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LABORATORY OF INFORMATION TECHNOLOGIES

REPORT ON RESEARCH ACTIVITIES IN 2004

Report to the 97th Session
of the JINR Scientific Council
January 20–21, 2005

Dubna 2004

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The main task of the Laboratory of Information Technologies consists in provision with modern telecommunication, network and information resources of theoretical and experimental studies conducted by the JINR Member State institutes at JINR and other scientific centers.

In 2004, the LIT scientific programme covered mainly two first-priority topics of the "Topical Plan for JINR Research and International Cooperation in 2004". The Laboratory staff participated in 13 more topics of the Topical Plan in collaboration with other JINR Laboratories at project level and in 17 topics at cooperation level. The main aim of the Laboratory is the performance of work on the "Information, Computer, and Network Support of the JINR's Activity" (topic 09-6-1048-2003/2007, headed by V.V.Ivanov, V.V.Korenkov, and P.V.Zrelov) and in the field of the "Computer Physics for Theoretical and Experimental Research" (topic 09-6-1041-2002/2004, headed by I.V.Puzynin and A.Polanski). Main results of the investigations performed within these topics have been published in the well-known journals, proceedings of scientific conferences and preprints.

In the year 2004, a number of scientific projects presented by LIT staff members received grants of the INTAS Foundation, the Commission of the European Community in the framework of the EU-Russia collaboration, and 13 grants of the Russian Foundation for Basic Research. Seven projects are devoted to the creation and development of informational, computing and telecommunication resources for performing fundamental research, and the other six are initiative scientific projects.

During the year 2004, LIT participated in organizing two international conferences.

On 25 - 31 January, the XI International Conference "Mathematics. Computer. Education". The purpose of such conferences is to integrate the efforts of Russian and foreign scientists, specialists and teachers directed towards developing science and higher education in Russia and other countries of CIS as well as preserving the traditions of the Russian science and education and their integration in the international community.

On 29 June – 2 July, an international conference "Distributed Computing and Grid-technologies in Science and Education". The Conference was the first in Russia dedicated to the issues of implementation of advanced Grid-technologies and distributed computing in all fields of human activities. More than 200 scientists attended the Conference. The 79 reports dedicated to implementation of Grid-infrastructures and devel-

opment of tools for functioning such systems as well as to the issues of solving applied tasks with the help of the created structures were presented.

Information, Computer and Network Support of the JINR's Activity

In 2004, work in frames of the theme "Information, Computer and Network Support of the JINR's Activity" (topic 09-6-1048-2003/2007) was in progress.

External telecommunication systems

At present, JINR leases a 45 Mbps channel to Moscow from the Russian Satellite Communications Company (RSCC «Dubna»); thus, JINR has access to the Russian networks and information resources (up to 45 Mbps), as well as access to the international channel through shared RBNet+RUNNet in the common data stream 2.5 Gbps. The Dubna-Moscow channel bandwidth increasing up to 1 Gbps will be done in the year 2005. All the relevant documents have been prepared and signed by the Directorate of JINR and RSCC. Figure 1 shows the nearest future of the JINR external channels.
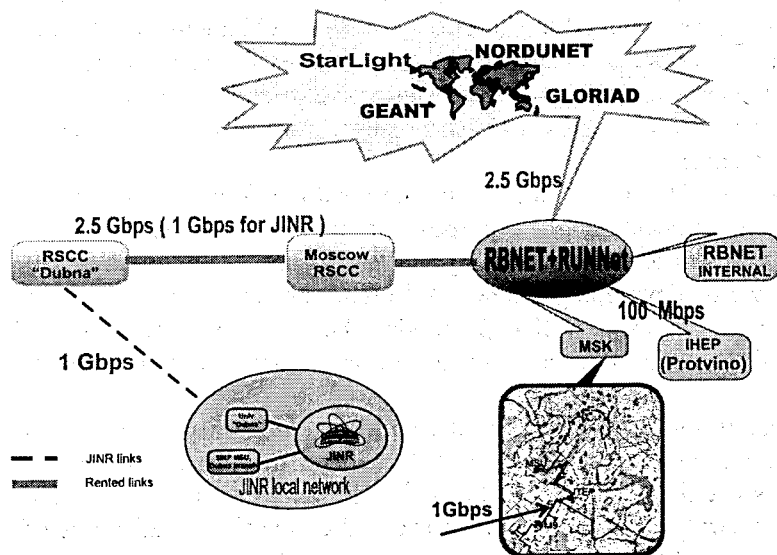

