [Beliaev, this issue].

Primary data are archived to binary files in predefined SC DB format. Data files contain the time ordered information about particle fluxes and spacecraft orbital elements (geographic coordinates, B and L-shell) and local time (LT and MLT). Orbital elements appended to data on the stage of data conversion.

The primary analysis includes:

- data validity cheeks;
- detector calibration and parameters;
- on line calculating of magnetospheric and heliospheric physical parameters.

The physical parameters values and diagnostic messages are presented in terminal of SC DB operator.

The additional SC DB software packages may be used by scientists to perform multidimensional graphic analyses of data in interactive regime and to develop various semi-empirical models of space environment. The flexible SC DB structure permits to develop the software for additional data processing.

OS DOS and high level programming languages (PASCAL, FORTRAN) were used to develop the SC DB software. The SC DB is currently used to perform data analysis for data obtained on CORONAS-I satellite and MIR station.

CALCULATION OF DECAY RATES OF THE $^{3,4}He^{1,2}H\mu$ SYSTEMS.

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Study of long-lived exotic molecular systems $He\,H\mu$ is important for the understanding the muon kinetic in hydrogen media and nuclear interaction at very low energies. The method of hyperspherical "surface" functions has been applied to the calculation of the nonstable three-body systems $He\,H\mu$, contained the $^{3,4}He$ and $^{1,2}H$ isotopes. Energies of these systems, radiationless decay rates and γ-ray spectra of radiative decay have been obtained and compared with the recent experimental data.

GAMMA-RAY ENERGY DETERMINATION BY NEURAL NETWORK TECHNIQUES IN A SILICON IMAGING CALORIMETER

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To detect gamma radiation in space, the RIM collaboration has suggested the adoption of a silicon calorimeter, composed of 20 planes 50×50 cm^2 wide, consisting of 8×8 modules; each module is made of two layers with 16 silicon strips implanted, mounted in mutually perpendicular X and Y directions. The aim is to investigate gamma rays in the energy range between 100 MeV and 100 GeV through the detection of the electromagnetic shower produced in the calorimeter by the incoming particle. In total we have 5120 energy and pointing signals about the gamma ray, corresponding to the shower deposits in 128×2 strips along the X and Y axis in each of the 20 planes of the detector.

The classification problem consists in reconstructing the gamma ray energy using its complete pattern. A hierarchical neural network classifier is used to solve this problem. At the first level of the hierarchy, a B.P. neural network performes a rough classification into six classes of energy; at the second level, a modified back-propagation algorithm is applied to classify the energy in each of the 6 groups into other 5 or 6 classes. To accurately specify the gamma ray energy, a weighted sum of the output of each activated neuron is finally performed. We used simulated data sets obtained with the Geant 3.15 code to train and test the neural network.

Optimized discriminating parameters have been used as input neurons for the nets. For the B. P. algorithm we considered the following seven functions:

- the total energy released in the calorimeter;
- the total number of hit strips;
- the maximum energy released in one plane;
- the sum of the energy released till the plane with maximum deposit;
- the "length" of the shower, from the interaction plane to the one with maximum deposit;
- the number of hit strips from the interaction plane to the one with maximum deposit;
- the mean width of the shower.

The results of the analysis obtained by the back propagation neural network algorithm have been compared with the classification obtained by classic statistical algorithms. The improvement of the N. N. classifier is evident: the number of correct energy classifications is 30% improved.

A SIMPLE IBM PC/AT MEMORY-MAPPED CAMAC BRANCH INTERFACE.

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An interface between the IBM PC/AT compatible computer and the CAMAC branch is developed. The interface meets most of the requirements of EUR-4600 standard for the multi crate CAMAC system with A-type crate controller. The interface maps 16-bit CAMAC registers onto the PC address space and occupies 8 Kilobytes. The CAMAC operations look like computer memory read/write commands, hence no software driver is necessary. The CAMAC functions are determined by state of the interface internal register. With fixed CAMAC functions the interface allows full throughput of the CAMAC system (up to 2 Mbytes/sec). Time parameters of CAMAC exchange supporting software (written in C and Modula-2) are discussed.

THE HALL EFFECT IN TWO-DIMENSIONAL MHD-PROBLEMS WITH TRANSVERSE MAGNETIC FIELD

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Mathematical models, based on the MHD-approach, are successfully used in solving pure and applied problems in the hot and dense plasma physics, including nuclear fusion and astrophysics. But investigation of some phenomena, e.g. interaction of plasma flows with the electrodes, need more complicated models, because the MHD-equation cannot recognize the electrode polarity. We consider a modified MHD-model, taking into account the Hall effect. It can distinguish among the ion and electron velocities, describes the electric current and magnetic field interaction in the Ohm's law and identifies the current direction relative to electrodes. The MHD-equations with the Hall effect are generally quasilinear, second order, but they degenerate to a first order nonlinear sytem in two-dimensional problems with transverse magnetic field. The paper presents conditions of this system to be hyperbolic (evolutionary) and characteristic velocities in the case of week Hall effect.

The model is realized in investigations and computations of axisymmetric flows in coaxial channels of high-current plasma accelerators with azimuthal own magnetic field. Two regimes of electric current transfer in the channel are considered and analyzed: by electrons and by ions.

Special attention is called to Hall boundary layers along the electrodes. To investigate them the finite high plasma conductivity is entered into the model.

There are obtained in computations steady-state flows with regular current distribution and effective plasma acceleration in the channel, as well as unstable ones with explosion type singularities near the electrodes. The instability is developed in the boundary layers and it reflects a gap between the equipotential boundary condition and the Hall flow nature. Parameter value regions, corresponding to the both flow regimes, are indicated.

A PRACTICAL APPROACH TO SOLVING KINEMATICAL ANALYSIS PROBLEMS HELP OF LOBACHEVSKY VELOCITY SPACE QUASI-CONFORMAL MAPS

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When analyzing kinematics of multiparticle reactions in high energy physics, physicists traditionally use the energy-momentum language. In the same time, as it is well known, velocities in they totality constitute a space (velocity space) having non-Euclidean geometry, namely, Lobachevsky geometry, with the speed of light as the characteristic constant determining space curvature. As it has been shown elsewhere, relativistic kinematics "coincides" with Lobachevsky geometry. It turns out that the language of velocity space can give an additional insight into relativistic kinematics and even into dynamics, because it is the only one conserving *all symmetries* of kinematic information about investigated physical objects.

N.A.Chernikov and E.G. Bubelev have given correspondingly the theoretical and the applied framework that, together, open a way to practical use of this feature. So called conformal and quasi-conformal velocity maps conserve the main reaction's symmetries and permit, in particular, to visualize (in an "half"-invariant form) statistical patterns for partial physical channels as well as kinematic pictures for individual multiparticle events.

The usage of this new point of view on kinematics, apart from the traditional way of thinking, looks perspective. Taking that considerations as the starting point, we try to make this approach constructive.

In this work we use the so called transverse (to reaction axis) map of doubled transverse "half-velocities" and azimuthal angles, based on the known Poincaré conformal mapping, and a new longitudinal quasi-conformal map with the same transverse coordinate and longitudinal rapidity (coinciding with known Feinman variable "y") as longitudinal one.

A first prototype program, based on an early written model Fortran text, is under development now in the Windows 95 environment with the use of the C++ language and the object oriented programming style. The current version of the program is capable to build above mentioned velocity maps for every event providing for the physicist a possibility to settle questions about sought for kinematical symmetries based on visual information.

In the future it will be possible to work with the program interactively forming and verifying statistically compatible hypothesis on qualitative kinematical type of event or/and its likeness to compatible physical reaction channels. Of course, the ultimate functional filling of our program system will strictly depend on the requirements of the working physical groups interested in having such a practical tool.

At the present time our program is at the beginning of its life. The intention is to develop it up to the complete form of a software system product that could be used by a physicist for himself, without the necessity to get every day support from the authors. The program system is to be portable. At least, it is planned to implement also a Unix version of it.

As a preliminary name for this project we take the "LoVelHEP" abbreviation meaning "Lobachevsky Velocity space usage in HEP".

NUMERICAL MODELLING PHYSICAL PROCESSES AND PHENOMENA USING DIFFERENTIAL EQUATIONS WITH HIGHER-ORDER DERIVATIVES

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In many areas of scince and technology the mathematical models of the objects under investigation can be represented as systems of non-linear differential equations containing not only first-order derivatives of the unknowns, but also higher-order derivatives. To solve such equations, one can use the well-developed numerical methods of the Cauchy problem, but the system of higher-order equations must then be reduced to first-order equations, which increases the dimensions of the system. A more serious drawback of this approach is that it cannot be used in cases when the given system of equations is not able to be solved explicitly with respect to the derivatives of the highest order. Existing numerical methods for solving higher-order differential equations are, in principle, applicable to equations of special form. The approach proposed in the report, which is based on polynomial interpolation with multiple nodes, is free from the above drawbacks [1,2].

To solve the equations which make the mathematical model numerical methods are suggested based on the approximation of the unknown variables by interpolation polynomials with multiple nodes. These methods do not require preliminary transformation of the initial equations to those with derivatives of the first order only. When implementing the given methods, the discrete values of all the derivatives are represented in the form of linear combinations of the approximate discrete values of the unknown ones and some of their derivatives found at the previous steps, and the unknown values of the functions corresponding to the current integration step.

The proposed methods are implicit many-step methods which makes it possible to solve systems of equations that are not reduced to normal form, as well as stiff systems of equations. The highest order of the derivatives can be different for each of the variables in eqiations solved by these methods. One can also solve algebraic-differential equations with highest-order derivatives. For these methods there is no characteristic initialization procedure, which is inherent in the majority of multi-step methods and which consists in the fact that so-called "starting points", which can be obtained by another, most frequantly one-step, method, are necessary for the method to work.

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NEURAL NETWORKS AND CELLULAR AUTOMATA FOR PARTICLE IDENTIFICATION AND FILTERING

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Neural Networks are now currently being used in several applications of particle recognition. In this work a neural network is employed to discriminate between different classes particles interacting with a cosmic ray detector. Due to the different and often contradictory behaviors the particles have in their interactions with the detector, the use of boolean logic cuts may result in very complicated algorithms where the purity of the sample is obtained at the expense of a low classification efficiency. The architecture proposed performs particle identification using a stochastic preprocessing to a neural network. Tests were performed on simulated (Geant 3.21) and experimental data obtained with Silicon Tungsten electromagnetic calorimeter, particularly suited for cosmic ray research. The input space consists of two matrixes in which the interaction of the particle in the calorimeter is stored. According to the nature of the particle, different interaction topologies may occur (e.g. electromagnetic or hadronic showers). These different, energy dependent interaction topologies require particle identification algorithms able to take them into account and filtering processes that are able to cope for induced noise.

Noise removal and track restoration techniques have been carried out using Cellular Automata, well known for their versatility and speed. One of the main advantages of these procedures lie in the fact that their are entirely automatic and allow for the same architecture to be used on different particle classes and on different energies.

UNDERGROUND CAVE FORMATION MODELING WITH CELLURAR AUTOMATA

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Underground cave formation is a process mostly due to solution of limestone by water. However, mechanical abrasion of the rocks and tectonic causes, such as faults or stress release, are often of significant importance; in vastly eroded areas there is also the phenomenon of rock collapse which may alter both the underground and the external landscape. In a typical cave it is often possible to recognize the effect of these different causes, from chemical reactions to the collapse of rocks of up to several meters size, taking place over spatial length scales of several orders of magnitude. Due to the phenomena originating its formation, a cave may have greatly varying shapes and size, ranging from the relatively simple vertical pits or underground rivers to majestically large environments of several kilometers, developing on several levels at different dephts. Any attempt to simulate and reproduce some or all these effects must therefore face both the typical computational problems and the complexity arising from the different physical processes involved.

Here a model simulating the formation of caves caused by rock fall is studied: for their simplicity and speed Cellular Automata (CA) have been used. To speed up calculations and to employ a binary state (rock/air) CA, all water erosion processes in limestone have been neglected in the present application: therefore only structures whose formation is due mainly to mechanical causes or where the role of water at a given stage of its history can be neglected are considered. The limestone removal role of water has been assumed to have taken place before the start of the Ca evolution; as initial conditions a percentage $P = 30\%$ of empty (air) sites has been assumed. In our case the two states that each site (or cell) of the binary automaton can assume represent, respectively, the presence (*State 1*) or absence (*State 0*) of rock. Vertical cave profiles were simulated in order to compare them with those of real caves. The evolutionary rules have been devised to take into account gravity and mechanical interaction among nearby rocks. In spite of the approximations used there is a good agreement between simulated and real data.

NOISE FILTERING APPLICATIONS USING CELLULAR AUTOMATA

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Two applications of the noise filtering capabilities of a cellular automaton are analyzed. Due to the "local" nature of the algorithm used (since the status of each cell depends only on the neighboring ones), cellular automata are a powerful tool for removing noise in particle tracks and restore segmented images. The first application concerns on tests carried forth on experimental and simulated events of particle tracks in a segmentec calorimeter. Simulated (noise-free) data show how the c.a. affects very little the track, leaving the physics of the event essentially unmodified. On the other hand, on experimental data, spurious hits are removed and segmented tracks are restored. Discriminating parameter ditributions after filtering are much closer to Montecarlo values. To improve the quality of the filtering and the recognition processes, a different approach may be used to remove one of the limitations of cellular automata, namely the fixed rules that are used to determine the evolution of the cells. This results in some particular noise patterns or track degradations that are not recoverable. With a neural network, however, it is possible to define several evolutionary rules and evolve the start track according to all of them. The NN has the task - at each iteration - to select only the most suitable ones untill convergence. This procedure allows the automata to choose the optimal evolutionary rules and results in a good filtering quality and a higher classification efficiency.

A second application is centered to the image filtering of autoradiographic DNA images: a proper choice of CA rules can be employed to increase the signal to noise ratio and enhance the enzyme bands. After convergence of the system each band receives its own colour and is easily segmented from others. This allows an eased and faster sequencing by either human or automathic methods.

ON THE MODEL OF NONLINEAR 2-D OPTICAL SYSTEM WITH CONTROLLED FEEDBACK FILTRATION [1]

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To describe the light field dynamics in the feedback optical system with the spatial filter we propose the following differential equation of the diffusion type for phase modulation $u = u(t, x, y)$:

$$\tau u_t + u = D\Delta u + K\left(\left|A_0 \exp(i\varphi(x,y))\right|^2 + \left|\sum_{mn} A_{mn}(t) p_{mn} \exp(iq_{mn}) \cos(\pi m x/l_1) \cos(\pi n y/l_2)\right|^2\right),$$
$$t > 0,\ (x,y) \in \Omega = (0,l_1) \times (0,l_2).$$

Which is complemented by initial and boundary conditions:

$$u\Big|_{t=0} = u_0(x,y),\ (x,y) \in \Omega, \qquad \frac{\partial u}{\partial n}\Big|_{(x,y)\in\partial\Omega} = 0,\ t > 0.$$

Here D, τ, K are characteristics of nonlinear medium, $\varphi(x,y)$ is the stationary input phase modulation, A_0 is constant amplitude of input field, $A_{mn}(t)$ are Fourier coefficients of the light field before filtration $A(t,x,y) = A_0 \exp(i\varphi(x) + iu(t,x,y))$, p_{mn} and q_{mn} are amplitude and phase characteristics of filter.

In contrast to the [1] where transverse plane of the light beam $\Omega = R^2$, in our model Ω is the bounded rectangular domain and the right part of our equation is presented by the Fourier series. The problem of input phase-distortion $\varphi(x,y)$ supression by the control of the filter parameters p_{mn} and q_{mn} is posed in the form of extremal problem, which is solved by gradient method. The problem of existence and uniqueness of the solution and its differential propeties are studied.

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[1] encouraged and supported by the grant N 96-01-01001 from the Russian Foundation of Basic Researches

MATHEMATICAL MODELLING OF INVESTMENT PROBLEMS IN ECOLOGY

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Principal problem of the mathematical investment theory is the optimal distribution of funds in objects of the investment or the problem of investment portfolio optimization.

Mathematical models of investment portfolio optimization problems usually are the linear programming problems

$$(\vec{\mathbf{x}}, \vec{\mathbf{a}}) \rightarrow \mathbf{max}$$

$$\vec{\mathbf{f}} - \mathbf{A}\vec{\mathbf{x}} \leq \vec{\mathbf{0}}$$

or quadratic programming problems

$$(\mathbf{w}\vec{\mathbf{x}}, \vec{\mathbf{x}}) \rightarrow \mathbf{min}$$

$$\vec{\mathbf{f}} - \mathbf{A}\vec{\mathbf{x}} \leq \vec{\mathbf{0}}$$

where $\vec{\mathbf{x}}$ is a vector of the distribution of funds in objects of the investment.

In this time the mathematical model of investment portfolio optimization problem in the ecology is the problem of nonlinear programming (nonconvex).

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THE TENDENCIES OF CENTRALIZED COMPUTING AND NETWORKING AT PETERSBURG NUCLEAR PHYSICS INSTITUTE

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This paper is intended to summarize main results in PNPI networking and centralized computing.

The problem of restructuring the computer resources and importance of the networking was recognized at the Institute in 1990 [1].

In January of 1993 we finished with a closing of a range of the old fashion mainframes (ES-1046, ES-1060, BESM-6, etc.).

In May of 1993 we put into operation a first segment of TCP/IP on the base of thin Ethernet (10 Mbit/sec). Total number of all type computers in that network was in limit of 10. At that time we had only way to communicate with the colleagues: e-mail over dial-up telephone line and UUCP.

In March of 1994 we have realized the first Institute IP channel to ITEP (Moscow) and later to NPI MSU (Radio/MSU - Moscow) over switched telephone line ISKRA-2 with channel capacity about 12 Kbit/sec. The network traffic by month over that line is shown in the table ..

Table 1. The External PNPI Network Traffic by Month

Year	Month	Traffic in bytes
1994	March	22,824
	April	51,136,349
	May	127,018,780
	November	250,045,736
	December	506,406,294
1995	April	1,079,912,090
	September	2,684,354,138
1996	January	10,243,529,900

In second half of 1994 we began to build internal institute network structure. First reasonable result came with putting into operation first Institute fiber optic line between two large buildings. Many people obtained the possibility to receive an information from the Internet and many people became interested for the same.

In September of 1995 we installed the satellite IP channel to DESY (Hamburg, Germany) in according to the project INTAS-93-56. That channel gives us 64 Kbit/sec. On the first stage of our network development it was important the support we obtained from DESY in according to the experimental program HERMES [2] where Institute was involved.

Meanwhile internal Institute network structure was developed as well. Already several Institute buildings are connected to the Institute network centre by the fibre optic cables.

In total Institute has about 3 Km FO lines. Everyday Institute IP external traffic exceeds 300 MB (about 1 GB for three days). Approximately 40% of total external network traffic is outgoing from the Institute and 60% of total external network traffic is ingoing to the Institute. Our network is part of Russia High Energy Physics network (RUHEP-Radio-MSU) [3]. More than 300 scientists have an access to the Internet. The Institute LAN consists of more than hundred computers.

PNPI has now several www and ftp servers: main server - "http://www.pnpi.spb.ru/", main ftp server - "ftp.pnpi.spb.ru" and news-server.

We think that an information interchange is the driving wheel for intellectual work of any type. To participate in the information exchange anybody should follow one of the known scenario. There are several scenarios which are supported by appropriate technical tools. I mean the following: e-mail, ftp, www, netnews, telnet, irc, talk, white-board (the component of MBONE [4]), etc. All of them are available in PNPI.

Last time we undertook several experiments with a realization of an audio graphic channel over the Internet. In particular we used satellite 64 Kbit/sec channel PNPI-DESY. It was found out that audio was of acceptable quality. The quality of the video images were less acceptable with low frame rate (about 0.2-0.5 frame/sec).

The obvious Institute requirements in the information area are as followed:

- to increase the IP channel banwidth at least to 128 Kbit/sec;
- to disseminate the consistent information about the Institute scientific works;
- to give the physicists intellectual tools to search the required information in the Internet;
- to build (to adopt) a distributed computing model to analyse the experimental data in remote research centres from PNPI terminals.

Some useful information on PNPI networking can be found in our www-page [5].