Fig.1: Planned JINR external channels

Figure 2 shows the incoming and outgoing JINR traffic in 2004 (solid line) and 2003 (dashed line). Total eleven month incoming traffic was 32.69 TB (18.55 TB in 2003) and outgoing traffic - 40.22 TB (21.8 TB in 2003).
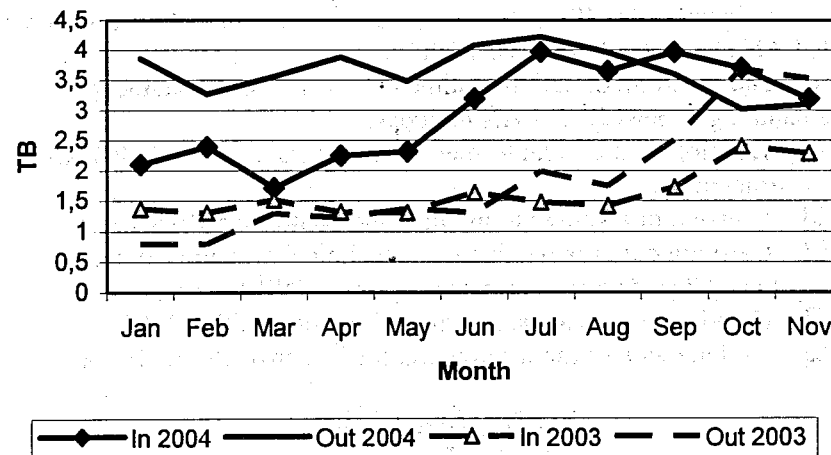

Fig. 2: Incoming and outgoing JINR traffic in 2004 (solid line) and 2003 (dashed line)

The table below shows an eleven month traffic distribution among the JINR divisions (>500 GB on incoming traffic).

JINR Laboratories	Incoming (IN)	Outgoing (OUT)	% (IN)	% (OUT)
LIT	7.87 Tb	10.52 Tb	24.08 %	26.16 %
DLNP	4.61 Tb	5.6 Tb	14.11 %	13.92 %
Servers	3.6 Tb	1.17 Tb	11.02 %	2.92 %
FLNR	3.58 Tb	3.72 Tb	10.94 %	9.24 %
LPP	3.22 Tb	3.29 Tb	9.84 %	8.19 %
VBLHE	2.21 Tb	1.48 Tb	6.76 %	3.67 %
Uni-Dubna	2.06 Tb	1.93 Tb	6.3 %	4.79 %
BLTP	2.03 Tb	1.88 Tb	6.21 %	4.67 %
FLNP	1.57 Tb	7.82 Tb	4.82 %	19.43 %
Adm	621.47 Gb	1.5 Tb	1.86 %	3.74 %

Systematic work on the LAN management was performed by the Network Operation Centre (*http://noc.jinr.ru/*). Present-day statistics can be found at *http://noc.jinr.ru/inform/inf_main_stat.shtml*.

JINR Local Area Network (JINR LAN)

Currently the IP addresses database contains 4801 registered JINR LAN elements (4506 in year 2003).

The spectrum of activities aimed at creation of a reliable, protected and high-speed JINR LAN includes:

❑ Development of a fault-tolerant architecture of the JINR LAN Backbone.
❑ Creation of a system to monitor and control the JINR LAN.
❑ Carrying out organizational and technical measures to provide the 1 Gbps data transfer rate across the JINR Laboratories.
❑ Creation of a network security system of the JINR LAN.
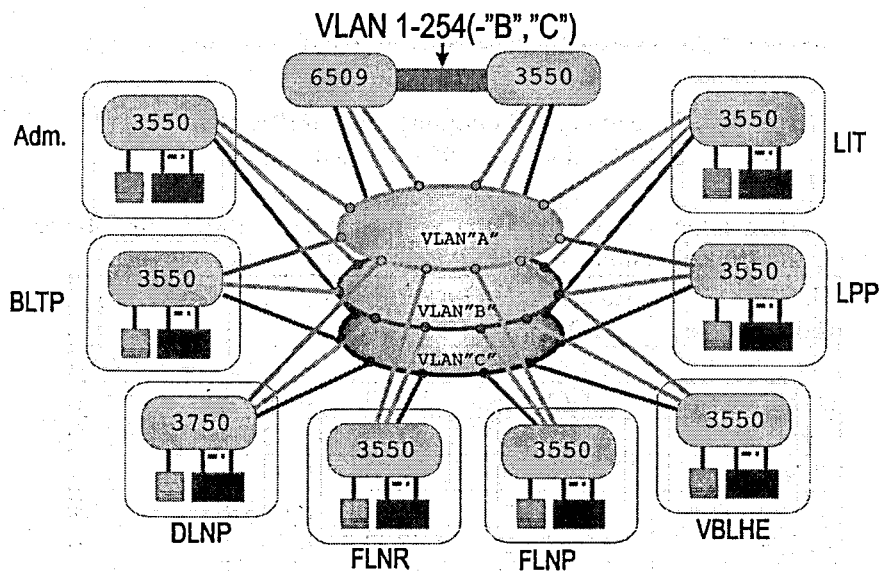❑ Optimization of the information traffic across the JINR LAN.

Fig. 3: Logical scheme of JINR LAN

All fiber optic cabling to have the transport media for the JINR Gigabit Ethernet LAN was made in 2003. The communication equipment (six Cisco Catalyst 3550-10T switches plus 2 Cisco Catalyst 3550-10G) to make this Gigabit Ethernet LAN was purchased in 2003 too.

During the 1-st quarter of 2004 all the work to launch Gigabit Ethernet LAN was done: testing of the new single mode fiber optic communication lines, creation of the switches configuration files and verifying the proper functioning of first component parts of the structure and then the entire JINR Gigabit Ethernet LAN.

The JINR Gigabit Ethernet LAN became available for users in March 2004. Cisco Catalyst 3550 family switches in 8 JINR main divisions (7 Laboratories and Administration), being connected by the fiber optic segments to the main Cisco Catalyst 6509 switch in LIT, formed the "star" topology of the JINR Gigabit Ethernet LAN backbone.

The core idea behind the inventing of the Cisco Catalyst 3550 family switches was to create 8 separate sub-networks (one sub-net in each of eight main JINR divisions). Having the separated sub-networks, we isolate a local traffic within the division, and all possible local problems will not be visible by the rest of the network users. The next result – we will get a canonical backbone, formed only by communication equipment. It means that not all sorts of PCs or workstations can have direct access to the high-speed backbone. Then the network isolation will ease the security issues. With fail-over Cisco PIX-525 Firewall JINR LAN protected from external attacks, networks scanning, and flooding. Security problems cannot be solved at once with installation of a hi-tech box, much more activities should be provided both by network administrators and by users themselves.

The creation of the sub-networks in the divisions goes through the so-called process of renumbering, when the network attributes of every host (PC, workstation, server, network printer) should be changed. There are around 4800 IP addresses at JINR. 90% of the changes should be made manually by the network administrators. This work began after launching the Gigabit Ethernet LAN, 80% of work has been done, and the rest of work is expected to be complete in the 1-st quarter of 2005.

When this process is over, the JINR Gigabit Ethernet LAN will become a hierarchical structure with all relevant positive features of the network hierarchical structures. It means that the whole JINR Gigabit Ethernet LAN can be easier monitored and controlled with the help of specialized software packages.

The Principal Component Analysis, especially the "Caterpillar"-SSA approach, was applied to the network traffic measurements. This

approach is proved to be very efficient for understanding the main features of terms forming the network traffic. The statistical analysis of leading components has demonstrated that a few first components already form the main part of information traffic. The residual components play a role of small irregular variations which do not fit in the basic part of network traffic and can be interpreted as a stochastic noise. Based on the feature characteristics of residual components, a statistical method for the selection and elimination of residuals from the whole set of principal components was developed. *[I. Antoniou, V.V. Ivanov, Valery V. Ivanov and P.V. Zrelov: Principal Component Analysis of Network Traffic Measurements: the "Caterpillar"-SSA Approach, "Particles & Nuclei, Letters", 2004, Vol. 1, N4 (121), pp. 87-100.]*