All these things gives us the idea that the Institute is an organization for transformation of the information from one form to another one. From this point of view all the data required for the Institute should be in electronic computer readable form. That means main difficulties in computing are in transition from the hardware and software architecture to the data architecture.

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OPERATOR-SPLITTING SCHEMES FOR THE INCOMPRESSIBLE NAVIER-STOKES EQUATIONS WITH CONSIDTENT APPROXIMATION OF OPERATORS

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New implicit finite difference schemes to solve the time-dependent incompressible Navier-Stokes equations using primitive variables and grids of various types are developed in this work. Methods are implemented on non-staggered (colocated), partially staggered (ALE-type) and fully staggered (MAC-type) grids and a comparative study of these grids is conducted. The main feature of the methods is the fact that the discrete equations are essentially consistent with the initial differential equations in operator properties. A priori estimates are derived for the discrete solution of the methods. The estimates are similar to the corresponding ones for the solution of the differential problem and guarantee boundedness of the solution. To handle complicated computation domains, the fictitious domain method was employed.

To evaluate efficiency and accuracy of methods developed, a comparative study has been conducted for the above grids of various arrangement. Three test problems have been predicted in the 2D case: a lid-driven cavity flow, a buoyancy-driven flow in a cavity with insulated top and bottom and side walls of different temperature as well as free convection of a heat-generating fluid. All prediction are performed on the sequence of grids $21 \times 21, 41 \times 41, 81 \times 81$ and 161×161 in order to evaluate asymptotical accuracy of the techniques.

It was found that the method on the fully staggered grid of MAC-type provides much more accurate results in compare with two other grids. In all problems the method on this grid has indicated the second asymptotical order of accuracy.

The methods on the basis of the regularizing operator and second order approximations lead to similar results on non-staggered and partially staggered grids. It is interesting that on a lid-driven cavity flow these methods demonstrate practically the first asymptotical order of accuracy whereas in the problem of a heat-generating fluid there is obtained the second order for both techniques. A possible explanation of this fact is in peculiarities of the pressure for this problem and the fact that the pressure is included into the regularizer.

AN INVERSE PROBLEM OF PARTICLE SIZE MEASUREMENT WITH A LASER BEAM

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New methods of ecology, medicine, veterinary medicine, agriculture and pharmacology demand accurate measurement of size and time distribution function f(r,t) of microscopic particles (e.g., human, animal, or plant cells) at the process of their sticking into clusters. The devices and mathematical methods available now [1,2], do not provide the necessary resolution. They are based on an extraction of f(r,t) from a measured angular distribution of a scattered sounding light (wavelength λ) intensity $I(\theta,t)$

$$I(r,\theta,\lambda) = \int \Phi(r,\theta,\lambda) f(r,t) dr,$$

here $\Phi(r,\theta,\lambda)$ is an individual scattering function for particles r. A simple enhancement of the angular measuring points number Θ (usually, $\Theta < 50$) is not enough.

A method is developed and realized that provides: conservation of the total particles number N, $\partial N/\partial t=0$; the absence of f(r,t) negative values; discrete set of dispersing objects volumes (V, 2V, 3V..., here V is a particle volume); and some other conditions. It is based on an explicit computation of f(r,t) with the least mean squares approximation of the experimental $I(\theta,t)$ and the said conditions (with arbitrary weight factors). For $\Phi(r,\theta,\lambda)$ specification, the traditional simplification ($r >> \lambda$) is not used.

The cycle of computation by IBM PC AT 386 with $\Theta=2700$ provides a real time data processing with the measurement time steps $\Delta t \geq 5$ s, which is sufficient for the applications.

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CALCULATION OF CANONICAL NORMAL DISTRIBUTIONS ON THE GROUP $SO(3)$ AND THEIR APPLICATION

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The orientation distribution function (ODF) of a polycrystalline sample is of special interest in texture analysis, but the ODF is seldom if ever determined in a direct manner. Some integral projections of the ODF (so-called pole figures (PF's)) are measured with the help of diffraction experiments. The mathematical problem of quantitative texture analysis is to calculate the ODF from experimentally obtained PF's. With any sets of PF's the solution of this problem is non - unique. ODF determined from PF's by classical spherical harmonics method can have ghosts effects and regions of negative values which are caused by the loss of information on the "odd" part of ODF. Therefore additional information about ODF structure is necessery. We consider ODF as superposition of the canonical normal distribution (CND)on the rotation group $SO(3)$ [1].

The examples of CND on the group $SO(3)$ and their PF's for quartz are calculated.

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NUMERICAL SOLUTION OF REISSNER–MINDLIN PLATES WITH HIERARCHIC FINITE ELEMENTS

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The Reissner–Mindlin model is widely used for thin to moderately thick plates. Despite its simple formulation, the numerical approximation is not straightforward. When standard low order finite elements are used for the approximation the solution degenerates very rapidly for small thickness (*locking* phenomenon). To overcome such a behavior non standard formulations of the problem are usually combined with low order finite elements to weaken or possibly eliminate the locking of the numerical solution.

In recent years high order finite elements, both as separate elements or in the so-called p version of the finite element method, have been introduced and succesfully applied in several fields, e.g., for elasticity and Kirchhoff plate problems. Following this way we have introduced a family of hierarchic high order finite elements to solve the Reissner-Mindlin problem in its plain formulation. Our numerical results indicate that high order elements are able to strongly weaken the locking phenomenon for a wide range of thicknesses. Based on the suggestions of Refs., we have developed a family of finite element of Serendipity type, i.e., elements with the minimum number of degrees of freedom in order to minimize the dimension of the final stiffness matrix. A natural extension was the addition of a suitable number of degrees of freedom for comparing the performances of the two classes of elements. The comparison between Serendipity and bubble-plus families has shown that, when the error vs. number of degrees of freedom is considered, the latter outperform the former. Moreover, at least for rectangular decompositions, no locking appears for elements of degree $p \geq 3$. The numerical experiences are carried out on classical benchmark problems with distributed load.

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FUNCTION PARAMETRIZATION BY USING 4-POINT TRANSFORMS

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A continuous parametrization of the smooth curve $f(x) = f(x; \mathcal{R})$ is suggested on a basis of four-point transformations. Coordinates of three reference points of the curve are chosen as parameters $\mathcal{R}$. This approach allows to derive a number of advantages in function approximation and fitting of empiric data. The transformations have made possible to derive a new class of polynomials (monosplines) having the better approximation quality than monomials $\{x^n\}$. A behaviour of an error of the approximation has an uniform character. A three-point model of the cubic spline (TPS) is proposed. The model allows to reduce a number of unknown parameters in twice and to obtain an advantage in a computing aspect. The new approach to function approximation and fitting are shown on a number of examples. The proposed approach gives a new mathematical tool and a new possibility in both practical applications and theoretical research of numerical and computationa methods.

USING "TG GSS" DIALOGUE-GRAPHICS PLATFORM FOR PROCESSING THE COSMIC GAMMA-RAY SPECTRA IN CORONAS-I SPACE EXPERIMENT.

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The results of cosmic gamma-ray spectrum processing by means of CASE (computer applied software environment) technology are presented. The gamma-ray spectra are detected by the SONG-instrument (SOlar Neutrons and Gamma-rays) onboard CORONAS-I satellite. This computer technology is an example of screen editing the subject area and software and allows to form the intellectual work station (IWS) for experimental data processing and operating with their graphical imaging.

The particle acceleration, propagation and absorption on the Sun and other astrophysical objects are investigated by the SONG-instrument. One of the investigation methods is analysis of gamma-ray lines formed in nuclear interactions between the accelerated particles and environment matter. Gamma-ray lines are observed from Solar Flares, gamma-ray bursts and in Galactic centre spectrum. These phenomena are detected simultaneously with gamma-ray on-orbit background associated with galactic cosmic ray interactions with Earth atmosphere, spacecraft and detector material.

The IWS for physicist-investigator was created by means of TG GSS platform. The main goal of the IWS is the recovery of gamma-ray spectrum from SONG-instrument data. This recovery procedure includes: gamma-ray background analysis, estimating instrument calibration time dependence, computer searching solar and celestial gamma-ray lines, study of its spectral and intensity dynamics.

The linear-exponential dependence is used as the mathematical model of calibration function approximation. The algorithms of searching and estimating of the resonance inhomogeneities (lines) are based on the original version of methods using the inter-covariance function analysis.

The data processing is realised in the form of expert prepared software metastructures which include, in particular, the data editing and running utilities. The operator has a possibility to check and control the main analysis stages and to get a computer system dialogue. The computer system allows in many cases to avoid the spectrum distortions caused both by external apparatuses and by own instrument electronic curcuits. The IWS possibilities were presented and discussed last year in following centres:

- Navy Research Laboratory, Maryland, Washington DC, USA.
- Marshall Space Fly Centre, Space Sciences Laboratory, Huntsville, Alabama, USA.

КОНЦЕПЦИЯ ФОРМИРОВАНИЯ ОБЪЕМНЫХ СЦЕН НА ОСНОВЕ ЭКСПЕРИМЕНТАЛЬНЫХ ДАННЫХ

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В докладе рассматриваются следующие темы:

1. Топологические классы геометрических объектов, являющиеся элементами пространственной сцены;

2. Экспериментальные данные и способы представления их в форме пространственной сцены;

3. Геометрический объект – интерпретационный символ;

4. Геометрический объект – интегрированный интерфейс управления процессом решения научно-практических задач;

5. Легенда объемной сцены;

Все рассматриваемые темы объединены единой теоретико – конструктивной концепцией, содержание которой в следующем:

1. Основой геометрического объекта является многообразие;

2. Качественные свойства экспериментальных данных обеспечивают установление следующих соответствий:

данные – топологический род геометрического объекта,

данные – топологический вид геометрического объекта,

данные – геометрический тип объекта (тип характеризует метрические свойства объекта);

данные – топологический род, вид и тип объекта.

3. Интерпретация геометрического объекта базируется на парадигме:

метод-средства-нотация.

VISUALIZATION IN RELATIVISTIC STRING THEORY [1]

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Relativistic string is a curve, which moves according to the following principle: a surface spanned in motion of the string through the space-time should have an extreme area. The physical destination of string theory is the description of strongly interacting particles (hadrons), which are treated as strings with character size 10^{-13} cm and tension 10 tons. Strings with smaller size and greater tension are also used in Grand Unification Theory.

Interesting property of classical string theory in the space-time with low dimension (3 and 4) is a presence of topologically stable singular points. Singularities on strings have a form of cusps, where the linear density of energy infinitely increases. In 3-dimensional case cusps behave like point particles on the string they move with a speed of light, scatter or annihilate in collisions, can form coupled states. In 4-dimensional case cusps appear only for one instant, periodically in the same place on the string. These phenomena were described in [1].

In works [2] the exotic sector of classical string theory was considered, containing strings with negative energies and negative square of mass. Such extraordinary phenomena as creation/annihilation of strings in vacuum and ultra-light average motion of system with sub-light motion of parts are observed in this sector.

In the cited works specially developed programs for string visualization [3] were used. These programs generate the images of string evolutionary surfaces and also represent string dynamics as interactive computer film.

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[1] encouraged and supported by the Russian Ministry of Science

ON A VARIANT OF DOMAIN DECOMPOSITION METHOD FOR SOLUTION OF MATHEMATICAL PHYSICS PROBLEMS

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The domain decomposition methods are used widely in the solution of partial differential equations in order to reduce the problem to some separate problems in more simple subdomains. Such methods are especially effective when they are realized on multiprocessor parallel computing systems. Two main approaches are considered in this method. The first one is connected with using implicit difference schemes which are solved by iterative processes like component-wize splitting-up method, alternating direction method and others. The second approach is characterized by constructing noniterative methods directed to nonstationary problems. In both cases it seems most perspective to use multicomponent alternating direction schemes [1,2], which have several advantages in comparison with classical schemes.

In this report the new method of net domain decomposition is suggested. It involves the construction of the explicit iterative schemes with the improved convergence conditions in each subdomains. Multicomponent alternating direction method is used for this goal. By virtue of their intrinsic structure these algorithms do not demand the sweep method and give high degree of parallelizing. Convergence of the iterative procedures are investigated.

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APPROXIMATE FORMULAE FOR FUNCTIONAL INTEGRALS BASED ON INTERPOLATION OF MEASURES

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In this report appoximate formulae for computation of functional integrals with respect to a class of quasimeasures are given. The integrals are defined on a space of functions $X = X[0,T]$ and the quasimeasures have characteristic functional of exponential form with some special symmetric $2p$- linear form as a power.The formulae are based on interpolation of quasimeasure and generalize analogue formulae for integrals w.r.t. gaussian measures [1,2].

More exactly, we exploit the formula

$$\int_X f(x(\cdot))d\mu(x) = \int_X f(x(\cdot))d\mu_0(x) +$$

$$+((2p)!)^{-1}\int_0^1\int_X\int_0^T\overset{(2p)}{\cdots}\int_0^T(B-B_0)(t_1,...,t_{2p})\times$$

$$\times f^{(2p)}(x;t_1,...,t_{2p})dt_1\cdots dt_{2p}d\mu_s ds,$$

where $f^{(2p)}$ is the functional derivative of $f(x)$, $B(t_1,...,t_{2p})$ is the kernel of above mentioned symmetric $2p$- linear form, in order to receive an expansion including integrals on the space $X[0,T/2^l]$ $l=1,2,....$ Here $(B-B_0)(t_1,...,t_{2p}) = B(t_1,...,t_{2p}) - B_0(t_1,...,t_{2p})$, μ_s is the quasimeasure like μ with $B(t_1,...,t_{2p})$ replaced by $B_s(t_1,...,t_{2p}) = sB(t_1,...,t_{2p}) + (1-s)B_0(t_1,...,t_{2p})$. Special choise of the kernel $B_0 = B_0(t_1,...,t_{2p})$ corresponding to μ_0 is used.

The integrated functionals have the form $f(x(\cdot)) = \exp\left\{\int_0^T V(x(\tau))\,d\tau\right\}$ where $V(y)$, $y \in R$, is a sufficiently smooth function. Functional quadrature formulae similar received in [1] are applied to evaluate integrals on $X[0,T/2^l]$.

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CRITICAL-COMPONENT METHOD SOLUTIONS OF ILL-POSED LINEAR ALGEBRAIC EQUATIONS

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In the report, a new effective critical-component method, offered in refs. [1, 2, 3] for the inversion of the C_3-tridiagonal matrices of the general form, and solution of the systems of the linear equations $C_3 \cdot X = Y$; $C_2 \cdot X = f$; $A \cdot X = F$, where C_2 – two-diagonal and A – completely filled quadratic matrices of the general form, is considered.

The analysis of the numerous calculations on IBM (including the known ill-posed matrices C_2, C_3, A) with the use of the new programs created on the base of the algorithms of the critical-component method indicates, that in the case of C_3-tridiagonal, C_2-two-diagonal matrices, these programs generally exceed, in most respects, any of known programs of the similar type. In the case of A-matrices new programs, having generally better precision characteristics, concede only to DEQN – the best program among the known ones of CERNLIB-CERN program library (Short Writeups). Application Software Group Computing and Networks Division. CERN, Geneva, Switzerland (May, 1993).

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ORTHOGONAL WAVELETS ON LOCALLY COMPACT ABELIAN GROUPS

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Let G denote a locally compact Abelian group. We write $L^2(G) = L^2(G, \mu)$ where μ is the Haar measure on G. Suppose that H is a discrete subgroup of G such that G/H is compact and there exists an automorphism A of G such that $A(H) \subset H$. Let us say that a pair (G, A) is admissible if (i) G is metrizable and second countable and (ii) A is continuous and its inverse A^{-1} is a contraction. For this kind of (G, A) the concept of a multiresolution and the semiorthogonal spline wavelets were studied in [1].

Let $s = card(H/A(H))$. Using the concept of QMS-systems (see [2] for the definition), we give the general scheme to constract the orthogonal wavelet bases $\{\psi_i(A^j \cdot -h) | 1 \le i \le s-1, j \in \mathbf{Z}, h \in H\}$ in $L^2(G)$. We show that for the admissible pairs (G, A) our scheme can be realized in the cases related to some recent generalizations (see [3]) of the Schoenberg interpolating theorem and the Shannon–Whittaker–Kotel'nikov sampling theorem. The corresponding generalizations of the classical Littlewood–Paley decomposition will also be presented.

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THE APPLICATION OF THE COUPLED-CHANNEL CODE TO THE NUMERAL ANALYSIS OF THE NUCLEAR REACTIONS WITH RADIOACTIVE BEAMS

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The modified version of the ECIS code [1] is applied to the analysis of the reactions with nuclear radioactive beams. Both quasielastic scattering angular distributions and total reaction cross sections at different energies are under consideration.

The coupled-channel calculations have been performed for the elastic scattering of light exotic nuclei on stable target-nuclei. A fairly good description of the known experimental data [2–5] is obtained within a rather restricted range of the two free parameters for volume and surface absorption. The influence of these parameters on the total reaction cross sections is investigated for different systems. The performed analysis confirms the long neutron tail (halo) in ^{11}Li and supports a rather thick proton skin in ^{8}B and, to a lesser extent, in ^{7}Be.

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ON CORRECTNESS OF THE SYSTEM OF NONLINEAR OPERATOR-DIFFERENCE SCHEME [1]

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We consider the system of nonlinear operator-difference scheme (ODS)

$$\begin{cases} y_t + A\left(\chi^{(\sigma_0)}, \tilde{D}(y,\hat{y})\right) = \varphi(t) \\ \chi_t = P\left(\chi^{(\sigma_0)}, \tilde{D}(y,\hat{y})\right) \end{cases}, \quad t \in \omega_t = \bar{\omega}_\tau \setminus \{T\}, \tag{1}$$
$$y(0) = y_0, \chi(0) = x_0,$$

where $\bar{\omega}_\tau = \{0, \tau, \ldots, T\}$, $(y,\chi)(t) \in H_h = H_{1,h} \otimes H_{2,h}$, $\chi^{(\sigma_0)} = \sigma_0\hat{\chi} + (1-\sigma_0)\chi$, $(y_0, x_0) \in H_h$, and D, A, P are nonlinear operators: $D: H_{1,h} \to H_{1,h}$, $A: H_h \to H_{1,h}$ и $P: H_h \to H_{2,h}$.

Let form $\tilde{D}(y,v)$ be

$$\tilde{D}(y,v) = \int_0^1 D(\sigma_k v + (1-\sigma_k)y), \quad \text{or} \quad \tilde{D}(y,v) = \sum_{k=1}^{q} l_k D(\sigma_k v + (1-\sigma_k)y),$$

where $\sigma_k, l_k \in [0,1]$: $\sum l_k = 1$,

Proved: Let operator D be strong monotone and potential, operators A and P be satisfied of some assumptions of smooth and $A(v,\eta)$ is monotone in η, when arguments of all operators are in locality of some fixed element of H_h. Then there is solution $(y,\chi)(t)$ of ODS (1).

The results on the local correctness of ODS (1) is applied to study the solvability and convergence of special difference schemes for the nonstationary Navier-Stokes problem in Lagrange variables in assumptions of existence of a smooth solution of the differential problem and sufficiently general assumptions on functions which equations contain.

[1] encouraged and supported by Russian Foundation of Basic Research under Grant 9?-01-00400.

SOME DIRECT AND INVERSE PROBLEMS FOR ONE THREE-PARAMETER COMPLEX POISSON DISTRIBUTION

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The direct and inverse problems for three-parameter complex Poisson distribution with generating function

$$P(z;\lambda,\epsilon,k) = exp(\lambda \sum_{\nu=1}^{k}((1-\epsilon+\epsilon z)^{\nu}-1))$$

are solved.

Three probabilistic problems are possed that result in such distribution. Some properties of it are ascertained such as the explisit form of the probability functions P_n and distribution $F(x)$, moment characteristics (cumulants and central moments), recursive relations between them, derivatives of any order of the probability function with respect to continual parameters λ and ϵ .

Direct problems - calculations of $P_n(F(x))$ and of different moment characteristics with given parameters are solved by recursive relations per n and k. The examples of calculations are given as well.

The inverse problems - of point estimation of parameters λ, ϵ and k under sample of the finite size are set and solved. The estimates of the moments method of all the variants of λ, ϵ and k estimation are received and investigated. The asymptotic shifts and the dispersions of the moments method estimates are put down. The system of the equations of maximum likelihood is also put down. In particular case (k=2) one its integral is recieved. The model problem is numerically solved.

NONLINEAR DYNAMICAL MODEL OF EVOLUTION OF A 3-COMPONENT SYSTEM CONSERVING TOTAL NUMBER OF OBJECTS

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A mathematical model, allowing to forecaste the distribution of votes, casted for some candidates to the post, has been studied. The model offered here is a modification of Volterra-Lottka nonlinear differential equation system, and closer to one was used by D.S. Chernavsky et al [1]. Let us considered this problem for simple most and frequently appared situation: to select one of the two candidates, having its groups of supporters at present and remaining voters, who make their decision during the election campaign as a result of interaction of the three groups mentioned. Let us write the equation for the change of number of supporters of groups 1 and 2 for 1 day denotes δa_1 & δa_2 respectively

$$\begin{aligned} \delta a_1 &= \lambda_1 \times a_1 \times (1 - (a_1 + a_2)/A) - \kappa \times a_1 \times a_2, \\ \delta a_2 &= \lambda_2 \times a_2 \times (1 - (a_1 + a_2)/A) + \kappa \times a_1 \times a_2. \end{aligned}$$

The new number of supporters for the next day will be

$$\begin{aligned} a_1' &= a_1 + \delta a_1, \\ a_2' &= a_2 + \delta a_2. \end{aligned}$$

On the plane with orthogonal co-ordinates $a1$ & $a2$ we are looking for the solution in the domain to be an triangle $a_1 \geq 0$, $a_2 \geq 0$, $a_0 \geq 0, (A - a_1 - a_2 \geq 0)$. The solution of the system satisfies

$$\begin{aligned} a_0 + a_1 + a_2 &= A, \\ a_0^{\kappa} \times a_1^{-\lambda_2} \times a_2^{\lambda_1} &= C. \end{aligned}$$

where A and C are constants. There do exist some characteristic regimes of oscillation of number for each group: from near harmonic to relaxational one, and also aperiodic stationary solutions depending on the value of the parameters. Let us note that the model considered differs from the usual dynamical population model "predator - sacrifice" the Malthus - Verhulst [2] and from the equation of chemical reaction in the problem of chemical kinetics due to the fact that in our case the "voters conservation law"(the whole number of objects remain unchanged in the system) fulfills. It is expressed by the constrain equetion and corresponding antysimmetry of the matrix coefficients.

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ДИФФУЗИОННАЯ МОДЕЛЬ ДИНАМИКИ АУКСИНА

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Известно, что в меристемах (зонах деления и формообразования) у растений изменение концентрации ауксина имеет колебательный характер. В настоящее время нет единного мнения о том, какие реальные процессы в растениях вносят основной вклад в возникновение такого режима.

Для описания изменения концентрации ауксина в меристемах нами предлагается диффузионная модель, которая отличается от обычных уравнений "реакция - диффузия" нелинейной зависимостью коэффициента диффузии ауксина и представляет собой квазилинейную систему параболического типа. Кроме этого, в данной модели учтены автокаталитический синтез ауксина и/или его ингибитора [1].

$$\frac{\partial u}{\partial t} = f_{\text{ak}}(u,c) + f_{\text{in}}(u,c) + \frac{partial}{\partial x} D_1(u) \frac{\partial u}{\partial x},$$

$$\frac{\partial c}{\partial t} = g_{\text{ak}}(u,c) + g_{\text{in}}(u,c) + \frac{partial}{\partial x} D_2 \frac{\partial c}{\partial x},$$

где $u(x,t), c(x,t)$ -- соответственно концентрации ауксина и ингибитора,

$$f_{ak}(u,c), f_{in}(u,c), g_{ak}(u,c), g_{in}(u,c)$$

-функции, описывающие процессы активации и инактивации ауксина и ингибитора.

В отсутствии ингибитора решением первого уравнения системы является бегущая волна. В свою очередь, решение второго уравнения системы тоже может являться бегущей волной (типа Колмогорова - Петровского - Пискунова или Зельдовича - Франк-Каменецкого). Данная модель позволяет не только оценить размер меристематической зоны, но и определить вклад модельных компонентов, влияющих на кинетику ауксина.

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QUARK AND GLUON JET SEPARATION USING NEURAL NETWORKS FOR THE SOLENOIDAL TRACKER AT RHIC

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This paper presents an application of the quark-gluon jet separation using neural nets for the RHIC STAR Detector. The discrimination is possible due to the difference of the branching of quarks and gluons according to QCD. That displays in visible variables such as the part of momentum, which carries the leading particle of the jet, the jet "width" and the number of particles in jet cone.

Picking out of the following processes (as qg → qg) in polarized protons will help to obtain information on the gluon spin distribution.

Jets were generated with PYTHIA subprocesses $f_i f_j \rightarrow f_i f_j$ and gg→gg with $-.6 \leq \mathrm{abs}(\eta) \leq .6$ and range off allowed $\hat{m} = \sqrt{\hat{s}} \in [60.,80.]$ GeV for interacting partons.

For each event were selected charged particles (that can be detected by TPC) and π^o (which can be calculated using energy deposition by γ in electromagnetic calorimeter) with $P_T \geq 0.5$ GeV. Jets were recognized by a cone-type jet-finding algorithm. If transverse energy of jet is greater then 20 GeV, and $\eta_{jet} \in$ [-0.6,0.6] the jet was accepted for future consideration. In total, 9000 jets of each type were generated; 7000 of them were used for training and 2000 for test purpose.

Our strategy was to use such variables that describe jet, az a whole object. The main information for neural network is the concentration of the jet energy - number of particles N_C needed to collect significantly large part E_C of jet energy. Three values of E_C - 60% , 80% and 90% were used. The jet transverse energy, the minimum and maximum second moments of the jet in $(\phi - \theta)$ plane, and the part of the energy in XY semicircle, which belongs to jet, we also use as input variables When input variables have essentially different magnitude the network concentrates at the variable with the largest one, and hardly learns the others. To prevent such defect all input variables were moved to a "flat" form $X = \frac{\int_{x_{min}}^{x} dx}{\int_{x_{min}}^{x_{max}} dx}$

The neural network was the feed forward type with 7-10-1 architecture in JETNET package frame. After 60 epoch of training the probability of the correct identification of the jet type reaches 75%.

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STABILITY CRITERION FOR DIFFERENCE SCHEMES WITH VARIABLE WEIGHTS FOR 2-DIMENSIONAL HEAT CONDUCTION EQUATION.

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The difference scheme with variable weights is studied for equation

$$\frac{\partial u}{\partial t} = \frac{\partial}{\partial x_1}\left(k_1(x_1,x_2)\frac{\partial u}{\partial x_1}\right) + \frac{\partial}{\partial x_2}\left(k_2(x_1,x_2)\frac{\partial u}{\partial x_2}\right)$$

with first type boundary condition in $G(0 < x_\alpha < l_\alpha, \alpha = 1,2)$. The rectangular nonuniform grid are supposed for space variables and constant time step. The stability criterion of difference scheme is obtained with respect to initial data. We formulate theorem here for case $k_1 \equiv k_2 \equiv 1$ and uniform grid with steps h_α in the direction of $x_\alpha, \alpha = 1,2$ for the sake of brevity. The difference scheme

$$\frac{y_{ij}^{n+1} - y_{ij}^n}{\tau} = \sigma_{ij}\Delta_h y_{ij}^{n+1} + (1-\sigma_{ij})\Delta_h y_{ij}^n, \qquad (1)$$

$$(i,j) \in \omega, \omega = \{(i,j) | i = 1,2,...,N_1 - 1, j = 1,2,...,N_2 - 1\},$$

$$y_{ij}^n = 0, (i,j) \in \partial\omega, n = 0,1,...$$

has been studied where Δ_h is five–point Laplace operator, $y_{ij}^n = y(x_1^i, x_2^j, t_n), x_1^i = ih_1, x_2^j = jh_2, t_n = n\tau$.

Let us associate with scheme (1) the eigenvalue problem

$$\gamma_1(\mu_{i-1j}y_{i-1j} + \mu_{i+1j}y_{i+1j}) + \gamma_2(\mu_{ij-1}y_{ij-1} + \mu_{ij+1}y_{ij+1}) +$$

$$+(q - 2(\gamma_1+\gamma_2)\mu_{ij} - 1)y_{ij} = 0, \ (i,j) \in \omega, \qquad (2)$$

$$y_{ij} = 0, \ (i,j) \in \partial\omega,$$

where $\gamma_\alpha = \tau/h_\alpha^2, \alpha = 1,2, \mu_{ij} = \sigma_{ij} - 0.5$.

Let us denote by $\|y^n\|$ the grid L_2–norm of y_{ij}^n.

T h e o r e m 1. *If scheme* (1) *is stable in some norm, then all eigenvalues of the problem* (2) *are nonnegative. Conversely, if the minimum eigenvalue of problem* (2) *is nonnegative then the inequality*

$$\|\Delta_h y_{n+1}\| \le \|\Delta_h y_n\|, n = 0,1,...$$

takes place, so that scheme (1) *is stable.*

The solution of the problem (2) can be obtained in explicit form only for some special sets of σ_{ij}. In the general case the smallest eigenvalue of the problem (2) can be calculated numerically.

ABOUT THE METHOD FOR A SUBAPERTURE TESTING INTERFEROGRAM REDUCTION

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For a long time was clearly, that the shape of an optical surface can be controlled by several interferograms representing overlapping parts of the same surface, and the technique of determination of the shape was correct in the beginning [1,2]. For this, there was required to minimize the deviation of the polinomial approximation from a whole data set by varying of a set of coefficients, relating to the shape of a surface, and sets of coefficients, relating to orientations of a surface at different measurements. However in the beginning of the 1980's this algorithm was replaced faulty. On the basis of formal-mathematical reasons the authors [3-5] etc. have omitted the necessary requirement of an overlapping of the measuring areas. Basis of their reasons was that the Zernike polynomial, the radial part of which is present a combination of degrees of a radius-vector, on a greater circle is presented by a combination of the Zernike polynomials with degrees, not exceeding an initial maximum. If the real surface was really presented precisely by a combination of finite set of polynomials, and if there was not measuring errors, this conclusion was justified. But the shapes of real mirrors are not analytical functions and are not described precisely by the finite polynomial sets. Therefore the mutual connection of slopes of the parts of the surface, testing in different measurements, can not be confidently established by the continuation of approximation of one area to another. Second, it is required more polynomials for approximate of the greater area than for approximation with the same accuracy of the smaller area, but the authors of a "modernized" method take these numbers equal on the mentioned above basis. So, the error occurs because of mixing of analytical properties of the approximation and of the real surface.

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TWO-DIMENSIONAL STEFAN PROBLEMS IN GROUND FREEZING AND RELATED TOPICS.

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The lecture is aimed to review an effective technique developed recently for solving the problem entitled and to study in detail the physical effects which appear during the solidification of liquid under the hydrodynamic field. The main efforts will be directed to analysis of two dimensional one-phase Stefan problems (dendrite growth in porous media or in the Hele-Shaw cells and so on) and peculiarities of limiting two-phase free boundary problems.

The problem admits a formulation in terms of non-local Löwner-Kufarev type PDE for analytical functions which gives a useful tool for study the nontrivial effects. We shall show that mathematical formulation of some physical problems coincides with that of the well known Hele-Shaw problem, in particular, the evolution of solitary dendrite is described by the Polubarinova-Galin equation.

Two-phase problems can be also reduced to a system of nonlinear equations of the same kind, however the straightforward mathematical analysis of such problems becomes hindered. At the same time, in most physically interesting situations the problems mentioned above have steady limiting statement in terms of free boundary problems. Fortunately, these free boundary problems are reduced to some boundary value problems for analytic functions and can be effectively solved by technique of the boundary integral equations. We shall demonstrate in detail the methods proposed.

CALCULATIONS OF ENTROPY AND CRITICAL PHENOMENA BY MONTE CARLO METHODS [1]

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Calculations of Entropy and Critical Phenomena are challenging problems in computational physics, which have attracted the attention of many researchers. We have proposed histogram Monte Carlo simulation methods (HMCSM) [1, 2, 3, 4], which are useful for solving these problems. There are two versions of the HMCSM: simple sampling (SS) [2, 5] and important sampling (IS) [3, 4]. Our SS-HMCSM is simpler than our IS-HMCSM; it may be applied to random percolation models on very large lattices and correlated percolations corresponding to spin models or hard-core particle models [6, 7] on not too large lattices. Our IS-HMCSM may be applied to correlated percolation on large lattices and it is still simpler than the method of Ferrenberg and Swendsen [8]. Our HMCSM may be applied to calculate very accurate entropy of phase transition models with relatively little effort. The HMCSM may also be combined with a percolation renormalization group method [9] to obtain very accurate critical point, critical exponents, and thermodynamic order parameter of phase transition models [1, 5]. Recently, we applied our HMCSM to calculate the existence probability E_p, the percolation probability P, and the probability W_n for the appearance of n, $n = 1, 2, \ldots$, top to bottom percolating clusters on finite square (sq), planar triangular (pt), and honeycomb (hc) lattices. Here $E_p(G,p)$ is the probability that the system percolates and $P(G,p)$ is the probability that a given lattice site belongs to a percolating cluster. We found that, by choosing appropriate aspect ratio for each lattice and nonuniversal metric factor for each model, E_p, P, and W_n for six percolation models on planar lattices have universal scaling functions [10, 11, 12, 13].

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AN APPLICATION OF TOEPLITZ MATRICES FOR QUANTUM CHEMISTRY PROBLEMS

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Nowadays the one of significantly problem of quantum chemistry is a search of global minima of interaction of two or more atoms. There are many methods for the different conditions and properties of atomic systems which applied to solve this problem.

So general and at the same time significantly accurate methods based on Hartree–Fock equations of Density Functional Theory are reduced to solution of variational problem for nonlinear operator. It leads to nonlinear polinomial eigenvalue problem.

Good selection of basis for this variational problem is the open question now. At the present a widely used basises are based on particular solutions of Schroedenger equation. However, in the cases the problem have two or more too proximal eigenvectors corresponded to lowest eigenvalues it is necessary to strongly increase the total number of basis functions. It leads to computational costs to K^4 times for an extension of basis to K times.

It is suggested an approach with regular basis set. The problem becomes so lattice-ordered and some special computational methods should be used. Thus nonlinear eigenvalue problem might be represented in matrix terms as finite sum products of toeplitz and sparse band matrixes. Only taking into consideration mentioned above properties yields the reducing a computational cost of each iteration more then hundreds and thousands times. So a dependence of the computational cost increases as about $K \log_2 K$ times where K is the total number of basis functions. Moreover in some particular cases this nonlinear eigenvalue problem might be reduced to a problem for linear equation system with several right hand sides. The total size becomes nonsignificant greater (only to constant times).

This approach was tested on several examples for determine an interaction of atoms in crystalline lattice for widely used chemical systems. Good results of accuracy was obtained.

RADIO WAVE PROPAGATION IN NON-HOMOGENEOUS SPACE WITH ROUGH INTERFACE BETWEEN TWO MEDIA

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We consider the practical problem of the diffraction of the electromagnetic field which coming into existence when radio-locating sounding of the sea water. The dependence between the reflected electromagnetic field and the configuration of the reflected surface is investigated.

The most burning problem for practical applications is the inverse problem, that is reconstruction of the electrodynamic and geometric parameters of the earth's surface in question by the measured characteristics of the reflected electromagnetic field. To solve the inverse problem of the determination of the parameters of the reflected surface it is necessary to have the effective numerical solution for the direct problem.

The direct problem is limited to problem in which the surface impedance concept is applicable. The surface impedance concept is appropriate when the tangential electro-to-magnetic field ratio at the boundary is approximately independent of the particular excitation, as in the case of propagation over good conducting earth. At the interface between the two media which is suitable for sea water we impose the exact boundary conditions for electromagnatic fields.

The mathematical statement of the direct problem is the solution of Maxwell's equations in the half-space with unregular boundary. The boundaries under consideration may be periodic in one direction or unperiodic. These boundaries assumed to be cylindrical and either conducting or the interface between two semi-infinite media characterized by permittivity and permeability.

The vector electromagnetic problem for these boundaries is reduced to two separate scalar problems corresponding to E- and H- polarization respectively. The diffraction problem is reduced to the sistem of integral equations. We constructed the numerical regularization algorithm based on explicit representation of the logarithmic singularity contained in the equation kernels and to study the reflect field for the different electrodynamic parameters.

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METHODS AND SOFTWARE FOR SPACE ALIGNMENT OF COORDINATE DETECTORS [1]

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The contemporary position-sensitive detector modules allow to register the coordinates of a point of a particle trajectory in its own local system of coordinates. It is necessary to determine the parameters of the corresponding transformation for integrating the measuring modules into the unified system for registration of the trajectory information. The results of the geodesy measurements and of the particle trajectory registration (the special test-calibrated and working physics information) are used as the initial data. The mathematical model of the problem (an overdetermined system of the nonlinear algebraic equations taking account of the stochactical nature of the initial data) is formulated in the report and the method for the decision of this problem is described. The application of the geometrical corrections improves the precision of the trajectories and events parameters estimation and radically decreases the statistical errors of the first and second kind at all stages of the trajectory information recognizing and analyzing.

The program CORPAR is based on the algorithm considered. Several dynamically selected regimes, each of which allows the external parametric tuning, were realized. It is possible to determine the angular and linear corrections for a local coordinates systems. The program CORPAR is a component of the software for experiments carried out on the EXCHARM spectrometer on the 70 GeV accelerator (Protvino, Russia). The results of the discrete detectors (MWPC) geometric parameters definition are used for simulation, mathematical processing and physical analysis of experimental information.

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[1]encouraged and supported by the Russian Fund for Fundamental Research Grant N 95-01-00736, N 96-07-89190

ПАРАЛЛЕЛЬНАЯ СИСТЕМА ДЛЯ МАССОВОЙ ОБРАБОТКИ ЭКСПЕРИМЕНТАЛЬНЫХ ДАННЫХ (ПАРИС-96) [1]

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Разработка эффективных методов и средств обработки данных экспериментов в физике высоких энергий должна прямо учитывать циклопические объёмы экспериментальных данных, требующих огромного количества вычислений. Например, в цикле экспериментов EXCHARM (У-70, Протвино) для обработки одного файла данных, регистрируемых в течение 18-20 минут реального времени, только для первичной обработки требуется около 10 часов процессорного времени на самой мощной UNIX-ЭВМ общеинститутского пользования. Одно из направлений повышения производительности и эффективности систем массовой обработки связано с распараллеливанием процесса обработки.Именно этот подход положен в основу создания ПАраллельной Расширяемой Интегрированной гетерогенной Системы (ПАРИС-96). Основой параллелизма в рассматриваемой системе является распараллеливание данных. Создаваемая система включает различные компьютеры под ОС UNIX, связанные через сеть ETHERNET (ПЭВМ, локальные рабочие станции, централизованные компьютеры). Кластер ПАРИС создается по схеме клиент/сервер. Сервером является выделенный компьютер под ОС LINUX, предоставляющий клиентам(рабочим макромодулям) такие ресурсы, как общее дисковое пространство и программу-монитор для доступа к очередям ввода/вывода данных. Управление всем кластером локализовано на сервере. Клиенты используют собственный ЦП для обработки информации, а данные берут с сервера. Запуск удаленных заданий на компьютерах-клиентах производится автоматически специальной резидентной программой, которая выполняется на сервере. Все устройства внешней памяти (стримеры типа EXABYTE) подключены к серверу, поэтому гигабайтные информационные потоки локализованы. Макромодули системы благодаря их мультипрограммности могут использоваться в интерактивном режиме для мониторинга, анализа данных , подготовки программ и т.п. на фоне прохождения основного процесса-автоматической массовой обработки данных. Основные свойства системы: высокая производительность; масштабируемость; невысокие запросы ресурсов рабочих модулей (интенсивно используется только ЦП); возможность использования удаленных ЭВМ, так как интенсивный обмен с внешними носителями локализован внутри сервера; высокая надежность; высокий уровень автоматизации.

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FAST COMPUTATIONS WITH DISCRETE POINCARÉ-STEKLOV OPERATORS FOR THE BIHARMONIC AND LAMÉ EQUATIONS.