A modification of the Prigogine-Herman kinetic equation related to the network traffic was presented. A solution of this equation for homogeneous time-independent situations and for the log-normal desired speed distribution function, obtained from the traffic measurements was discussed. This solution clearly shows two modes corresponding to *individual flow patterns* (low concentration mode) and to *collective flow patterns* (traffic jam mode). For situations with low concentration there is almost a linear dependence of the information flow versus the concentration and for the higher the average speed the lower the concentration at which the optimum flow takes place. When approaching the critical concentration, there are no essential differences in the flow for different average speeds, whereas for the individual flow regions there are dramatic differences. *[I. Antoniou, Victor V. Ivanov, Valery V. Ivanov, Yu.L. Kalinovsky and P.V. Zrelov: On a Kinetic Model of the Internet Traffc, "Discrete Dynamics in Nature & Society", 2004:1 (2004) 19-34.]*

Distributed informational systems, JINR Central Computing and Informational Center

About 450 staff members of JINR and other research centres are using the JINR Central Computing and Informational Center (JINR-CCIC). The JINR CCIC users distributed over JINR divisions are tabulated as follows:

LIT	DLNP	LPP	VBLHE	FLNR	BLTP	Other Institutes	FLNP	Adm.
157	100	52	42	28	14	24	12	8

The JINR-CCIC is part of the Russian Grid Segment used for LCG and other applications.

Nowadays the JINR-CCIC comprises: an interactive cluster of common access; a common access computing farm for carrying out simulation and data processing for a number of physics experiments in which the JINR participates; a computing farm for the tasks of the LHC experiments; a computing farm for carrying out parallel calculations on the basis of the modern network technologies (Myrinet, SCI, etc.); LCG-2 computing farm included into a worldwide computing infrastructure; mass storage resources on disk RAID-arrays.

Total CCIC PC-farms performance is: CPU 8.0 kSPI95, disk space 14.0 TB. During the eleven months (of year 2004) the total CPU time used was 3 657 567.60 hours, average loading was 31.7%. The average loading of a common access farm is 49.2% during the year and 82.25 in April, 2004.

JINR CCIC facilities were used by experiments E391A (KEK), KLOD , COMPASS, DO, DIRAC, HARP, CMS, ALICE, ATLAS, HERAb, H1, NEMO, OPERA, HERMES, IREN for mass event modelling, data simulation and analysis For ALICE, ATLAS, CMS and LHCb experiments, the sessions of the mass modelling of physical events have been conducted this year in frames of the JINR's participation in DC04 (as example: the CMS production run - 75000 events (~ 300 GB each) 0.5 TB data on B-physics was downloaded to the CCIC for the analysis). ALICE participation (JINR & Russian centers) in DC04 was at a level of 4.0% and 1.4% - the JINR investment to a total number of successfully done Alien jobs. LHCb - (Russian centers & JINR) - 4.85% investment and 0.5% - JINR.

The table below shows the percentage of CPU time using by JINR Laboratories on CCIC PC farms.

LIT	FLNR	DLNP	LPP	FLNP	BLTP	VBLHE	Prod. run	Others
6.5	1.2	11.0	15.0	3.0	14.0	8.0	38.5	2.8

Computing service and creation of a JINR Grid-segment

In 2004, LIT actively worked on using Grid-technologies for experimental data processing.

The Dubna-Grid Project was elaborated in 2004 in collaboration of LIT, University "Dubna", Directorate of the Programme for develop-

ment of the science city of Dubna, University of Chicago, USA, and University of Lund, Sweden. The main aim of the project is creation of a Grid testbed on the basis of resources of Dubna scientific and educational establishments, in particular, JINR Laboratories, International University "Dubna", secondary schools and other organizations. This project will allow one to use more than 1000 CPU on the basis of Grid technologies.

In the year 2004, the Laboratory also performed

- *Adaptation and support of new versions of ANAPHE* (former LHC++) Library for Linux, Windows and Sun Solaris platforms. Technical and programming assistance of the software development for LHC experiments.

- *Continuation of support of the existing software for LHC* (ATLAS, ALICE and CMS) and non-LHC experiments.

- *Participation in Pre-Challenge production* for ALICE, ATLAS, CMS, and LHCb and DC04.