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Fast iterative solvers for the first biharmonic boundary value problem (BVP) and for the Lamé equation are presented. A biharmonic BVP is solved by the conjugate gradient (CG) method with spectrally equivalent interface preconditioner based on an almost optimal algorithm of a matrix-vector multiplication for the matrix which corresponds to the discrete biharmonic Poincaré-Steklov operator [3]. This algorithm was applied to solving the two-dimensional Lamé equation. For a particular harmonic BVP, the cascadic CG[4] and CG with the multilevel preconditioner on the refined interface [1, 2, 5] are used. Results on comparative analysis of both algorithms and computing tests are presented.

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B-CONVERGENCE OF L-DECREMENTED *ROW* METHODS. [1]

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Many applied problems lead to the *Stiff Ordinary Differential Equations* (SODE) systems. Among them there are chemical-kinetic problems, transitional processes in electrical circuits and some other problems, for example, heat conduction and diffusion problems which can be transformed to SODE by method of lines. These applications are very important, therefore a lot of special methods and program codes (such as *BDF*- and *ROW*-methods, Gear code, LSODE, ROS4 *etc*) were produced by different authors. But most of these methods and codes are insufficiently universal and need considerable expenditures for adoption to problems of different types.

ROW methods, which will be discussed, seem to be more efficient in comporison with Rosenbrock schemes with complex coefficients and IRK ones because they use only real arythmetic, do not need iterations and Richardson extrapolation for the error estimation and time step control. There are found some schemes which allow to make an exact calculation of the main term of truncation error (and time step evaluation) and satisfy to additional properties of A-stability and L-stability.

There was done theoretical and numerical investigations of B-convergence this methods on typical model problems usually used in ODE theory (Kaps, Prodero-Robinson, Van der Pol problem). There was shown that effective order of B-convergence of L-decremented shemes is at least just the same as for DIRK methods while the real accuracy is better.

[1]encouraged and supported by grants of RFFR N94-01-01618, N94-01-00490A and Minestry of Science of Russian Federation.

DERIVATIVES OF THE DIGAMMA AND COTANGENT FUNCTIONS FOR RATIONAL ARGUMENTS

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It is well-known that, for rational arguments $x = p/q$, the digamma function $\psi(x) = d\log\Gamma(x)/dx$ can be expressed in terms of trigonometric functions and logarithms. This is a classical result which goes back to Gauss.

Using properties of the polylogarithm function $Li_n(z)$ on the unit circle, in particular the inversion formula which relates $Li_n(z)$ to $Li_n(z^{-1})$, it is shown that the higher derivatives of $\psi(x)$, i.e. the polygamma function $\psi^{(k)}(x)$, can be expressed, for rational arguments $x = p/q$, in terms of trigonometric functions and the Clausen function $Cl_{k+1}(\pi x)$ for rational $x = j/q (0 \le j \le q-1)$. The formula for $\psi(x) (k = 0)$ is then a special case.

With the help of the reflection formula for $\psi^{(k)}(x)$, which relates $\psi^{(k)}(p/q)$ and $\psi^{(k)}(-p/q$ via the higher derivatives of the cotangent function $\cot\pi x$ for rational $x = p/q$, formulae for the values of $\psi^{(k)}(p/q)$ in terms of trigonometric function and Bernoulli numbers are established.

By using these results and certain special values of the Clausen function, the even derivatives of $\psi(x)$ for $x = \alpha$ and $x = 1-\alpha$, where $\alpha = \frac{1}{6}$ and $\alpha = \frac{1}{3}$, are shown to be expressable in the form

$$\left\{ \begin{array}{c} \psi^{(2k)}(\alpha) \\ \psi^{(2k)}(1-\alpha) \end{array} \right\} = -r_1\zeta(2k+1) \mp r_2\sqrt{3}\,\pi^{2k+1},$$

where $\zeta(n)$ is the Riemann zeta function and $r_1 > 0$, $r_2 > 0$ are rational numbers which depend on α and k; in particular r_2 is a weighted sum of Bernoulli numbers $B_{2h}\,(0 \le h \le k)$.

In this context, formulae for the derivatives $\psi^{(k)}(x)$ at $x = \frac{1}{4}$, $x = \frac{3}{4}$ are given in terms of Bernoulli numbers, Euler numbers, the Riemann zeta function $\zeta(2k+1)$, and the related series of reciprocal powers of integers $\beta(2k)$.

Finally, by using certain of the values of $\psi^{(k)}(p/q)$ so obtained, a few special cases of the generalized hypergeometric function ${}_{q+1}F_q((a), b; (a+1); 1)$ with rational $a, b \in Q$ are given in closed form.

THREE–BODY RESONANCES IN FRAMEWORK OF THE FADDEEV CONFIGURATION SPACE APPROACH

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The present work (see details in [1]) is devoted to developing a numerical algorithm to search for three-body resonances on the base of recently found explicit representations [2] for the three-body T-matrix in unphysical energy sheets as well as analogous representations for the scattering matrix and resolvent. Our method is based on a statement following from the representations [2], that three–body resonances in an unphysical sheet Π_l are actually those values of energy z for which a suitable truncation $\mathbf{S}_l(z)$ of the total scattering matrix $\mathbf{S}(z)$ considered in the physical sheet, has eigenvalue zero.

In the work we utilize a code based on the finite-difference algorithm [3,4], for computations of s-state *nnp* resonances situated in the unphysical sheet $\Pi_{(0,1)}$ connected with physical one by crossing the spectral interval $(E_d, 0)$ between the deuteron energy $z = E_d$ and breakup threshold $z = 0$. We solve the two–dimensional Faddeev integro–differential equations [4] with $(2 \to 2, 3)$ asymptotical boundary conditions at complex energies z and extract the scattering matrix truncations $S_{01}(z) = 1 + 2ia(z)$ with a, the amplitudes of elastic *nd* scattering in the physical sheet. The *nnp* resonances in the sheet $\Pi_{(0,1)}$ are searched for just as the roots of the function $S_{01}(z)$. The algorithm developed is also applied to search for the resonances in a model three-boson system [1].

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TRANSITIONS FROM PERIODIC TO GLASS-LIKE STRUCTURES IN FOAM SATURATED CAPILLARIES

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The problem of foam distribution in porous media exites interest due to wide applications of foams in different technologies, begining with oil and gas recovery and ending at medicine (Hanssen, 1992; Kovscek and Radke, 1994). It is found (Hanssen, 1992; Kovscek and Radke, 1994) that a foam-saturated sample can withstand a finite pressure differential in the absence of motion, if all active channels are blocked by foam lamellae. This issue is of interest for better understanding of initial penetration of the externally applied pressure difference into a porous sample saturated by gas and foam.

If compressibility of the gas in bubbles is not accounted for, to increase the pressure by a factor of Δp in a sample with macroscale L it is required to overcome the very large capillary barrier $\Delta p \approx \sigma L/r^2$, where σ is the surface tension and r is the pore size. The experimental values are essentially lower than this estimate. It turns out that allowance for the gas compressibility offer a clearer view of how the capillary barrier is broken. Notice, that the mathematical statement of the problem is close to that of the problem of the critical field determination for vortex creation in a Josephson superconductor (Hansen and Lindelof, 1984; Kornev, 1995).

We consider the 1D model of foam in porous medium as a bubble chain immersed in capillary with wavy crossectional area. The model is close to the Ulam mapping and the problem of determination of the critical pressure drop required to shifting the bubble train is reduced to analysis of transition regular-chaotic regime for this mapping. Using the computer experiment based on the theory of dynamic system we find the critical pressure drop as a function of input parameters such as surface tension, gas compressibility and number of lamellae in train. Conditions for transition from periodic to glass-like distributions of foam lamellae is found and comparison with existing experimental data is presented.

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MODELLING OF TOROIDAL PLASMA EQUILIBRIUM EVOLUTION WITH ACCOUNT OF NON-OHMIC CURRENTS [1]

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The work is devoted to mathematical modelling of phenomena in toroidal systems with magnetic plasma confinement, such as tokamaks.

In "quiet" regimes the tokamak plasma is in a near-equilibrium state. This state, however, does not remain unchanged. On the one hand different plasma processes lead to a slow rearrangement of magnetic field, by changing the pressure and current, and on the other hand these plasma processes are themselves influenced by the magnetic field. Thus there is self-consistent evolution of the plasma column and its gradual transition from one quasi-equilibrium state to another.

Most existing models give either too general a formulation, which is very difficult to implement, or concentrate on one or other particular aspect of the problem, ignoring the others. In particular they do not allow accurate self-consistent description of some important phenomena, such as externally driven non-ohmic currents.

The problem of toroidal plasma equilibrium evolution with account of non-ohmic currents is considered. With the help of a special choice of phase space variables and the introduction of special unknown functions, the problem is reduced to the coupled solution of (i) the system of two, strongly non-linear equations involving the partial derivatives for the magnetic field and (ii) the system of four non-linear transport equations that determine the evolution of quantities like the spatial distribution of plasma pressure. The mathematical formulation of the problem is given with discussion of its specific features. A complicated numerical algorithm was developed, and the code SCoPE was written to solve the problem. Results of numerical modelling for tokamaks plasma of different geometries are presented. It is shown that the intrinsic pressure-gradient-driven currents can play an important role in the evolution process. In particular, these currents can lead to the current density being greatest away from the plasma centre, which may indicate how improved plasma confinement regimes could be obtained.

Formulation and solution of the current profile control problem using external current-drive systems is presented. Examples of maintaining a given radial profile in the case of strong time-variation of plasma parameters are given.

An eventual aim of replacing transport equations with more accurate kinetic (Fokker-Planck) equations is discussed.

[1] The UKAEA work was jointly funded by the UK Department of Trade and Industry and by Euratom.

THE NUMERICAL METHOD OF SOLVING CHARGED PARTICLES MOTIONS FORMATION PROBLEM

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The charged particles motions formation in axially simmetric magnetic field in accordance with the preassigned velocities field is considered. The problem of magnetic field finding, initiating the preassigned charged particles dynamics can be reduced to the solving of Goursat problem for the system of quasi-linear differential equations of the first order [1]. We consider the way of solving this system on the base of characteristic method. For the construction of numerical solution of Goursat problem we substitute the differential equations of characteristics for corresponding finite difference equations. The problems of characteristics network construction, those of initial conditions choice are discussed. The algorithm and the formulas for calculation of magnetic field components, providing needed particles dynamics are proposed.

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NUMERICAL SOLVING OF THE TRANSPORT THEORY INVERSE PROBLEMS BY CONJUGATED FUNCTIONS.

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The statement of the transport theory inverse problems for the reconstraction of environment characteristics and independent source distribution function is considered.

Conjugates equations relatively mesured values of the leaving radiation stream on a boundary environment are used [1], [2].

Continious establishment approaches and discrete iterative analogues are suggested for a numerical solution of linear and nonlinear transport theory inverse problems.

Analysis of the stability and the precision of constructed numerical algorithms are carred out.

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NONLINEAR WAVES IN ACTIVE – DISSIPATIVE DISPERSIVE MEDIA

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Nonlinear waves which are described by the generalized Kuramoto-Sivashinsky equation are considered [1-2]. It is shown that this equation does not pass the Painleve property and It can not be integrable in the general case. The exact solutions in the form of solitary waves, kink-shaped waves and cnoidal wave are presented at concrete values of parameters of problem. To study the nonlinear waves in the much more general cases the difference equation are used. Numerucal results of interaction of solitary waves with another solution are discussed. It is observed that the solitary wave which describes by exact solution, interact elastically with other disturbances and behaves like a solution. Therefore the generalized Kuramoto-Sivashinsky equation has the soliton-like solution, but only one. However another disturbance alters with time and its amplitude increases. The process of increasing takes place independently of the solitary wave in active-dissipative dispersive media at different initial condition. Other peculiarities of solitary waves were investigated. The evolution of the periodical solution in the model also is considered. Formation of a row of saturated soliton like pulses in nonlinear system have been observed.

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THE NEW ANALYTIC TOOLS OF THE SPASE R^n

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The concept of *R^n-structure*, which includes the strongly nonsingular symmetric matrix A, the indecomposable Hessenberg matrix T and the system of biorthogonal polynomials, is introduced. The biorthogonality nodes are eigenvalues of matrix T and the column space the triangular matrix R ($A = R^T R$) is the Krylov space, generated by the matrix T. R^n-structure has only $n(n+3)/2$ degrees of freedom.

The matrix T is symmetrix and the biorthogonal polynomials are ortl ogonal in especially important case of positively definite Hankel matrix A (*Hankel R^n-structure*). The number of freedom's degrees is reduced to $2n-1$. It is proved that the oscillation system with n degrees of freedom is involved in Hankel R^n-structure with positively (semi-)definite matrix T.

The new properties of Hankel R^n-structure are obtained. The conception of complementness for Jacobi matrix is introduced. It's connected with representation the system of polynomials as a function of two variables, one of which being integer. The class of pseudoorthogonal polynomials is described also. These polynomials have a single real roots that is supported by weak separation of the roots of neighborhood polynomials. The ordering waights of pseudoorthogonal polynomials have one change of sign.

АЛГЕБРАИЧЕСКИЕ АЛГОРИТМЫ ДЛЯ ЧИСЛЕННОГО РЕШЕНИЯ ОДУ ВТОРОГО ПОРЯДКА С ПОЛИНОМИАЛЬНЫМИ КОЭФФИЦИЕНТАМИ

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Численный расчет решений линейных уравнений второго порядка с полиномиальными коэффициентами (имеются особые точки как регулярные, так и иррегулярные сводятся (точно!!) к решению разностных уравнений, эквивалентных исходным дифференциальным уравнениям. Граничные условия для разностных уравнений ставятся в соответствии с тем, какого сорта решение дифференциального уравнения разыскивается. Это может быть решение, заданное своим предельным поведением в особой точке, это может быть решение Флоке, сохраняющее свой характер при обходе особой точки, это может быть собственная функция задачи Штурма-Лиувилля, заданная своим поведением в двух особых точках. Основной упор делается на собственные функции задач Штурма-Лиувилля.

Переход к разностным уравнениям производится разложением в ряд Тэйлора по степеням независимой переменной решений предварительно "подготовленной" дифференциальной задачи.

Предлагаемый метод включает

- Преобразование интервала рассмотрения либо в [-1,1] либо в [0,1] без каких либо иных особых точек кроме, возможно, концов интервала, внутри единичного круга.
- Преобразование заменой зависимой переменной исходного дифференциального уравнения к форме, где искомые решения имеют конечные пределы в граничных точках интервала.
- Преобразование дифференциального уравнения в разностное уравнение для коэффициентов ряда Тэйлора, представляющего решение.
- Постановка и исследование граничной задачи для разностного уравнения, эквивалентной исходной задаче Штурма-Лиувилля. Доказательство сходимости ряда Тэйлора
- Обрезание разностного уравнения, что приводит исходную задачу в матричный вид с ленточной матрицей.
- Численное решение линейной алгебраической задачи стандартными для ленточных матриц методами.

В качестве примеров специфических вариантов реализации метода рассматриваются биконфлюентное уравнение Гойна, дважды конфлюентное уравнение Гойна и триконфлюентное уравнение Гойна. Первое и третье из этих уравнений используется для моделей в квантовой механике, второе уравнение в теории черных дыр.

ON ILL–POSED MIXED PROBLEM FOR LAPLACE EQUATION

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The problem of analytic continuation of stationary temperature field in cylinder from its base may be reduce to ill–posed mixed problem for Laplace equation with Cauchy data on the base of cylinder. Stable solution may be obtained with reduction to integral equation of first kind and application of Fourier method and Tikhonov scheme.

USING APS TECHNIQUE FOR APPLIED MATHEMATICAL ANALYSIS PROBLEMS

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The Algebraic Programming System APS, developed in Glushkov Institute of Cybernetics, is based on rewriting rules mechanism. However, in distinction from traditional approach, it is possible in APS to combine arbitrary systems of rewriting rules with different strategies of rewriting which may be specified explicitly by means of procedural definitions. The separation of equational definitions in the form of rewriting rules from the strategy of rewriting essentially extends the possibilities of rewriting technique enlarging the flexibility and expressibility of it.

The APS integrates four main programming paradigms (procedural, functional, algebraic and logic) by adjusted use of corresponding computational mechanisms. This approach allows the algebraic specification environment for a large class of mathematical problems. The well-developed theory of algebraic computation may be successfully applied to the algorithms which are expressed by means of rewriting rules.

The APS basic tools for computer algebra computations were used for analytical research of applied mathematical analysis problems. In particular, modification of Dzyadik method for solving Cauchy problem for linear differential equations with a polynomial's coefficients LDEPC (LDEPC with a singular point) and LDEPC with algebraic nonlinearities is developed in this methodology.

Especially, the advantages of APS-approach appeared in implementation of Buchberger's algorithm. This one with a set of different heuristiques has simple and expressive algebraic programming representation.

Some more efficient programs have been also developed in C. This programming language was used for implementation of interpreter of Algebraic Programming Language. The programs of APS were used as prototypes.

Dzyadyk method provides the best approximation in Chebyshev metric for one dimensional case. It is similar to a well-known Lanzosh τ - method but in the difference of that one (τ - method is empiric) Dzyadyk method has a good theoretical background (for instance, the Existence Theorem for approximation polynomials is proved).

Our method is more simple algorithmically than Dzyadik one. The modified method eliminates the computation of a kernel and polynomials of the integral equation that models LDEPC Cauchy problem. The accuracy of solution approximation is better than Lanzosh or Miller methods.

NEW APPROACH IN THE METHOD OF PARAMETER EVOLUTION

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The Method of parameter Evolution (MPE) was suggested by I.D. Rodionov and developed by him with co-authors as an effective numerical method for solving many-parametric spectral boundary value problems of mathematical physics [1-2]. The MPE belongs to continuation methods; its formulation on the functional level, evolution (continuation) scheme and procedure of dimension de- creasing are given in [1]. The theorem about convergence of the MPE is proved in [2]. Numerical algorithms were developed in detail for various classes of spectral boundary value problems.

However, in previous works all numerical algorithms essentially used the logarithmic derivatives of eigenfunctions, that is functions of the kind of $D(x) = (1/u(x))(du(x)/dx)$, where x is spatial variable and u(x) is eigenfunction. It is clear, that zeros of u(x) are the poles of D(x). The necessity of accurate calculation D(x) has made the method elaborators expend many efforts and display some inventiveness [1-2].

In this work a new variant of MPE is suggested. The new approach is based on using phase variables, that is eigenfunction and its derivative are presented via smooth functions - amplitude and phase [3]. It appears that under such approach the calculation of Evolution Operator requires the same number of arithmetic operations while appropriate functions do not have any poles. Using extrapolation on embedded grids makes possible to reduce the general number of operations. Besides under phase approach the possibility to jump from one mode to another during calculating is practically excluded, because a number of eigenfunction zeros (i.e. mode number) is fixed by phase-function conditions.

In present work the MPE in phase variables (PhV-MPE) is developed for solving one-dimensional Sturm-Liouville spectral problem, the Evolution Operator is constructed, the Newton correction is given and the numerical algorithm is is considered in in detail. PhV-MPE is generalized for the case of non-self-conjugated spectral boun- dary value problem for second-order ordinary differential equa- tion.

The accuracy orders of six evolution schemes are studied on a simple Sturm-Liouville problem. It is shown that the classical evolution scheme used in previous works is not optimal in sense of accuracy improvement with the help of extrapolation on embedded grids. The optimal schemes are indicated.

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INVESTIGATION OF A VARIATIONAL INEQUALITY ARISING IN NON-LINEAR NON-STATIONARY FILTRATION THEORY [1]

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We study the solvability in the class of non-negative functions and finite difference methods for the following evolutionary variational inequality:

$$\int_0^T < \frac{\partial \varphi(u)}{\partial t}, v - u > dt + \int_0^T < A(u, \nabla u), v - u > dt \geq$$

$$\geq \int_0^T < f, v - u > dt, \quad \forall\, v \in K. \tag{1}$$

The degeneration of the coefficients in this problem is possible both in solution ($\varphi(\xi) = 0$ *for* $\xi = 0$) and in its gradient (coefficients $k_i(x, \xi)$ can be equal to zero for some $\xi \in R^n$).

Existence of a non-negative solution for variational inequality (1) is proved under sufficiently general assumpions on the input data. Semidiscretisation in time and penalt method is used in proof.

Then we consider two explicit finite difference schemes with penalty operators approximating the problem (1). In the first finite scheme we use the penalty operator $\beta = - \mid u^- \mid^{p-2} u^-$ while in the second one the penalty operator is the grid approximation of $\sum_{i=1}^n - \frac{\partial}{\partial x_i}(\mid \frac{\partial(-u^-)}{\partial x_i} \mid^{p-2} \frac{\partial(-u^-)}{\partial x_i})$.

The convergence of the discrete solution to a solution of (1) is established. The first finite difference scheme is proved to be convergent if supplementary condition $k_i(x, \xi) = g_i(x, \xi)\xi_i$, $g_i(x, \xi) \geq 0$ is valid. The convergence for the second finite difference scheme is proved under the same assumptions on the data as for the solvability of (1).

[1] encouraged and supported by Russian Foundation of Basic Research under Grant 95-01-00400.

ON SOME APPLICATION OF NUMERICAL FUNCTIONAL INTEGRATION METHOD IN QUANTUM PHYSICS [1]

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The method of computation of characteristics of quantum systems with many degrees of freedom on the basis of representation of the matrix element of evolution operator in the form of path intergral is developed [1].

The approximation formulas for the multiple functional integrals with Gaussian measures in complete separable metric spaces exact on a class of polynomial functionals of a given total degree [2] are applied to numerical investigation of 3D Bose gas.

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[1]encouraged and supported by the RFBR, Grant No 95-01-01467

CODES PACKAGE FOR THE RFQ DYNAMICS & OPTIMIZATION [1]

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Mathematical methods of control and optimization are extensively used in many fields of science and engineering. Development of specialized software for various applications becomes of increasing importance.

Special class of problems attracting attention of numerous researcher is the control and optimization. The proposed paper develops the optimization methods in this direction for the dynamic systems of the special form. The problem of control is set as a problem of trajectory ansemble control.

The computer codes has been developed for the RFQ ion linac design and analysis. The package consists of the three levels codes as well as linac designing process has three main stages: channel choose, exact calculation, simulation and optimization. The first level can be used for accelerating/focusing RFQ channel calculation and help user in choosing the best channel version. The second is the program for the simulation of the charged particles beam dynamics. By using this mathematical model it is possible the problem of the optimization for the RFQ parameters. New classes of functionals are introduced for estimation of beam dynamics. The optimization methods are developed for the presented functionals and mathematical models.

[1]encouraged and supported by the Russian Foundation for Fundamental Researches 96-01-00926

HYDRODYNAMICAL APPROACH TO MODELLING A DYNAMICS OF SEA-WAVES GENERATED BY A HURRICANE

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We are studying a new mathematical model describing a dynamics of waves generated by a hurricane moving over a sea-surface. This model is based on the initial value problem for the Navier-Stokes equations taking into account a heat transfer. A time-dependent impermeable surface is dividing the space R^3 into two parts: the atmosphere and the sea.

This surface, taken to be of the form $x_3 = \psi(x_1, x_2, t)$ with unknown ψ, represents itself a surface of internal discontinuity in the air-water medium at which stresses from the both sides are equal, and tangent stresses are proportional to differences of tangent velocities (the latter together with impermeability are usually referred to as the Navier boundary conditions). Heat fluxes from the both sides are equal and proportional to the differences of temperatures at the surface of discontinuity.

The function ψ is being approximated by a linear combination

$$\psi^n == \sum_{j=1}^{n} C_j^n \psi_j (x_1, x_2, t) \quad .$$

with respect to some given set of wave-like functions ψ_j, and with unknown coefficients C_j^n. For a given set of C_j^n the above initial boundary value problem with internal discontinuity is being solved by modified Galerkin's approximations. To determine coefficients C_j^n we are making use of the free boundary equation, minimizing in a suitable functional space a discrepancy between normal velocity of the air-water medium at the surface of discontinuity and normal velocity of the surface itself. Modification of Galerkin's approximations in the evolutionary problem under consideration implies time-independence of the Galerkin's coefficients with respect to time-dependent basic vector-functions. Existence of the generalized solution in anisotropic Sobolev space $W^{1,0}_{2,x,t}$ is established for any given Lipschitz ψ. Heattransfer is taken into account via the usual convective heat equation and via the balance of forces rather than some state equation, namely, the temperature gradient is being considered responsible for a surplus acceleration of the medium.

COMPUTATIONAL SIMULATION OF MICROCHIP HOT-WIRE FLOW SENSOR.

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Last years various microchip hot-wire flow sensors with floating membrane have been developed and applied in many applications. Their application demands for consideration the specific physical factors, which influence on forming output signal dependence on flow value. Due to nonlinearity and inertia of such sensors additional expensive experiments, calibration and electronic tricks are often necessary to achieve desired accuracy. So computational modelling of gauge based on such sensors to evaluate its performance before construction is quite useful.

Flow sensor described in [1] is considered as a representative of its family. The sensor is silicon chip covered by silicon nitride layer of 0.1 mcm thickness with three separate nickel resistors formed on it. Silicon is removed from area under formed resistors, so they are hanging on thin membrane of silicon nitride. Thickness of nickel resistor is also about 0.1 mcm. character width is 20 mcm, length is 1mm and resistance is about 150 Ohm. Sensor chip is placed in flow channel (20x4x1mm) formed inside standard DIP24 package so that flow direction is perpendicular to resistor. Each resistor can be used as hot-wire thermoanemo- meter itself or some of them can be used as flow heaters and flow temperature sensors or various bridges like [2] can be constructed. Here one resistor is considered.

When electric current heats the resistor, heat balance is established when elec- tric power becomes equal to heat leakage through resistor terminals and through air around resistor. Heat leakage through thin silicon nitride membrane is neg- ligible in fist approximation due to its low heat conductivity. The resistor temperature is equal to product of electric power by heat resistance caused by mentioned factors. The resistance increases with the temperature due to the tem- perature coefficient of nickel and changes the electric power emitted as heat. The dependence of resistance changing on applied voltage, heat resistance and material temperature coefficient can be expressed by transcendental equation.

The heat resistance, caused by heat transfer throughout surrounded air depends on average velocity of the flow passing over the heated resistor. To find this dependence the stationary problem for heat transfer equation in moving substance has been solved numerically at different flow velocities. The geometry of the resistor and flow channel makes possible to consider twodimensional problem. The fact that working temperature of resistor is on y 10-15C over the flow tem- perature gives possibility to state that flow is not disturbed considerably pas- sing near the resistor. The experiments with sensor have shown that turbulence takes place at Re>100-150, where sensor is not used. At lower Re values the flow is viscous with parabolic velocity distribution across the flow. Boundary conditions for heat transfer equation define temperature on the walls of flow channel. A few parameters of nonlinear model connected the heat resistance and average flow velocity has been found by the regression of the numerical modelling results of the flow of dry air.

Finally the resistor model could be represented as 4-pin pole with two pins for input average flow velocity and other two pins for connection to any measurement system. This model is not specific to concrete way of measurement, for example, it can be used to calculate output signal dependence for "constant power" and "constant temperature" circuit and for any other one. The model version suitable for PSPICE circuit simulation package is available. The direct experimental measurement has been compared with calculation results, good accuracy has demonstrated.

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РАЗНОСТНЫЕ СХЕМЫ НА НЕРАВНОМЕРНЫХ СЕТКАХ ДЛЯ МНОГОМЕРНЫХ УРАВНЕНИЙ

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При численном моделировании современных задач науки и техники с особенностями (ударные волны, пограничные слои и др.) часто используют неравномерные сетки. Как правило, при этом порядок локальной аппроксимации обычно падает.

В [1] построены схемы повышенного порядка аппроксимации для обыкновенного дифференциального уравнения второго порядка с переменными коэффициентами, для одномерных параболических и гиперболических уравнений. Получены соответствующие оценки точности разностных решений с использованием техники операторно-разностных схем с переменными весовыми множителями [2,3]. В [4] полученные в [1] результаты обобщаются на p-мерное уравнение Пуассона. Соответствующая монотонная консервативная схема второго порядка аппроксимации на неравномерной сетке имеет вид:

$$\sum_{\alpha=1}^{p} \sum_{k=1,k\neq\alpha}^{p} (y + h_k^+ y_{x_k} + h_k^- y_{x_k})_{\bar{x}_\alpha \hat{x}_\alpha} = -f(\bar{x}), \quad \bar{x} = (\bar{x}_1, \bar{x}_2, ..., \bar{x}_p),$$

где $\bar{x}_\alpha = x_\alpha + \tilde{h}_\alpha$, $\tilde{h}_\alpha = (h_{\alpha+} - h_\alpha)/3$, $h_\alpha^\pm = 0,5(\tilde{h}_\alpha \pm |\tilde{h}_\alpha|)$.

В данном сообщении будут приведены разностные схемы повышенного порядка точности на неравномерных сетках для квазилинейных одномерных параболических и гиперболических уравнений, а также для многомерного уравнения теплопроводности.

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METHODS OF CONFLUENCIEL ANALYSIS

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1. In the rapport is resolved a capital problem of algebra and regressional analysis "How to calculate pseudo solution in the case of passive erratic measure of matrices and right part?" It is demonstrated the following result: [1]

   - For the square matrix, all vector columns or part of him is measuring with errors, the classic method of Creamer of calculating of solution s right.
   - For the rectangular matrix, all vector columns or part of him is measuring with errors, It is constructed the method of least distances, which demonstrate that the utilisation of traditional Gauss transformation is errata.

2. It was demonstrated the methods to calculate normal pseudo solution of irregular systems of linear algebraic equation in the case of passive erratic measure of matrices and right part.

3. The results was developed to the case of the active part of matrix and complex experiences.

   - In this case the Cramer method to calculate solution for square matrix and Gauss transformation for rectangular matrix was erata. It is necessary to apply the maximum likelihood method.

This results have the large field of applications.

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ELECTRICAL ACTIVITY OF THE SENSORY AFFERENT PATHWAY IN THE ENTERIC NERVOUS SYSTEM [1]

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In this work we develop a mathematical model for the electrical activity of the afferent pathway, formed from the coupled primary and secondary sensory neurons. The primary sensory neuron possesses the electrical properties of AH neurons; the secondary sensory neuron displays the tonic type of electrical behavior. Free nerve endings of the mechanoreceptor form the receptive field of the pathway. Based on the general principles of the Hodgkin-Huxley description of excitable cells, the model simulates the following sequence of events: stretch of the receptive field initiates the dendritic potential at the mechanoreceptors; the excitation causes the soma action potential development at the primary sensory neuron which is followed by soma action potential generation at the secondary sensory neuron.

Mathematically this problem is described by three systems of nonlinear differential equations. The system of equations was solved numerically using the Runge-Kutta and Victorri et all [1] methods. Numerical calculations have shown that the model is capable of reproducing different electrical patterns within the pathway under normal physiological conditions and after treatment with charybdotoxin, iberiotoxin, tetrodotoxin, ω - conotoxin GVIA, A1-A2 purinoceptor agonists, a protein kinase C-activator, and a δ-opioid receptor agonist. Comparison of the computational results with experiments conducted on the neurons of the submucous and myenteric plexi of the small bowel demonstrate their good qualitative and quantitative agreement.

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[1]encouraged and supported by Russian Foundation of Basic Research under Grant No 95-01-00400.

МОЗАИЧНЫЕ АППРОКСИМАЦИИ ДИСКРЕТНЫХ АНАЛОГОВ ОПЕРАТОРОВ КАЛЬДЕРОНА-ЗИГМУНДА

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Постановки задач математической физики в виде интегральных уравнений после аппроксимаций типа Галеркина-Петрова в конечноэлементных базисах приводят к плотным матрицам. К сожалению, существующие методы аппроксимации для сложных векторных трехмерных задач имеют невысокий порядок и, как следствие, требуют вычисления $O(10^6 - 10^9)$ матричных элементов несмотря на то, что параметры, описывающие геометрию рассматриваемого тела или области даже в наиболее сложных инженерных задачах исчисляются всего лишь сотнями. Значит, есть все основания полагать, что $O(N^2)$ элементов плотной матрицы являются не очень сложными функциями значительно меньшего числа параметров.

Для сжатия таких плотных матриц универсальный и эффективный метод *мозаичных аппроксимаций* был предложен Е.Е. Тыртышниковым. В нем матрица разбивается на блоки, каждый из которых аппроксимируется матрицей малого ранга. В данной статье мы стараемся с единой точки зрения проанализировать различные мозаичные аппроксимации дискретных аналогов операторов Кальдерона-Зигмунда. Мы улучшаем оценки на мозаичные ранги для известных мозаичных покрытий, а также предлагаем новые мозаичные покрытия. При этом асимптотическая сложность умножения на дискретные аналоги одномерных операторов Кальдерона-Зигмунда оказывается равной $O(N \ln N \ln \varepsilon)$, где ε — точность аппроксимации, что улучшает и обобщает известные оценки.

STANDARD BASES IN NON-COMMUTATIVE ALGEBRA

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Non-commutative algebras given by generators and defining relations are under consideration. The main point of the research is the canonical bases of ideals of a relatively free algebra. If it is possible to construct such bases then it is possible to solve a number of algorithmical problems for factor algebras. In the report we present general results on canonical bases. We touch carefully associative and Lie algebras and superalgebras and discuss some non-associative examples. A series of algorithms with the use of canonical bases are presented.

PRIMITIVE ELEMENTS OF FREE LIE ALGEBRAS

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A system of elements of a free algebra is primitive if it is a part of some set of free generators of this algebra. We give matrix criteria for a system of elements of the free Lie algebra to be primitive. Algorithms to recognize primitivity of a system of elements are constructed. We present also algorithms to construct a complement of a primitive system of elements with respect to a free set of generators. Some problems concerning primitive elements of the polynomial and free associative algebras are under consideration. We observe primitive elements of free groups.

НЕКОТОРЫЕ АСПЕКТЫ МОДЕЛИРОВАНИЯ ПОЗНАВАТЕЛЬНЫХ ПРОЦЕССОВ ПРИ ОБУЧЕНИИ

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Taking into account the leading role of feed back we must emphasise the importance of modelling operations of the learner. Their valuation is one of the fundamental tasks in building educational systems. A very careful analysis of the main factors, which influence on the whole process of forming of learner's operations, finding out dominating motivations and set-ups, and also researching new methods and means of valuing their formation and progress is needed. Content of our method in solving the given modelling problem of a educational system is defined by the limits of given problems. Elaboration of the limits needs special formalize methods of pedagogical meanings, which characterise structure of such qualities of knowledge as completeness and efficiency, where in the basement for the education modelling method the idea of formalization such definitions as "knowledge", "problem solving skill" is suggested and defined. This definitions are fundamental definitions, that characterise educational operations of the learner in the process of solving problems by him, where regarding of its main components while modelling the education is not limited only by describing "condition" of the process. With the help of an expert (a group of teachers) description is made in the form of structural linguistical model, which is also a special object of elaboration [1]. So, we think that there are computers with large memory storage and software, which allows us to make an active dialogue in question - answer mode by the charts "instructed - PC", expert - PC" etc. This structure of system blocks allows us to objectify expert's knowledge in the way of treatment his conception about education process, about structure of main psycho - pedagogical concepts, about the field of problems and education aims, this gives us an opportunity to model in the language of software not only concepts of the subject field, which compose "learner's knowledge", but also important mechanisms, that determine learner's operations for solving typical problems. And this compose co-ordinate "learner's skill". We shall try to give formal definitions of used terminus: APPROACH TO FORMALIZATION OF SOME CONCEPTS, ESTIMATION OF LABOUR-CONSUMING TASK, PROCESS OF MAKING SKILLS, SOME ASPECTS TO FORMALIZATION OF ESTIMATION OF COMPLETENESS OF LEARNER's KNOWLEDGE. At first we must limit the subject field of knowledge and skills, in the limits of which the education process takes place. The rate of formalisation of used terminus must be really high, because only in such conditions in realisation of these processes with the help of a PC needed rate of feed back will be received.

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NUMERICAL ANALYSIS OF GEOMETRY OF A GAP IN SOLID BOUNDED BY TWO RANDOM SURFACES

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The geometry of fractures in rocks and rocks materials is analyzed by using a numerical model where a fracture is represented as a void volume between two random surfaces numerically generated. Each surface is described by its heights with respect to a given reference plane. The heights are assumed to be normally distributed with a given standard deviation. The distance between the average planes of each surface is the mean aperture of the gap. The heights of one surface may be assumed to be spatially correlated; a particular correlation function has been chosen which contains two parameters, the correlation distance and a characteristic exponent. The method of random surface generation with given statistical properties is described. A spatially periodic stochastic field is generated on a unit cell by the method of Fourier transforms. Various macroscopic geometric entities such as number of contact zones, close and open fracture volumes, percolation threshold are studied as functions of independent parameters of fractures. Some analytical expressions for the mean contact area and the mean fracture volume are presented. A Monte-Carlo approach is used to obtain mean characteristics of fractures by numerical generation of great number of statistically equivalent gaps. The influence of the form of the correlation function on the distribution of contacts is studied. The percolation problem on a discrete lattice which represents void volume of a fracture is analyzed. Percolation properties and the structure of the percolation cluster are considereed for various correlation functions. Critical exponents near the percolation threshold are calculated.

DEFORMABLE TEMPLATES FOR CIRCLE RECOGNITION

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An algorithm for the circle recognition using deformable templates was carried out and its performances was studied. The displacement of the points from circles and the presence of noise that appear in real situations were taken into account. The deformable templates algorithm are initialized by Hough transforms. These two methods complement each other.

The coventional Hough transform procedure performs a low resolution search for circles. It provides the approximate number of circles and a rough evaluation of centers and radii. However the existence of non - perfect circles and noise points makes the standard Hough transform less effective. Therefore a new fast Hough transform procedure was proposed. It consists of two steps: first, the coordinates of centers are found and then the corresponding radii are determined. In order to automatical chose the appropriate cut on histograms and to handle the problem of splitting peaks we use local averages on histograms.

Having the approximate number of arms and the corresponding initial values of the parameters from the Hough transform as input, a neural network finds circles with high resolution. To avoid getting stuck into local minima we decrease the interaction between the arms and use the simulated annealing procedure where the system is allowed to thermalize for a sequence of temperature according to the Boltzmann distribution. Besides we penalize the case in which an elastic circle stopped its evolution having not enough points on it.

This technique was explored in a number of different situations ranging from sets of simulated circles to real data obtained in lead-gold interactions from the RICH detectors used in CERES / NA45 experiment. We studied the efficiency of the algorithm in depending of such factors as the noise level, displacements of the points from circles, the number of points per circle and the distance between the centers of two overlapped circles. Results shows the satisfactory robustness of our algorithm to background contaminations. It can be used in many data handling problems that appear in high energy physics like Cherenkov ring recognition and track reconstruction.

ON A NEW THEORY OF HYPERGEOMETRIC SERIES AND ITS PROSPECTIVE USAGE FOR COMPUTER-AIDED ANALYTICAL TRANSFORMATIONS

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The vast majority, up to 95%, of the **special functions** involved in description of fundamentally important processes are connected with **hypergeometric series** which thereby give us a key to a substantial part of **applied mathematics really needed by numerous users** . It suggests that along with elementary functions higher transcendental functions of hypergeometric type will inevitably turn into an **obligatory component of modern software** especially for the new computer generation with prevailing role of " intellectual " interactive symbolic analysis over purely numerical computations.

The report is aimed at giving account of recent progress in building up a new theory of hypergeometric series based on the operator factorization method which uses a new binary analytical operation $< u * v \mid x >= u(d/ds)v(xs) \mid_{s=0}$ [1,2]. The operation allows any hypergeometric series (in any number of variables) to be expressed through simpler, eventually, simplest series of the same hypergeometric type (closeness property). Utilizyng known properties of the simple series any property of the initial complicated series can be established with the help of convenient operator technique. In practice this very simple idea works with striking effectiveness .