- *JINR participation in the LCG project:*

• tests on data transferring by the GridFTP protocol (Globus-Toookit 3);

• installation of the server on monitoring of Russian LCG sites; study of GridICE and MapCenter tools usage for monitoring of Russian sites;

• activities on the CMS Monte Carlo Event Database;

• development of the toolkit (GoToGrid) on the automatic installation and tuning of the LCG-2 package;

• software design for installation and control of MonaLisa clients on the base of RMS (Remote Maintenance Shell);

• the further development of the LCG web-portal: a new system on collecting, keeping and visualization of monitoring data on CPU and Storage Resources usage at the Russian LCG sites; a new informational block on the CPU and Storage Resources which are available at the Russian LCG sites.

- *Creation of events database and repository of generators.* Dynamical home-page http://hepweb.jinr.ru has been created for testing Monte Carlo Generators. The page also allows one to estimate the main properties of hadron-nucleus and nucleus-nucleus interactions (includes FRITIOF model, HIJING model, and tools for Glauber and Reggeon theories calculation).

- *Participation in the EGEE project:*

JINR together with 7 institutes of Russia (IHEP, IMPB RAS, ITEP, KIAM RAS, PNPI RAS, RRC KI, and SINP-MSU participate in the EGEE *(Enabling Grids for E-sciencE)* project (leaded by CERN) which was started on 1 Aprill, 2004. In frames of this work the first prototype for resource centre at JINR was installed and is working now. The farm consists of 20CPU; the LCG-2 software was installed. The site JINR-LCG2 is included in the GOC Grid monitoring (http://goc.grid.sinica.edu.tw/gstat/lcgce01.jinr.ru/). The JINR LCG-2 site was actively used by some LHC experiments for testing and data production.

Maintenance of the JINR Program Library was in progress. New documents have been prepared and introduced in WWW. They include realization at JINR of electronic access to the CPCLIB, CERNLIB (http://www.jinr.ru/programs/), adaptation programs on the JINR computer platforms, and filling the JINRLIB (about 100 programs have been included and tested).

DATABASE and WWW Service

A systematic supplement and maintenance of the earlier created databases and information systems continued taking into account the users' needs. Among these are:

• System for accounting and statistics of operating the JINR basic facilities (http://iis.jinr.ru/basic-fac/).

• Information system «JINR Topical Plan for Research» (http://www.jinr.ru/plan/ptp-2004/title.htm).

• (http://lib.jinr.ru/dmitry/uni/rus/simple.html) – electronic catalog at JINR Library.

• http://lib.jinr.ru/maillist/newslistru.html online sending lists on preprints, JINR communications, etc. at the JINR Library.

Work was in progress at LIT on the development of WWW-tools on the main information servers as part of the JINR Central Computing and Information Complex (CCIC): www.jinr.ru and lit.jinr.ru. The allocation and support in the "Web-hosting" mode of information sites of a number of JINR subdivisions and external organizations was performed. The web-pages of four conferences were prepared and maintained.

Steady support of one of the main general-purpose FTP-servers was provided: faxe.jinr.ru. Total eleven month hits were 956 383 and visits – 547 568. This server also was utilized for support and load on call of

anti-virus programs into JINR PCs.

The LIT employees fulfilled necessary work for the JINR's STD AMS on the software and centralized support of administrative databases, including modernization of the interface and contents of the database "JINR Staff", software support of the JINR Accounting Department and accounting departments of the Institute's sub-divisions, processing of information on pension benefits at JINR for the Pension Foundation, etc.

Computer Physics for Theoretical and Experimental Research

In 2004 the investigations on topic "Computer Physics for Theoretical and Experimental Research" (09-6-1041-2002/2004) was continued. More than 120 scientific publications, reports at conferences and JINR preprints were published and presented.

Development of methods for modeling and processing experimental data

A new algorithm Jetfinder based on a wavelet analysis has been developed in frames of the VBLHE-LIT collaboration that realizes a jet reconstruction under conditions of intensive background. The algorithm works in the space of pseudorapidity η versus φ using as weights transverse momenta for STAR TPC or ECAL energy. Its idea is to make a 2D wavelet decomposition and then make filtering with the threshold value equal to $\lambda * RMS$ of a layer for each layer of decomposition individually, where λ is a global control parameter for all layers. After the inverse transformation all residuary peaks are accepted as possible jet directions. The main advantages of the Jetfinder algorithm, as compared to the standard procedure LUCELL (UA1) which uses tree parameters, are in using the only control parameter λ and its remarkable robustness. Besides the Jetfinder analyzes all scales automatically by one pass of the algorithm. [G.A. Ososkov, A.V. Stadnik. // Effective neural network algorithms for experimental data processing, // Information technologies and computing systems, No.1, URSS, Moscow, 2004, P.103-125.]