Many properties of the series including functional expansions, recurrence relations, linearization theorems, addition and multiplication formulas, generating functions, etc. were investigated in detail. Most general relations covering a great number of particular linear and quadratic transformations and analytical continuation formulas have been obtained and prepared for coding. The algebraic structure of the new method was found to be sufficiently simple, universal and algorithmically efficient to permit computer-aided analytical transformations of numerous higher transcendental functions to become feasible and very promising for the first time in their history. Execution of the project may give us a useful and sophisticated superstructure over existent computer algebra systems . The total outcome of the project is expected to exceed in power all known means of analyzing special functions. Moreover the projected interactive knowledge-based Special Functions Adviser is expected to acquire essentially new faculty of synthesizing necessary relations at the moment they are needed by the user.

Inquiries about technical details of the project are invited to be sent to the author by the above working address or residence address: Russia 300 062, Tula, Gorky st., 11, 304.

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EXPERIENCES WITH PARALLEL MONTE CARLO CODE MCNP4 ON SUN WORKSTATIONS NETWORK AND CONVEX EXEMPLAR SPP1000 SYSTEM

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The Monte Carlo code MCNP4 [1] has been implemented on Sun workstation network (in FLNP, Dubna) and on Convex C3220 (HERA), Convex C3820 (RHEA), Convex Exemplar SPP1000 (VESTA), IBM RISC System/6000-550 (RITA) (in Research Center Rossendorf) to allow scalar and parallel computing of Monte Carlo n - γ transport processes. This has been achieved by means of the communication tool PVM (Parallel Virtual Mashine)[2]. The software package PVM is a public domain UNIX-based code Oak Ridge National Laboratory and is available via **http://www.NETLIB.org/pvm3/**.

Experiences are described and problems are explained. The efficiency of the scalar and parallelized MCNP4 is assessed for two realistic problems: upgrade of the **IBR-2** reactor in Dubna and neutron load of the reactor pressure vessel at the **Rheinsberg** nuclear power plant, Germany.

Table 1 compares scalar and parallel calculations for sample problem.

Computer	*Time calc.*	*Opt. Level*
C3220(Convex OS 11.0)	55.53	no opt
C3820(Convex OS 11.0)	23.27	no opt
C3820(Convex OS 11.0)	21.57	-O3
C3820(Convex OS 11.0)	17.60	-O2
C3820(Convex OS 11.0)	17.48	-O1
C3820(Convex OS 11.0)	17.17	-O0
IBM (AIX XL v.3.1)	25.30	default
Sun 20(Sun OS 4.1)	15.66	default
Sun's 10,20	6.49	PVM(4 proc)
HP 9000(UNI Leipzig)	7.25	default
VESTA(SPP UX 3.1)	11.51	no opt
VESTA(SPP UX 3.1)	9.00	-O0
VESTA(SPP UX 3.1)	4.04	-O0 + PVM(4 proc)

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ON NUMERICAL SOLVING OF DIRECT REGULATOR PROBLEM

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ITER tokamak plasma shape control problem is investigated.
System of the form

$$\frac{dx}{dt} = Ax + Bu, \quad y = Cx, \tag{1}$$

where A, B and C are matrices given, and asymptotic observer equation

$$\frac{dz}{dt} = Az + Bu + H(y - Cz), \quad u = K(z - x^*)$$

are considered. Transient processes of (1) closed with controls of $u = K(z - x^*)$ and $u = K(x - x^*)$ are known to be equal if $A - BH$ matrix is Hurwitz and $x(0) = z(0)$. (Here x^* is a constant vector.)

Transient process analysis problem is reduced to the analysis problem of system (1) closed with $u = K(x - x^*)$ control. Matrix K is chosen to provide eigenvalues given for $A + BK$ matrix.

The algorithm of matrix spectrum assigning for closed system based on exploitation of special orthogonal transformation is proposed. The corresponding computer programme is composed.

MATHEMATICAL MODELS OF NON-STATIONARY INTERNAL WAVES IN STRATIFIED FLUIDS

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Several mathematical models for the internal waves in incompressible inviscid rotating and stratified fluids described by non–classical initial – boundary value problems for the differential equation of composite type are considered. The fundamental solution of the equation is obtained in a simple explicit form and its properties are studied. On the base of these results the explicit solution of the Cauchy problem is obtained, and its asymptotic behavior at large times is investigated. The existence of steady regimes is proved. The phenomenon of quasifront propagation in incompressible stratified and rotating fluid is described. The theory of dynamic potential is developed and applied to prove the classical solvability of initial – boundary value problems describing the exitation of the internal waves.

The problems of excitation of internal waves by the curves (the analog of the classical problem of Keldysh–Lavrent'ev–Sedov for the Laplace equation) are studied. On the base of the theory of dynamic potentials the classical solvability of these problems is proved. In some special cases the explicit solutions of the problem are constructed and the limiting regimes at large times are studied.

COMPUTER ALGEBRA ALGORITHMS FOR SELECTING THE FORM OF APPROXIMATION EXPRESSIONS AND SPLINES

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Let a function $f(x)$ be approximated in the interval $[a,b]$ by one of the expressions

$$F_i(A,x) = F_i(a_0, a_1, \ldots, a_m; x),\ i = 1,2,\ldots,s, \tag{1}$$

or by balanced approximation by splines with r links of form (1). Balanced approximation is the approximation with equal error on each subinterval. If there are several approximating expressions or splines then it is logically to use the one that gives the least maximum error in C norm with the number of $(m+1)$ parameters.

The simplest way to choose the optimal approximating expressins or spline from s given in to build each approximation and take the one that given the least error. Such method is time consuming. Particularly much time is need to find the balanced approximations by splines. Therefore it is proposed to select approximating expressions or splines from error expressions

$$\mu_i = \frac{r^{m-1}}{2^{2m+1}(m+1)!}\left(\int_a^b |\eta(f(x), F_i)/w(x)|^{\frac{1}{m+1}}\,dx\right)^{m+1}\left[1 + O\left(\frac{b-a}{r}\right)\right] \tag{2}$$

Here $\eta(f, F_i) = \eta(f(x), F_i)$ — error kernels with respect to exproximating expressions (1), $w(x) > 0$ — weight of approximation. Kernels depend form function $f(x)$ derivatives.

Algorithmes are programmed as procedures in algebra computer system Maple V R3. They include the formulas for kernels withdrawals and numerical value (2) computations. The general properties of kernels are used as basis for the kernels withdrawals formulas. Procedure selection (f, m, a, b, w) selects the optimal number of k and l and the analytic expression for kernel if approximating expression is rational polynom $R_{k,l}(x) = P_k(x)/Q_l(x)$ and $k + l = m$. To speed up the evaluation in (2) instead of kernel the expression we use its series expression in the neighbourhood of the point $x = (b+a)/2$. If the fourth argument is absent then $x = a$, if the third argument is absent then $x = 0$.

Example 1. Find the optimal k, l and kernel for $f(x) = e^x$, $m = 9$.

```
> selection(exp,9);
```

$$5, 4, \frac{1}{126}e^x.$$

Example 2. Find the optimal k, l and kernel for $f(x) = \Gamma(x)$, $x \in [1,2]$, $m = 2$.

```
> selection(GAMMA,2,1,2);
```

$$0, 2, \Gamma(x)(\Psi(2,x) + \Psi(x)^3 - 3\Psi(x)\Psi(1,x))$$

Known results and numerical experiments confirms the correctness of procedures.

ON MODELING OF PROCESSES CONTROLLED BY TRANSFORMS OF INDEPENDENT SPACE VARIABLES IN NONLINEAR OPTIC EQUATION [1]

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We offer a mathematical description variant for wide class of pointwise field transforms $f(x)$ in transverse light beam section Ω realized in the feedback loop of nonlinear optical system:

$$\tau u_t + u = D\Delta u + F(u), \quad t > 0, \; x \in \Omega \subset R^2,$$
$$\left.\frac{\partial u}{\partial n}\right|_{x\in\partial\Omega} = 0, \; t > 0, \quad u\Big|_{t=0} = u_0(x), \; x \in \Omega.$$

Here $u = u(t,x)$ is an additional phase modulation generated by the nonlinear optical element, $F(u)$ is a functional acting as

$$\langle F(u), \varphi\rangle = \int\limits_{\{x\in\Omega | f(x)\in\Omega\}} F(u(x))\varphi(f(x))\,dx\,.$$

This approach defines more precisely the base equation from [1] in case of smooth reversible transforms $f(x)$ with determinant $|f'(x)| \neq 1$ and allows to describe arbitrary nonsmooth and irreversible transformations $f(x)$ from the class of measurable functions. The existence, uniqueness of the solution $u(t,x)$ and its differentiability as a function of transform f are investigated. Some states of optimization problems with transform f as a control are considered. Opportunities to solve these problems numerically by iterative gradient procedures are discussed.

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ITERATIVE NEWTONIAN PROCEDURES FOR SOLVING NONLINEAR EQUATIONS OF PHYSICS [1]

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The talk presents results of development and application of a class of iteration schemes for numerical analysis of modern mathematical models of physics. The object of the numerical analysis is nonlinear boundary and spectral problems for differential, integro-differential and integral operators and systems of boundary and spectral problems arising from the study of critical or bifurcating behavior in physical systems. The continuous analogue of Newton's method and its generalization serve as a unified basis for constructing the iteration schemes.

Further analysis is restricted to iteration schemes with optimal parameters [1] and with the optimal control function [2]. These iteration schemes can be applied to the solution of evolution equations as well [3]. The relation is established between the iteration methods obtained and a number of standard methods. The questions of software including that for vector- parallel computational systems are considered [4]. Applications to the problems of nuclear physics and condensed matter physics are given [5]-[8].

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THE COMPUTATIONAL METHODS OF THE DETERMINATION OF SCATTERING POTENTIAL OF MOLECULES

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R-matrix, linear algebraic and continuum multiple scattering methods are mainly used for solving of the electron-molecule, positron-molecule and other scattering problems . All these methods require a single-center expansion of the interaction potential (static, exchange and polarization). The expansion of static interaction potential can be obtained by solving the Poisson equation assuming the electron charge of molecule is expressed in the same way.

In the numerical approach molecular orbitals and electronic charge density are tabulated on a grid and integrated the product with spherical harmonic. The double quadrature may be performed using Gauss-Legendre quadratures. Single quadrature is used in the case of linear molecule. Though numerical integration allows the efficient application of vector processors our investigations show that for small and large distances from the center of mass and for $l > 20$ the accuracy of the radial part of the expansion is lost. For this reason the development of the analytical methods of determination of expansions is sensible.

The transformation matrixes from Cartessian Gaussian functions into spherical Gaussian functions were determined. The analytical expansion of spherical Gaussian functions in the case of linear molecules was achieved using formulas.

The computer algebra system REDUCE for determination of radial part of the expansion was used.

УСЛОВИЯ ВОЗНИКНОВЕНИЯ КОЛЕБАНИЙ КОНЦЕНТРАЦИИ АУКСИНА В ЗОНЕ РОСТА СТЕБЛЯ

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Ауксин – одно из важнейших гормональных веществ растений, принимающее участие в ростовых и формообразовательных процессах. Физиологическое действие ауксина зависит от его локальной (например, внутриклеточной) концентрации и динамики её изменения, имеющей выраженный колебательный характер. С помощью математической модели исследованы условия возникновения колебательной кинетики.

Зона роста стебля в модели представляет собой ранжированный по объёму ряд клеток, связанных между собой потоком ауксина. Согласно данным литературы [?, ?] выделены основные факторы, влияющие на изменение концентрации фитогормона в клетке: процессы активации (автокатализ) и инактивации (взаимодействие с ингибитарами), а также приток из предыдущей клетки и отток в следующую.

В общем виде математическая модель имеет следующий вид:

$$\frac{dx_i}{dt} = J_{\text{in}}\left(x_{i-1}(t), v_i(t)\right) + f_{\text{ak}}\left(x_i(t)\right) + f_{\text{in}}\left(x_i(t), x_i(t-\tau)\right) + J_{\text{out}}\left(x_i(t), v_i(t)\right),$$

где $v_i(t)$ – объём i–й клетки, $x_i(t)$ – концентрация ауксина в i–й клетке, f_{ak} и f_{in} функции, описывающие процессы активации и инактивации, J_{in} и J_{out} – приток и отток ауксина.

Численное исследование модели позволило определить значение параметров, при которых изменение концентрации ауксина имеет колебательный характер. Такая динамика фитогормона наблюдается, если концентрация ингибитора максимальна в конце зоны роста стебля. Этот результат хорошо согласуется с экспериментальными данными.

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COMPUTER ORIENTED METHOD FOR SOLVING PARTIAL DIFFERENTIAL EQUATIONS [1]

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Based on the Wahlquist-Estabrook technique[1] a new method for construction of a wide class of solutions of partial differential equations in two independent variables is presented. This method is reduced to a large number of routine algebraic manipulations with non-commuting variables. Therefore, there is a need to use computer algebra methods and software. In spite of the fact that there may arise infinitely dimensional Lie algebras[2, 3, 4], and at some intermediate steps we use the Baker-Campbell-Hausdorf sum, in some particular problems, one can proceed algebraically up to the very end. The new approach is demonstrated by example of linear diffusion equation and Burgers equation.

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MODERN NUMERICAL METHODS IN QUANTUM CHEMESTRY AND THEORETICAL SPECTROSCOPY

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In modern quantum chemistry all numerical methods, which may be used, may be separated by two types of features:

a) by used mathematical approaches;

b) by used physical approaches.

From the mathematical point of view all methods may be divided to methods of direct calculation and algebraic one, and also on one-step and iteration one. All algebraic methods base on the theorem about presentation of function from L_2 as a sum of Furier row of some ortonormal full system of functions. And this methods also base on the variation principle. Iteration procedures establishes on the principle of compressed reflections. Methods of direct calculation are standard numerical methods of solution the problem with boundary conditions.

Among physical approaches well known:

1) the Born–Oppenhimer approach;

2) the one–electron approach;

3) the approach of harmonic nuclei motions.

In difficult cases this approaches may be uncorrect, but this trouble may be remove by using of special combinations of different mathematical methods. In report I use results of real molecular systems investigations.

МАТЕМАТИЧЕСКИЕ МОДЕЛИ, АЛГОРИТМЫ И ЧИСЛЕННЫЕ РЕШЕНИЯ КОНТАКТНЫХ ЗАДАЧ, ВОЗНИКАЮЩИХ ПРИ КОМПЬЮТЕРНОМ МОДЕЛИРОВАНИИ ПРОЦЕССОВ ОБРАБОТКИ МЕТАЛЛОВ ДАВЛЕНИЕМ.

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В докладе обсуждаются постановка и решение класса задач, возникающих при математическом моделировании технологических процессов обработки металлов давлением. Рассматривается случай абсолютно жестких инструментов, движущихся согласно задаваемым законам, и деформируемого твердого тела с физически нелинейными определяющими соотношениями. Области контакта заготовки с инструментами, а также разбиение этих областей на подобласти сцепления и проскальзывания, подлежат определению в ходе решения. В зонах проскальзывания действует трение, подчиняющееся одному из известных законов. Предлагаются классическая и обобщенная постановки описанной выше задачи. Характерной особенностью классической постановки является формулирование некоторых граничных условий в виде неравенств. Это приводит к тому, что в каждый фиксированный момент времени задача описывается математическим объектом типа квазивариационного неравенства, эквивалентного в ряде случаев задаче минимизации недифференцируемого функционала на замкнутом выпуклом множестве. Анализируются альтернативные пути решения:

- непосредственное решение задачи с односторонними ограничениями;
- решение аппроксимирующей последоваетельности задач с двухсторонними ограничениями.

После дискретизации по пространственным переменным решается как непосредственно вариационное неравенство, так и последовательность аппроксимирующих вариационное неравенство вариационных уравнений. Оценивается эффективность, точность и целесообразность использования такой аппроксимации для различных задач, представляющих практический интерес. Для некоторых из использованных постановок приводятся результаты общетеоретического исследования (существование решения, его единственность, сходимость итерационных процедур).

THE MAPLE-PACKAGE TO SOLVE LINEAR DIFFERENTIAL EQUATIONS IN SOME POWER SERIES CLASSES [1]

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An implementation of the algorithms of [1] is proposed. Given linear homogeneous ordinary equation $Ly = 0$, the program finds all points a and all solutions $\sum_{n=0}^{\infty} a(n)(x-a)^n$ such that $a(n)$ is a hypergeometric term (i.e. $a(n+1)/a(n)$ is a rational function of n). The case where $a(n)$ is a polynomial or rational function of n is considered as well.

The program choses the candidats for a as in [2]. Then it constructs a linear recurrence for coefficients $a(0), a(1), \ldots$ and solves the recurence.

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[1] Supported in part by grant J12100 from the International Science Foundation and the Russian Government

ИТЕРАЦИОННОЕ РЕШЕНИЕ РЕТРОСПЕКТИВНОЙ ОБРАТНОЙ ЗАДАЧИ ТЕПЛОПРОВОДНОСТИ

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Среди обратных задач теплообмена можно выделить ретроспективную обратную задачу по определению начального температурного состояния по температурным измерениям на конечный момент времени. Для ее приближенного устойчивого решения используются различные подходы. Среди основных можно отметить методы с возмущением исходного уравнения — методы квазиобращения в различных вариантах. Второй класс методов связан с возмущением начальных условий. Такой подход реализуется при использовании формулировки задачи как задачи оптимального управления. Аналогичная процедура фактически порождается при использовании процедур нелокального возмущения начальных условий.

В настоящее время в теории приближенных методов решения некорректных задач сформировалось направление исследований, которое связано с использованием итерационных методов. При таком подходе в качестве параметра регуляризации выступает число итераций, которое согласуется с погрешностью входных данных. При решении обратных задач для уравнений математической физики широко используются градиентные итерационные методы при вариационной формулировке обратной задачи.

В докладе для поставленной обратной задачи итерационно уточняется начальное условие, т.е. на каждой итерации решается обычная краевая задача для уравнения теплопроводности. На основе общей теории итерационных методов решения операторных уравнений устанавливаются достаточные условия сходимости итерационного процесса, проводится выбор итерационных параметров. Приведены примеры расчетов, которые демонстрируют возможности используемого вычислительного алгоритма.

OPERATOR-DIFFERENCE SCHEMES FOR PROBLEMS OF MATHEMATICAL PHYSICS

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General problems of approximate solving transient problems are considered for partial differential equations. After discretization in space (via finite differences or finite elements) a set of ordinary differential equations is obtained. The corresponding Cauchy problem is considered as a problem for an evolutionary equation in a Hilbert space. Discretization in time leads to operator–difference schemes.

In the present work there are formulated general criteria of stability with respect to the initial data and right hand side for two- and three-level difference schemes with selfadjoint and non-selfadjoint operators. The study of operator-difference schemes for unstable problems is based on the conception of ρ-stability of difference schemes. To construct schemes for ill-posed problems, the regularization principle is employed.

A general idea is considered for additive operator-difference schemes, where the problem operator can be represented as a sum (operator-splitting schemes). The emphasize is on unconditionally stable schemes with splitting onto three or more operators. Schemes similar to locally one-dimensional ones are constructed on the basis of the summarized approximation conception. Additive averaged schemes seem to be preferable for modern parallel computers. At present time unconditionally stable vector additive schemes are being studied intensively. These schemes are full approximation schemes.

Possibilities of the theory of operator-difference schemes are demonstrated on a transient convection-diffusion problem (a parabolic equation with a non-selfadjoint elliptic operator). In particular, the stability restrictions are formulated for weighted schemes as well as explicit-implicit schemes. Next, there are constructed the following basic classes of additive schemes: locally one-dimensional schemes, schemes with splitting onto physical processes, domain decomposition schemes.

NUMERICAL SOLUTION OF VOLTERRA INTEGRAL EQUATIONS OF THE FIRST KIND BY IMPLICIT RUNGE-KUTTA METHOD OF HIGH ACCURACY

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The considered analog of implicit Runge-Kutta method, applied for the solving of Volterra integral equations of the first kind, allows to obtain a high accuracy results under a sufficient simplicity and stability of used algorithm.

The estimation of numerical results for a fixed time step is performed. A special choise of integration's nodes and quadrature coefficients makes possible to get the estimation of error, decreasing exponentially under increasing the number of method's stages. That do create a good premise for using of high accuracy method and do permit to integrate with a big time step.

The stability of method to variations of kernel and right side of equation is proved.