Experimental data on sulfur and oxygen nuclei interactions with photoemulsion nuclei at the energies of 200 and 60 GeV/nucleon are analyzed with the help of a continuous wavelet transform. Irregularities in pseudo rapidity distributions of narrow groups of secondary shower particles in the pointed interactions are observed at application of a second-order derivative of Gaussian as a wavelet. The irregularities can be interpreted as an existence of the preference emission angles of the group par-

ticles. Such effect is expected at emission of Cherenkov's gluons in nucleus-nucleus collisions. Some positions of the observed peculiarities on the pseudo rapidity coincide with those found by I. M. Dremin et al. (Dremin I. M. et al., Phys. Lett. B. 2001. V. 499. P. 97). [V.V. Uzhinsky, S.N. Navotny, G.A. Ososkov, A. Polanski, M.N. Chernyshevsky. // Wavelet Analysis of Angular Distributions of Secondary Particles in High Energy Nucleus-Nucleus Interactions. Irregularity of Particle Pseudo rapidity Distributions. // Yad. Fiz. 2004, V. 67, № 1(in Russian).]

Simulation of the processes of multi-fragmentation and spallation in reactions of separated Sn isotopes with proton and deuteron beams at the energies 0.6, 3.5 and 8.1 GeV/nucleon has been performed. Cross sections of products yield are analyzed in connection with the number of accompanying neutrons. Results of the simulation are compared with experimental data obtained at LHE synchrophasotron. [A.R. Balabekyan, G. Musulmanbekov. // Isotopic effects of fragment – yields in proton induced reactions on Sn isotopes, // Nucl. Phys. A 735, 2004, P. 267 – 276.]

The improved model of decaying very excited post-cascade nuclei has been included into the program complex CASCADE, thus increasing drastically its accuracy, especially when computing isotope yield. Based on the complex, a mathematical model of the U-Pu assembly "Energy + Transmutation" has been designed, and a detailed analysis of its modes and neutron and gamma-quanta yields has been performed. A cheap modernization of the installation that essentially improves its characteristics has been proposed. Calculations were performed on particles yield and heat release in bismuth, leaden and tungsten targets of various configuration in a 660 MeV proton beam. A method of calculating the neutron spectra generating in splitting reactions inside various targets has been elaborated. [V.S. Barashenkov, H. Kumawat. // JINR P2-2003-207, // Kerntechnik 2004, V.69, P. 112; J. Adam, A. R. Balabekyan, V. S. Barashenkov, R. Brandt, V. M. Golovatiouk, V. G. Kalinnikov, K. Katovsky, M. I. Krivopustov, V. Kumar, H. Kumawat, R. Odoj, V. S. Pronskikh, A. A. Solnyshkin. // Spallation neutron spectrum on a massive lead/paraffin target irradiated with one GeV protons. // JINR E1-2004-16, Dubna, 2004. Evr. J. Phys 2004 (in press); V.S. Barashenkov, Ch. Kumavat, V.A. Lobanova, S.G. Stetsenko. // Targets of electronuclear set-ups. // Part. Nucl. Letters (in print)].

A visualization package for observation of the profile of a primary beam and its location on the target for effective operation of the fragment - separator of the setup COMBAS was developed. The package allows one to visualize data both in on-line and off-line modes. Visualization of the beam profile is developed on the basis of graphic library OpenGL, and the interface is constructed with the help of the toolkit
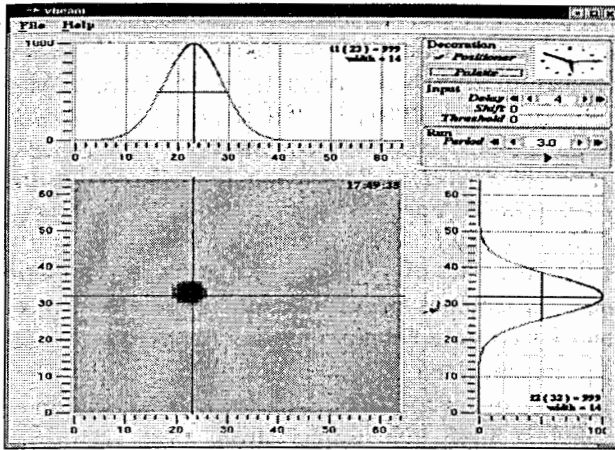
Fig. 4: Visualization of the beam profile

FLTK. When starting the package, a window containing a central field of survey of the beam profile and two auxiliary fields for its projections on axeses X and Y appear (see Fig. 4). By small modifications the package can be used for a broad spectrum of set-ups which use accelerator beams. *[A. Soloviev, G. Kaminsky, G. Musulmanbekov. // The beam profile visualization and control system for COMBAS setup. // Submitted to PEPAN Lett.]*

The structures of hadrons and nuclei are analyzed in the framework of the Strongly Correlated Quark Model. This model of dynamical quarks demonstrates an interconnection between constituent and current quark models and leads to representation of constituent quarks as solitons. It has been applied to explain various phenomena in diffractive and spin physics. Inside nuclei the quarks of bound nucleons are arranged in such a way that the nuclei get a crystal-like structure. The crystal - like structure of nuclei leads to appearance of a cluster and molecular type configurations in multinucleon systems. Significantly, the structure of exotic nuclei, especially borromean nuclei, can be explained by specifying the quark couplings of adjacent nucleons. The program of computer graphics for nuclei called Nuclear Visualization System (NVS) is being elaborated in collaboration with computer graphics group at Kansai University, Japan. It is based on graphics library OpenGL and toolkit FLTK, which allows one to create sophisticated interfaces. *[G. Musulmanbekov. // Do Nuclei Possess Crystal – Like Structure?, // Nucl. Phys. A 734 Supl., 2004, pp. 480 – 483; G. Musulmanbekov // Total cross section, inelasticity and multiplicity distributions, // Nucl.Phys., 2004, v. 67, N 5, pp. 90 – 99; Phys. Atom. Nucl., 67, No. 1, 2004, pp. 89 – 98; G. Musulmanbekov. // Quarks in hadrons and nuclei, // Amer.Inst.Phys., Conf. Proc., 717, 2004, Ed., E. Klempt, H. Koch, and H. Orth, pp. 701 – 705.]*
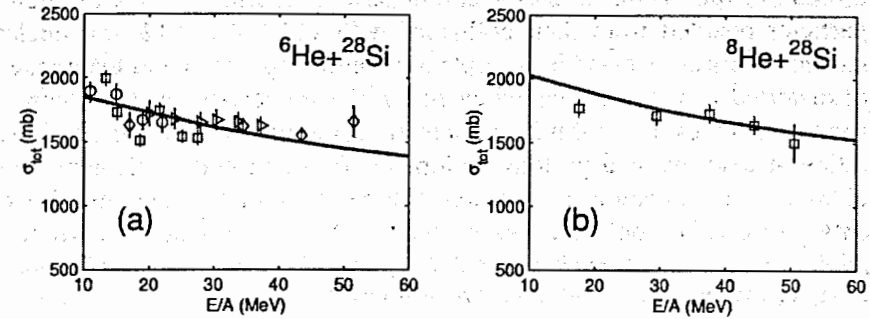
Fig.5: Total reaction cross section for ^{6,8}He + ^{28}Si calculated in the framework of the high-energy approximation, with the M-model point density distributions

In the framework of the Glauber-Sitenko microscopic optical-limit-model, calculations are made of the nucleus-nucleus total reaction cross-sections. The eikonal phases are reduced to the one-dimensional integrals with analytic profile functions for the point densities in the form of the "surface-matched" Gaussian functions for incident nuclei and in the form of the symmetrized fermi-functions for target-nuclei. Contributions into cross-sections of in-medium and trajectory distortion effects are estimated. A satisfactory agreement with existing experimental data at energies higher than 50 MeV/nucleon is obtained without introducing any free parameters. On the basis of the model, calculations of the ^{6,8}He+^{28}Si total reaction cross sections at intermediate energies have been performed. The target-nucleus density distribution is taken from the electron-nucleus scattering data, and the ^{6,8}He densities are used as they are derived in different models. The results of the calculations are compared with the existing experimental data (Fig.5). The effects of the density tails of the projectile nuclei as well as the role of shell admixtures and short-range correlations are analyzed. *[V.K.Lukyanov, E.V.Zemlyanaya, B.Slovinsky. Calculation of total cross-sections of nucleus-nucleus reactions using relativisitc distributions of nuclear densities. Izv. RAS, ser Phys., v.68, issue 2, 2004, pp.162-166; V.K.Lukyanov, E.V.Zemlyanaya, S.E.Massen, Ch.C.Moustakidis, A.N.Antonov, G.Z.Krumova. Testing ^{6,8}He density distributions by calculations of total reaction cross-sections of ^{6,8}He+^{28}Si. IJMPE, V.13, N.3, 2004, pp.573-584.]*