The above theoretical conclusions are confirmed by numerical experiments for Volterra equations of the first kind with different type kernels and equivalent Volterra equation of the second kind.

ANALYTICAL STUDY OF THE GARY SCHEME ON P.C. DISPLACEMENT OF OVERLAPPING GRIDS GIVES THE STABILITY

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By using the computing algebra systems REDUCE and MAPLE the Gary scheme with initial, complementary boundary and overlap conditions on substructured domains is studied. In the case of two different grids without displacement a power instability in space L_2 is proved: $||G^n||$ grows at least as $\sqrt{n}$, when $n \to \infty$. Here G is operator of transition from the layer $t = n\tau$ to the layer $t = (n+1)\tau$. It is an example of interesting instability phenomenon. The instability is observed in calculations, if only the overlapping interval for the outflow problem has an even number of full steps. We consider $\Delta = 2h_1$: the overlapping interval has two steps for the outflow problem. In the case of two grids with displacement ($\Delta = 2.5h_1$) the stability in L_2 is proved. The principal point of the proof is verification, if the spectrum lies in the unit disk $|z| \leq 1$. The spectrum of the considered problem is described by a system of seven polynomials equations with seven variables. We introduce new variables, which are symmetrical functions of initial ones. Using in addition symmetry properties, we reduce the problem to solving a polynomial of one variable (of the 900th and 924th degrees respectively with huge integer coefficients). The power instability in the first case is given by the unique (in $|z| \geq 1$) generalized spectrum point $z_0 = 1$. In the second case the spectrum is strictly contained inside the unit circle. This and the stability of the Cauchy problems corresponding to the different grids imply the stability of the considered problem with initial, complementary boundary and overlap conditions in space L_2. Previous attempts to study the stability of the Gary scheme under such nontrivial conditions have been based on numerical approaches.

EFFECTS OF SOLID SHADOWING IN THE VACUUM SPUTTERING PROCESS OF THIN FILMS IN FRAME OF COMPUTATIONAL EXPERIMENT

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The research subject of this paper is the description of the process of vacuum sputtering of thin dielectric films throw the solid mask, exactly - mathematical modeling of shadowing effects in such a process.

Till now there are a number of mathematical models describing these effects [1-5]. While first three of them were concerned as self-independent, the further were considered and formed in frame of computational experiment. Such a conception permitted not only to range all indicated models in a series of stages of the computational experiment, but also to find a better method of regularization - a sort of the Tychonov's regularization for this non correct inverse problem for the integral equation of the first kind. The method of constructing of the compact regularizing set with the help of the cone of convex non negative continuous functions [6] eliminated the regularization error from the total error of constructing of the approximate solution of the inverse problem of describing shadowing effects in the vacuum sputtering process.

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SMALL VARIATIONS OF THE SHADOWING MASK PROFILE CONNECTED WITH SMALL VARIATIONS OF THE SPUTTERING FILM THICKNESS IN FRAME OF A LINEARIZED MODEL

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In Sevastianov's paper (ibid) a method of mathematical modeling of shadowing effects in the vacuum sputtering process of the dielectric films is proposed. After manufacturing of the solid shadowing mask with computed in frame of proposed mathematical model parameter, then after executing of the sputtering experiment we get the film differing by thickness Δh from planned because of errors of manufacturing, errors of the sputtering experiment itself, errors of measuring of the film thickness h.

It was shown in practice that the difference of $|\Delta h|/|h|$ in C-metrics s rather small. So it is valuable to use the first variational difference of the full nonlinear model on all stages except regularization. This linearized model permits much more simple computer realization, economizes the volume and the time of numerical experiments.

A CONSTRUCTIVE APPROACH TO THE INTERPLAY BETWEEN FRACTALS AND NEURAL NETWORKS

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As we understand today, Nature abounds with non-Euclidean structures. Fractal objects, exhibiting in the general case a ragged shape, represent a broad class of them. The Universe itself might be seen as a big fractal. From scales of galaxies and their clusters up to subnuclear scales one can easily trace the realm of fractal geometry. It becomes evident that fractal sets and fractal functions constitute an important part in its own right of the common language of science. Therefore, the appropriate tools are now required to describe and to process fractals.

Mathematically many fractals can be represented (in a very concise, seed form) by so called Iterated Function Systems. An *iterated function system* (IFS) is a structure $(X, f_1, f_2, ..., f_N)$ consisting of continuous functions f_i, $i = 1, ..., N$, acting on a complete metric space (X, d), with metric d. In the case when functions f_i are contractions (*hyperbolic* IFS), there is a set $A \subseteq X$, such that $f_i(A) \subseteq A$, $\forall i \in \{1, ..., N\}$, which is called the *attractor* of the IFS. Operator $F = \bigcup_{i=1}^{N} f_i$ acts on another complete metric space, namely, on the space $\mathcal{H}(X)$ of compact subsets (fractals, in the general case) of X, $(\mathcal{H}(X), h)$ being complete with respect to the Hausdorff metric h. Therefore, we have a *dynamical system* $(\mathcal{H}(X), F)$, where $F(B) = \bigcup_{i=1}^{N} f_i(B), \forall B \in \mathcal{H}(X)$. The attractor of the IFS is an attractive fixed point of the dissipative dynamical system $(\mathcal{H}(\mathcal{X}), F)$. Realizing somehow the dynamics of an IFS, one can extract a (usually!) complex structure from the original simple formulas of the IFS.

An Iterated function system embodies another peculiar feature – as well as being a kind of genetic code for a fractal, it in the same time contains information on the synaptic matrix of an asymmetrical binary neural network. In such a case, the neural network fulfils the role of morphological realizator for the genetic code.

If we restrict our attention to the particular case of a two-dimensional X space and an affine IFS, we obtain the chance to construct *interactively* a desired fractal and the corresponding IFS, solving in this manner the inverse problem. The *collage theorem* enable us to reach the required accuracy.

It makes sense to mention yet another direction of investigations attributed to *measures on fractals*, each one being the fixed point (the invariant measure) of a *Random* IFS (an IFS with probabilities), as opposed to *Deterministic* IFSs considered up until this point. Again, it may be constructed a neural network formulation of a random IFS but in this situation we have to deal with Markov chains and analogue linear networks.

BINARY NEURAL NETWORKS HELP TO DO FRACTAL FUNCTION INTERPOLATION

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When processing experimental information (for instance, some spectrometric data), often we have to deal with *ragged* shapes, more suited to be approximated by fractal structures rather then by ordinary differentiable functions, fractal dimension of the latter being always integer-valued. On the other hand, fractal function interpolation of a set of experimental data yields new intermediate points reflecting the global structure of the data. Furthermore, one can control the value of fractal dimension of the fractal interpolation function, so derived. It is hoped that these features might be used for better subsequent smoothing of the original data. An additional point to emphasize is that fractal functions are an important part in its own right of the common language of science, since fractal geometry is intended to describe a broad class of non-Euclidean objects, of greatest abundance in nature.

Given a set of data points $\{(x_i, f(x_i))\}$, $i = 1, ..., N$, $x_1 < x_2 < ... < x_N$, it is possible to construct a so called *Hyperbolic Iterated Function System* $F = \{f_1, f_2, ..., f_N\}$, f_i - a *shear transformation*, whose attractor (a fracral set, in the general case) passes through the given data points. The attractor is the graph of the fractal interpolation function interpolating our data. Fractal dimension of the function could be controlled through the medium of a parameter of the iterated function system F so that it will agree with that of the original data.

As it has been found comparatively recently, do not only iterated function systems describe (in a concise, seed form) fractals (compact subsets of a complete metric space), but they also permit to build the synaptic weight matrix of an asymmetrical binary neural network, realizing the dynamics of the iterated function system.

In a recent work of the author, it has been shown how a binary neural network can be efficiently used to construct a fractal set (in fact, an approximation of it), defined by an iterated function system given in advance or generated interactively. This report shows how this approach could be applied to fractal function interpolation.

GRID APPROXIMATIONS FOR SINGULARLY PERTURBED PARABOLIC EQUATIONS WITH DISCONTINUOUS COEFFICIENTS AND CONCENTRATED FACTORS [1]

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One-dimens onal singularly perturbed parabolic equations with mixed boundary conditions are con sidered on composite domains. The perturbation patameter ε^2, i.e. a parameter multiplying the highest derivative, takes arbitrary values in the half-interval (0,1]. For $\varepsilon = 0$, the reduced equation contains the time derivative only. The coefficients and right-hand side of the equation have discontinuities of the first kind on the interfaces of the subdomains. "Almost concentrated" sources act in the δ-neighbourhood of these interfaces. Here the parameter δ can take any value in the half-interval $(0, d_0]$ where d_0 is the minimal width of these subdomains. This problem is a model for diffusion (or heat conductivity) p ocesses in inhomogeneous media and with complex exchange conditions on the interface of medium.

It is shown that, for mixed boundary conditions, the discrete solution by a usual, classical scheme may increase without bound for certain relations between ε and the step of the space grid. However, for a Dirichlet problem, the approximate solutions remain bounded unifor nly with respect to the parameter ε (see, e.g., [1, 2]). The ratio of the space derivative of the solution for the boundary value problem to the difference derivative of the discrete solution may unboundedly increase as the grids are refined.

For these boundary value problems, using special piecewise uniform grids that condense in the boundary and interior layers, we construct finite difference schemes which do converge uniformly with respect to the parameters ε and δ. The approximations of normalized diffi sion fluxes, i.e. the products of ε and the first-order derivative, in x, of the solutions fo the boundary value problems, are studied.

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[1] encouraged and supported by Grant N 95-01-00039 from the Russian Foundation for Basic Research

ИНФОРМАЦИОННАЯ МОДЕЛЬ ТЕОРИИ СПЕЦИАЛЬНЫХ ФУНКЦИЙ

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Специальные функции математической физики можно разделить на функции, задаваемые: 1) дифференциальными уравнениями, 2) разностными уравнениями, 3) интегралами.

Дифференциальные уравнения с полиномиальными коэффициентами можно классифицировать по принадлежности: 1) к классу, 2) к типу, 3) к форме.

Класс – наиболее общий информационный объект, тип по существу характеризует конкретное уравнение, форма выделяет уравнение из множества ему эквивалентных.

Простейшие специальные функции математической физики, задаваемые дифференциальными уравнениями, принадлежат одному из трех классов: 1) гипергеометрическому классу, 2) классу Гойна, 3) классу Пенлеве.

Первые два класса составляют линейные уравнения, третий класс – нелинейные уравнения. Соответственно можно говорить о спецфункциях гипергеометрического класса, спецфункциях класса Гойна, и "нелинейных" спецфункциях класса Пенлеве. "Существенно различных" типов уравнений – 5 в гипергеометрическом классе и 10 в классе Гойна, классе Пенлеве также можно выделить 10 типов уравнений.

Между уравнениями, принадлежащими к этим трем классам устанавливаются следующие соотношения (возможны исключения) 1) добавление особой точки в в уравнение гипергеометрического класса переводит его в класс Гойна, 2) уравнение классического движения для гамильтониана, отвечающего уравнению класса Гойна, принадлежит классу Пенлеве, 3) линеаризация уравнения из класса Пенлеве переводит его в уравнение гипергеометрического класса.

Классификация уравнений с полиномиальными коэффициентами может быть произведена на основе характеризующих их особых точек. Сами особые точки подразделяются на: 1) регулярные особые точки, 2) иррегулярные особые точки с целым s-рангом (неветвящиеся иррегулярные особенности), 3) к иррегулярные особые точки с полуцелым s-рангом (ветвящиеся иррегулярные особенности),

В соответствии с классификацией особых точек, уравнения с полиномиальными коэффициентами могут быть разделены на: 1) на фуксовы уравнения (только с регулярными особыми точками), 2) на конфлюентные уравнения, у которых иррегулярные особые точки могут быть только с целым s-рангом, 3) на редуцированные конфлюентные уравнения, где обязательно есть иррегулярные особые точки с полуцелым s-рангом.

Переход от уравнений, относящихся к одному виду к уравнениям другого вида осуществляется с помощью процессов 1) конфлюенции (фуксово уравнение – конфлюентное уравнение либо конфлюентное уравнение – другое конфлюентное уравнение), 2) слабой конфлюенции (фуксово уравнение – ветвящееся конфлюентное уравнение либо конфлюентное уравнение – ветвящееся конфлюентное уравнение), 3) редукции (конфлюентное уравнение – ветвящееся конфлюентное уравнение).

Решения рассматриваемых уравнений (специальные функции подразделяются на 1) локальные решения (решения, заданные поведением в особой точке), 2) собственные функции, 3) квазиполиномиальные решения.

В течение ряда лет на базе описанной информационной модели создается программная система – база знаний по специальным функциям. Программный продукт разрабатывался под операционную систему MS Windows 3.1 с использованием языка программирования Borland C++ 3.1 и библиотек Object Windows for Borland C++ 3.1. Использование операционной системы Windows 3.1 позволило обеспечить удобный графический интерфейс и гибкую работу с памятью. Пользовательский интерфейс позволяет видеть на экране окно с текстом и графикой, а также динамично переключаться между этими окнами, выбирая соответствующие пункты меню.

База данных будет служить учебным обучающим средством для студентов, изучающих теорию специальных функций.

MASSIVELY PARALLEL VLSI ALGORITHM OF MULTIDIMENSIONAL DISCRETE FOURIER TRANSFORM

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An m-dimensional discrete Fourier transform (m-DFT) is of practical significance in analyzing multidimensional signals in different physical systems. For instance, the 1-DFT and 2-DFT are needed in tomography and spectrum analysis, the 3-DFT is applicable in nuclear magnetic response imaging algorithms, the 4-DFT is used for frequency representation of signals, etc.

The m-DFT is known to be computationally intensive algorithm, although it requires a very high throughput in many applications. A vast amount of computations to be performed for the implementation of the m-DFT, when m is large, is an important restriction for the possibility of the practical use.

One of the ways out is the development of parallel algorithms for the m-DFT and the design of special-purpose multiprocessor devices for the efficient implementation of the algorithms. One of the most promising multiprocessor architectures is systolic one [1]: computations are performed by simple identical processor elements that are connected in regular lattice by local interconnections.

The design of the systolic arrays needs the construction of special parallel algorithms that are to meet some additional restrictions (these restrictions are caused by the topology of the array). Different approaches to the construction of systolic oriented parallel algorithms for the m-DFT are known: the reduction of the m-DFT calculation to the sequential calculations of the 1-DFT [2,3] and the reduction of this problem to the matrix-vector multiplication [2]. The drawback of the former approach is that it leads to structures with global interconnections, the drawback of the latter one is that every output demands N^{2m} multiplications.

We propose a systolic algorithm for the m-DFT with mN^{m+1} multiplications. The algorithm can be mapped onto 1- and 2-dimensional systolic arrays with only local interconnections.

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ATLAS MAGNETIC FIELD SIMULATION

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3D Magnetic field map generation for the Hadron scintillator calorimeter (TileCal) of the ATLAS General-Purpose pp Experiment at the Large Hadron Collider at CERN is described.

The results from the simplified TileCal magnetic field calculations are presented. The effects of glue gaps, end plates, front plates, laminated layer near girder, 2mm iron layers between tiles have been estimated. This results were obtained with the help of the TOSCA, OPERA-2D and POISCR calculations.

Some proposals for the general ATLAS magnetic field map calculation are given.

For the magnetic field map construction the result from the VF software TOSCA and OPERA-3D calculation of the General 3D Computer Model (G3DCM) of the ATLAS magnetic field distribution was used.

The TileCal magnetic field map generation method is demonstrated. For the interpolation process the finite element method was applied.

CODE LIBRARY FOR THE NUMERICAL SIMULATION OF HIGHLY CHARGED ION ACCUMULATION AND PRODUCTION IN THE ECR SOURCE

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The electron cyclotron resonance ion source (ECRIS) is one of the most widely used ion sources with step-by-step ionization by electron impact for accelerator and atomic physics application. The mathematical description of ionization processes of neutral atoms and charge changing transitions in plasma and in ion sources with electron impact ionization can be described with a set of nonlinear differential balance equations. If steady-state processes are considered, then the set of balance equations transforms into the set of nonlinear algebraic equations [1].

A new library of the computer codes for MS-DOS-PC was created for the numerical simulation of heavy ion production to interpret the experimental results and to predict new regimes of the ECRIS operation. About one hundred nonlinear algebraic or differential equations are used in these codes. The codes of the library were successfully used for numerical testing and examining of some ways of the ECRIS improvement [2].

The library includes the follows:

1. A data base of the atomic and ionic ionization potentials for the most important gaseous and metallic atoms [3].

2. A set of computer codes to simulate the static regime of ECRIS operation for the mixture of two different elements in the ECRIS. The special mathematical methods are used for the solution of nonlinear algebraic set of equations in these code. The mathematical simulation of ion cooling method with this code showed a good agreement with the experimental data [1,2].

3. A code of the numerical simulation of heavy ion production in the dynamic regime for the mixture of two ion components in the ECRIS. The use of differential equations in this code enables not only to look for stationary solutions, but, what is more important, also to simulate the dynamic or fast changing processes. The mathematical simulation of afterglow regime in the ECRIS with different operation conditions was fulfilled with this code [2,4].

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SOVEREIGII VELOCITY SCHEME FOR FREE CONVECTION PROBLEMS

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Computatio ıs of fluid flow and heat transfer in irregular-shaped domains are often performed by the finite-element or boundary- element methods. In present work the finite-difference meth od assigned to problems of complex geometry is described. The primitive variables equati ons of incompressible viscous thermoconductive fluid are used. The main features of the method are:

- the discre ization uses the nodes of several types,
- number of neighboring nodes fixes,
- simple for mulae is applied for calculation of higher derivatives.

In the case of 2-D problem the mesh consists of the nodes of three types: each component of velocity vect or is defined at own nodes and pressure and temperature are defined at individual node s. So it implies the first order difference operators defined on three nodes. The capabilities of the proposed scheme are demonstrated by its application to several different example problems. The numerical solutions are compared with the results of known numerical investigations. The comparisons are quite encouraging.

A DIFFUSION MODEL OF ION-IMPLANTED ARSENIC IN THE POLYSILICON-SILICON SYSTEM

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At present, ion implanted layers of polysilicon as a source of impurity diffusion are used for the VLSI fabrication processes [1]. Doped polysilicon diffusion allows to design heavily doped layers with small degree of lattice defect and small junction depth, since radiation defects remain in the polysilicon. Availability of the polysilicon layer causes the impurity segregation on the polysilicon-silicon interface. It complicates the process of the thermal diffusion. Therefore, the development of a model of impurity diffusion in the polysilicon-silicon system is very important.

Proposed model for the transfer of the impurity atoms in the system Si-Si^* under rapid thermal annealing take into account nonhomogeneity of distribution of point defects near interface of the phases. It allows us to describe phenomena of impurity segregation on the polysilicon-silicon interface. The defect diffusion equations are presented in the form that allows the analytic solution.

The conservative nonhomogeneous difference schemes for quasilinear diffusion equations and iterative process for solving the system of non-linear algebraic equations are also proposed.

The comparison of the results of numerical computations and the experimental data demonstrates the adequacy of the proposed diffusion model and the efficiency of the developed mathematical software. It allows us to use this model as a basis for the development of the simulation of VLSI fabrication technology with doped polysilicon. Moreover, the proposed model and software can be used for the description of other transfer processes on the interface of two phases, for example, for simulation of the process for the lattice disorder in the complex semiconductors [2].

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NUMERICAL EVALUATION OF INVERSE AND ILL - POSED PROBLEMS USING INVARIANCE PRESERVING TECHNIQUES [1]

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The present work primarily addresses the issue of the formulation of a finite difference ansatz to compute discrete operators (stencils) from measured non-exact data (grid points), based upon invariance criteria. This is described within the context of constructing a dynamical model from a given set of observational data using an optimal finite difference approximation. The criterion for optimality of a given stencil is dictated by the preservation of invariance at the grid point values of the discrete group generator when acting on the finite difference ansatz, which approximates the dynamical system.

An error-control paradigm is presented which enables the preservation of invariance at the grid point values, within a prescribed tolorance. This error-control paradigm is chosen to be a function of the step size. Generic issues of sensitivity, stability and convergence of the stated numerical model are treated. The use of the evolutionary representation of the vector field to achieve computational efficiency is also demonstrated.

In order to further demonstrate the efficacy of the present numerical paradigm, a methodology for the numerical differentiation of non-exact data is presented. The invariant numerical differentiation scheme is then analyzed with respect to competing schemes, by virtue of simple numerical examples, for the case of low order derivatives.

A case study that demonstrates the actual implementation of the numerical technique presented herein, to a specific example of PRACTICAL IMPORTANCE, is described. This involves the development of a grid control mechanism for an adaptive grid model. Herein, a refinement procedure for evolving source or driving terms (operators) is presented. Numerical examples for exemplary cases are provided, along with estimates of the performance of the numerical model when implemented on generic distributed computing platforms.

[1]This work has been partially performed under the auspecies of STR&DF contract CSM 03-95-20101-1961.

ON SOME NONLINEAR SINGULAR PROBLEMS IN RELATIVISTIC COSMOLOGY MODELS [1]

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Global behaviour of positive solutions to the second order nonlinear ordinary differential equations with singularities has been investigated. These equations arise in some models of relativistic cosmology : the equations of motion of spherical infinitely thin bubble in the Minkowski, Friedmann and de Sitter spaces. This object is investigated in the field theory with two degenerated vacuums. The equations are of the type $P(\ , u, u', u'') = 0$, where P is a polynomial with respect to u, u', u''; they degenerate for $u = 0$ and with respect to t in finite or infinite singular points. The following approach is used for analysis of solutions: theory of singular Cauchy problems and methods for construction of smooth one-dimentional nonlinear manifolds generated in the equation phase space by the solutions bounded in a singular point. It is shown that only in the de Sitter space the bubble does not collapse if the initial radius is large enough. This case is the richest in content: there are two families of solutions, which are divided by "critical" curve; the transition to the critical solution is singular with respect to the parameters; for the family of the solutions bounded in the singular point the disconnected set is formed in the cross-section of an integral funnel. For the equations in the Friedmann space behaviour of solutions in a neighborhood of a singular initial point is the most interesting.

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PIXEL DECIMATION MOTION ESTIMATION USING WAVELET TRANSFORM

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Traditional exhaustive Block Matching motion estimation is difficult to achieve in real time. Several methods had been proposed in order to simplify the whole process while at the same time maintaining good matching performance. Uniform pixel decimation [1] is one of the methods. The disadvantage of it is some crucial pixels in a block may not be selected for the motion matching criterion, resulting in inaccurate motion vectors. To overcome this problem Chan and Siu [2] proposed an adaptive pixel decimati on method. However this method is still containing non-high activity pixels at the beginning of the pixel selection stage, and since this method employs different number of pixels in each block which is considered not adequate for hardware implementation. In this paper, we use Wavelet Transform to extract the high activity pixels and adaptively select a fixed number of those most representative pixels for the matching criterion. This is due to the fact that high activity in luminance s ignal such as edges an Adaptive Pixel Decimation using wavelet transform: Wavelet Transform had been proved [3] & [4] to be very useful on extracting edge and texture features. We used Daubechies' 4 tap wavelet's high pass filter to process the current frame along both vertical and horizontal direction in parallel and retain every single output coefficients. This give the horizontal and vertical edge maps respectively. By combining these two maps together, the final edge map was obtained for this image. The pixel values within a block will be sorted in descending order. (The higher the value, the higher the activity of the pixel) Depending on the requirement of computational reduction, a certain number of pixels with the highest activity will be selected for motion estimation. For instance a 75 Experiment Results and Discussions: A series of experiments had been carried out to evaluate the performance of the above method using MPEG encoder and decoder. The results showed that much better performance were obtained than the uniform pixel decimation with similar computation reduction. The picture quality is indistinguishable when compare to MPEG.

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DATA DISTRIBUTION AND COMMUNICATION SCHEMES FOR LEAST SQUARES PROBLEMS ON MASSIVELY PARALLEL DISTRIBUTED MEMORY COMPUTERS

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In this paper we study the parallelization of PCGLS, a basic iterative method whose main idea is to organize the computation of conjugate gradient Method with preconditioner applied to normal equations. Two important schemes are discussed. What is the best possible data distribution and which communication network topology is most suitable for solving least squares problems on massively distributed memory computers. A theoretical model of data distribution and communication phases is presented which allows us to give a detail execution time complexity analysis and investigate its usefulness. It is shown that the implementation of PCGLS, with a row-block decomposition of the coefficient matrix, on a ring of communication structure is the most efficient choice. Performance tests of the developed parallel PCGLS algorithm have been carried out on the massively distributed memory system ParsytecGC/PowerPlus and experimental timing results are compared with the theoretical execution time complexity analysis.

LINEAR OPERATOR INTERPOLATION IN A SPACE OF FUNCTIONAL MATRICES

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Let X be the space of continuous on $[a,b]$ of square matrices of dimension n and $F: X \to X$.

Theorem 1. The matrix

$$L_1(A) = F(A_0) + \frac{1}{b-a}\int_a^b \delta F[A_0 + \frac{\tau - a}{b-a}(A_1 - A_0); A - A_0]\, d\tau,$$

where $\delta F[A;h]$ is the Gateaux differential at the point A in the direction h, is a linear interpolation matrix polynomial for the operator $F(A)$ with respect to knots A_0 and A_1. If the $F(A)$ is a matrix polynomial of the first order, then $L_1(A) \equiv F(A)$ $(A \in X)$.

In the class of continuously differentiable matrices, some of formula of linear interpolation are determined by the following

Theorem 2. Linear matrix polynomial

$$L_{10}(A) = F[A_0(\cdot)] + [A(a) - A_0(a)]A_1(a) - A_0(a)^{-1}F(\cdot) - F[A_0(\cdot)] +$$

$$+\frac{1}{b-a}\int_a^b \delta F[g(\tau,\cdot); A(\cdot) - A_0(\cdot) - A(a) + A_0(a)]\, d\tau,$$

where

$$(\cdot) = A_0(t) + A_1(a) - A_0(a), \quad g(\tau,t) = \frac{\tau - a}{b-a}A_1(t) + \frac{\tau - b}{a-b}(t)$$

are interpolation matrix polynomials of the first order in the space of continuously differentiable on $[a,t]$ matrices.

The polynomial $L_{10}(A)$ is equal identically to the $F(A)$ if

$$F(A) = K_0 + A(a)K_{00} + \int_a^b A'(t)K_{10}(t)\, dt,$$

where K_0, K_{00} and $K_{10}(t)$ are arbitrary given matrices.

Other formulas of linear interpolation for matrix-valued functions are also given. In particular, when $X = C^p(T)$ is the space of functional matrices that have continuous derivatives up to p-th order $(p > 1)$ on $T = [a,b]$ and $F(A)$ is an operator mapping $C^p(T)$ into another space of functional matrices.

ИССЛЕДОВАНИЕ АБЕРРАЦИЙ ТРЕТЬЕГО ПОРЯДКА В ЭЛЕМЕНТАХ МАГНИТНОЙ ОПТИКИ

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Рассмотрены возможности аналитического подхода при исследовании аберраций до третьего порядка включительно в ряде элементов магнитной оптики пучков заряженных частиц, а именно в дипольных магнитах, соленоидах и в промежутках ускорения.

Построены соответствующие нелинейные уравнения движения частиц с учетом их разброса по импульсам. В рамках матричного формализма получены аналитические формулы для коэффициентов хроматической и сферической аберраций.

Исследованы физические эффекты фокусировки и распределения плотности тока частиц в пучке.

СОГЛАСОВАНИЕ ФАЗОВЫХ ОБ'ЕМОВ И ОПТИМИЗАЦИЯ УПРАВЛЯЮЩИХ ПОЛЕЙ В КАНАЛАХ ОПТИКИ ПУЧКОВ [1]

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Дана математическая постановка проблемы согласования фазовых объемов при транспортировке заряженных частиц в ускорителях и других электрофизических установках.

При известных бетатронных функциях в начале и конце согласующего тракта получены аналитические формулы для величин длин пространств дрейфа и полей, необходимых для реализации поставленной оптимизационной проблемы согласования фазовых объемов.

Приведены физические примеры реализации предложенного метода.

[1]Работа выполнена при поддержке Российского фонда фундаментальных исследований, грант 95-01-0737.

ON THE PROPERTY OF S_+ TYPE FOR THE DEGENERATING OPERATOR. [1]

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Let Ω be a bounded domain in R^n with smooth boundary such that there are hold embedding theorems of S.L. Sobolev, V is a closed subspace of the space $W_p^1(\Omega)$ such that $\overset{\circ}{W}{}_p^1(\Omega) \subseteq V$, $p > 1$.

We define the operators $A, B : V \to V^*$ induced by the respective forms

$$< Au, v >= \int_\Omega g(|\nabla u|) \cdot (|\nabla u|^{-1} \nabla u, \nabla v)\, dx$$

$$< Bu, v >= \int_\Omega b(x, u, \nabla u) \cdot v\, dx$$

where the function $g(t)$ satisfies the following conditions
$g(t)$ is continuons, $g(t) = 0$ for $t \leq 1$, $g(t)$ strictly increases for $t \geq 1$,
there are exist $p > 1, c_1, c_2, c_3 > 0$ such thet for $t \geq 0$
$g(t) \leq c_1 \cdot t^{p-1}$, $g(t) \cdot t \geq c_2 \cdot t^p - c_3$.

We also assume that the function $b(x, \xi_0, \xi_1, \ldots, \xi_n)$ satisfies ty Caratheodory's conditions and moreover there is exist $s \in [1, +\infty)$ such that for any $u \in W_p^1(\Omega)$: $b(x, u, \nabla u) \in L_s(\Omega)$ and
$W_p^1(\Omega)$ compactly embedded in $L_{s^*}(\Omega)$, $s^* = s/(s-1)$.
Enfine let the operator $T : V \to V^*$ is the sum $T = A + B$.

It is hold the next result. The proof of this resultis carried out by analogy with the proof of the proporty S_+ (see [1]).

Theorem. Let the sequence u^i weakly converges to u in V and $\overline{\lim}\, < Tu^i, u^i - u >\leq 0$ as $i \to +\infty$. Then u^i strongly converges to u in $W_p^1(\Omega(u))$, where $\Omega(u) = \{x \in \Omega : |\nabla u(x)| > 1\}$

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[1]encouraged and supported by Russian Foundation of Basic Research under Grant N 95-01-00400.

ALGEBRAIC PROPERTIES OF LIOUVILLE EQUATIONS FOR DENSITY-MATRIX [1]

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We consider a Liouville equations

$$i\frac{d\rho}{dt} = [H, \rho] \tag{1}$$

for density-matrix ρ which describe an evolution of N-level quantum system. It is well-known that a solution of (1) has constants of motion of the type $\mathrm{tr}\,\rho^m$ and more complicated type provided that quantum system possesses some additional symmetry [1]. In previous paper [2] author shown that construction of same integrals is a purely algebraic task. It was given a formal algorithm for obtaining invariants of motion. A lot of papers (see, for example, [3] was devoted to finding a linear change of variables such that the initial system (1) decomposes to two or more independent subsystems. But it was unknown the general criteria of possibility of such decomposition and regular methods of searching of required change of variables was absent. In present work we give an explicit solution of these problems. The general idea is to pass from Hermitian operators H and ρ to some skew-hermitian analogues what allows us to use the Lie-algebraic methods. So, the problem of decomposition of equation (1) is reduced to technical task of constructing some Lie subalgebra in $su(N)$ and decomposing $su(N)$ to irreducible submodules as an L-module.

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[1] Author acknowledge a support by INTAS, grant 93-0893

"TG-GSS" MANAGER TO GENERATE APPLIED SOFTWARE FOR ANALYSIS OF DATA LIKE SET OF TIME SERIES AND ILL-POSED INVERSE PROBLEMS

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The principal problems of creating software manager for computer-aided procedure of simulating applied software for some typical kind of science investigations and industrial technologies, where images of observed data are like sets of digitised time series, are discussed.

Nowadays the situation around the using of computers and especially of personal ones has lead in many cases to necessity of essential reconstruction of methods, devices, simulating models, tools and numerical methods in applied systems of science investigations and industrial technologies. The red-lines of using computer-aided technologies are: the including of computer processors into detectors and devices, the using of data banks and data knowledges banks, of dialogue-graphics tools of representation of subject area objects and operating with their screen images, and at last giving to experts - knowledge engineers - the possibilities of planning the computer data processing and the choice of final solution.

Notice that the enough reach software and experience of its using is accumulated in each subject area. Therefore the last years the CASE (computer applied software environment) technology is widely using.

In our subject area the observed data may be represented by unique digital functions like time series. The mathematical model of phenomenon under investigation consists of two kinds of functions: one is enough smooth function, another part is a set of local resonances. The cause-consequence relations here are enough complicated and involve a non-linear calibration function, an efficiency function, a non-linear main dependence. Therefore the problems of data analysis are ill-posed ones. The top idea of regular algorithms in our subject area consists of computing, firstly, the most stable part of solution in that way then the model is nearly according to experimental data. The computing of other part of solution is possible only by taking into account whether time dependence in model whether another strategy of conducting experiment, detecting data and data processing. The non-unique models of experimental data interpretation take place also. The user has a possibility to get information from estimated data bank and data expert knowledge base.

Notice that the representing the screen objects images and operating under them are not so simply and are realised by using of special algebra. The special metalanguage was created in "TG GSS" to write the main calculating structures such as consequence, loop, switch etc.

The described methodology is realised in "TG-GSS" monitor to generate applied software to process, in particular, alpha and gamma spectra in elements analysis of samples. Other example of using "TG GSS" is analysis of cosmic gamma-ray spectra in CORONAS-I space experiment.

MATHEMATICAL MODEL OF RELAXATION EFFECTS IN A NON-HOMOGENEOUS DEFORMABLE SOLID AT NON-STATIONARY THERMOMECHANICAL INFLUENCES [1]

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At construction of model it is supposed, that the condition of each component of non-homogeneous solid is described by four thermodynamic functions: by free energy, entropy, stress tensor and vector of density of a heat flow. Arguments of these functions are absolute temperature, strain and strain speed tensors and internal parameters of a condition [1, 2], the physical sense of which consists in following.

Alongside with absolute temperature, used for description of equilibrum thermodynamic processes, in case of nonequilibrum (or local nonequilibrum) processes it is entered scalar internal parameter of a condition — thermodynamic temperature, conterminous with absolute temperature at zero speed of its change. Other scalar internal parameter characterizes non-regularity or change of a structure of non-homogeneous solid owing to phase transitions. For the description of process of distribution of heat are used vectorial internal parameters of a condition, associated with vectors of density of flows fonons and electrons at heat conduction. At last, the viscous properties of non-homogeneous solid characterize tensor internal parameters of a condition describe microgear of viscous internal friction and molecular interaction.

It is supposed, that in each point of solid the laws of preservation and second law of thermodynamics are executed, which permits to formulate restrictions on a kinetic equations for internal parameters of a condition. Such approach enables to construct in the reasonably common form of mathematical models of specified processes, taking into account cross effects and phenomena of delay. Concretization of such models for proceeding simultaneously processes of heat conduction, diffusion and deformation permits to study a feature of behaviour of non-homogeneous solid at highintensive influences by methods of computing experiment and to establish the area of parameters, in which the account of cross effects and phenomena of delay is necessary.

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[1] This work was supported by RFFI (project 94–01–01809).

THE CONTINUOUS ANALOGUE OF NEWTON'S METHOD AND NUMERICAL SOLUTION OF SCHRODINGER EQUATION

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Well known that most of used method for solving nonlinear problems is the Newton method. The convergence theorem for the Newton's method presupposed the existence of a good initial approximation to desired solution. In order to extend a range of convergence of this method were suggested a different modifications.

Among them the particular role play the continuous analogus of Newton's method (c.a.N.m) which is developped by E.P. ZHIDKOV, I.A.PUZYNIN and their pupils.

Our report is consists of two parties. The first of them is devoted to the convergence of c.a.N.m. The optimal choice of iteration parameters allows us to prove the automatically convergence of method. However the convergenve rate of c.a.N.m is linear, when the iteration parameters are far from 1. It is desirable to further accelerate this process. We are giving a several variants of acceleration procedure. The effectiveness of these procedures is illustrated by means of various examples.

The second part of this report is concerned with the numerical solution of the eigenvalue problem for the one-dimensional Schrodinger equation. The last years have seen considerable and fruitiful research in constructing a last and higher order accuracy algorithms for giving problem. Here wea re given an nonstandard three point difference scheme with 2nd order of accuracy on a nonuniform mesh. The obtained system of nonlinear defference scheme preperable to solve by c.a.N.m of shooting method. We are also presenting numerical results and comparison with a different methods.

ЧИСЛЕННОЕ МОДЕЛИРОВАНИЕ НЕКОТОРЫХ МАГНИТНЫХ СИСТЕМ СОЛЕНОИДАЛЬНОГО ТИПА

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Проектирование, оптимизация и создание многих магнитных систем, включая тракты линейных ускорителей, современных источников частиц и др., наряду с процессом длительного и трудоемкого физического моделирования в значительной мере опирается на численное моделирование распределения поля соленоидальных магнитов в рабочей области установки. Значимость численного моделирования при конструировании рассматриваемых магнитных систем определяется не только известными достоинствами вычислительного эксперимента, но и техническими особенностями конкретной установки, например, наличием криогенных температур, затрудняющих проведение измерений магнитного поля. Благодаря достаточной точности выбранной математической модели, с помощью вычислительного эксперимента решалась проблема выбора и оптимизации формы магнитных полюсов. Полученные распределения магнитного поля для широкого набора расчетных систем предлагаются для использования в качестве "заготовок" при конструировании электрофизических установок, содержащих соленоиды.

ON INCREASING OF THE ACCURACY OF APPROXIMATE SOLUTIONS OF THE BOUNDARY PROBLEM ON HALFLINE [1]

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There is considered the boundary problem on halfline for the second order ordinary differential equation. The problem of this kind appear in the quantum mechanics, in the theory of radiowaves and in the gas dynamics. For numerical solving of the boundary problem on halfline $[x_0, \infty)$ the last one is replaced by closed interval $[x_0, R]$. The condition in the point R is chosen by using of asimptotic behavior of the solution for $x \to \infty$. Then one has to solve the problem on this closed interval. The replacement generates an error which tends to 0 for $R \to \infty$ [1 - 2].

In this report the method increasing the accuracy of approximate solutions of the boundary problem on halfline is suggested. This approach is similar to the Richardson method. It is based on multiply solving of the problem on different closed intervals. Then the combination of the obtained solutions gives the solution of higher accuracy. The corresponding algorithm based on this method is constructed. It allows to find the solution with required accuracy. The numerical testing has shown the high accuracy of the results.

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[1] encouraged and supported by the Russian Foundation for Fundamental Research (grant 95 – 01 – 01467$_a$).

ON PARALLEL CONSTRUCTION AND INTERPRETATION OF MULTIDIMENSIONAL CHAINS OF RECURRENCES [1]

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We consider a way to expedite the computation of a multivariate closed form functions over the regular intervals. Computational tasks like this appear in such applications as plotting mathematical curves and surfaces, animation of plots, signal processing and so on. In order to expedite the needed computations a technique based on chains of recurrences (CR) can be used [1, 2, 3, 4]. The application of this technique consists of two steps: (an algebraic) conversion of the initial computational scheme into CRs; and than (a numeric) interpreting the chain based computational scheme.

In this paper we define multidimensional chains of recurrences (MCR), consider the general interpreting scheme of MCRs and show that MCR construction can be done in parallel without symbolic tools. Additionally we give parallel algorithms, which allows to get MCR for a multivariate polynomial in $c \cdot d \cdot n$ parallel steps, where d is the number of variables, n is the maximum of degrees of variables and the constant c is reasonable small.

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[1] encouraged and supported by the Russian Fund for Fundamental Research under Grant 96-01-01138a.

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Ответственный за подготовку сборника к печати Р.Р.Шахбагян

Макет Н.А.Киселевой

Рукопись сборника поступила 14.08.96. Подписано в печать 20.08.96
Формат 60 × 90/16. Офсетная печать. Уч.-изд. листов 7,53
Тираж 260. Заказ 49313. Цена 9136 руб.

Издательский отдел Объединенного института ядерных исследований
Дубна Московской области