A phenomenological and semimicroscopic analysis of data ac-

quired in experiments on elastic and inelastic scattering of 50-MeV alpha particles resulted from their collisions with 112,114,120,124 Sn nuclei has been carried out within the optical potential approach and techniques of distorted waves and coupled channels. For the low-lying states, corresponding values of deformation parameters, deformation lengths, and the ratios of neutrons and protons multipolar transition matrix elements are obtained and comparison between obtained parameters and published data is carried out for other types of the projective particles. *[K.A.Kuterbekov., I.N.Kuchtina, B.M.Sadykov, E.I.Ismatov. The Ukrainian Physical Journal, 2004, v. 49, № 9, pp. 841-850].*

The energy dependence of Total Reaction Cross-Section for α-particles on ^{28}Si has been directly and accurately measured by the transmission method. These data show that σ_R has a different energy dependence from theoretical predictions at low energies. The σ_R corrections due to inelastic scattering to the first excited state were made by integrating corresponding angular distributions. *[K.A.Kuterbekov, I.N.Kuchtina, T.K. Zholdybayev, B.M.Sadykov, A.Mukhamedzhan. Alfa-particles scattering and structural characteristics of ^{28}Si nucleus. Izvestiya MON RK, physico-mathematical series, 2004, No. 2, pp. 29 – 34].*

Anomalous decays $\pi^0, \eta \rightarrow \gamma\gamma$ in the framework of the three-flavor Nambu-Jona-Lasinio [NJL] model, in the vacuum and in quark matter in β - equilibrium, are studied. It is found that the behavior of the relevant observables essentially reflects a manifestation of the partial restoration of chiral symmetry, in non strange and strange sectors. The probability of such decays decreases with density, showing that anomalous mesonic interactions are significantly affected by the medium. *[Pedro Costa, M. C. Ruivo, Yu. L. Kalinovsky. Anomalous decay of pion and eta at finite density. Phys. Lett. B581 (2004) 274-275.]*

Phase transitions in hot and dense matter and the in-medium behavior of pseudoscalar mesons are investigated, in the framework of the three flavor Nambu--Jona-Lasinio model, including the 't Hooft interaction, which breaks the $U_A(1)$ symmetry. Three different scenarios are considered: zero density and finite temperature, zero temperature and finite density in quark matter with different degrees of strangeness, and finite temperature and density. At T=0, the role of strange valence quarks in the medium is discussed, in connection with the phase transition and the mesonic behavior. It is found that the appearance of strange quarks, above certain densities, leads to meaningful changes in different observables, especially in matter with in β -equilibrium. The behavior of mesons in the T-ρ plane is analyzed in connection with possible signatures of res-

toration of symmetries. *[Pedro Costa, M. C. Ruivo, Yu. L. Kalinovsky, C. A. De Sousa. Pseudoscalars Mesons in Hot, Dense Matter. Phys. Rev. C 70 (2004) 025204; D. Blaschke, Yu. Kalinovsky, V. Yudichev. Heavy Mesons and Impact Ionization of Heavy Quarkonia. Lect. Notes Phys. 647:366-375,2004.]*

The photon-proton scattering reactions the $\gamma p \rightarrow \gamma'\pi'$, $\gamma p \rightarrow \pi^{0'}p'$ and the $\gamma p \rightarrow \gamma'\pi^{0'}p'$ are investigated via the field-theoretical one-particle $\pi\omega\rho$-meson, nucleon and Δ-isobar exchange model. Unlike the other relativistic approaches, our resulting amplitudes of the γp multichannel reactions require one-variable covariant vertex functions as input ingredients. In the present three-dimensional time ordered formulation, it is well known, that in the Coulomb gauge the current conservation condition is satisfied for any diagram from the corresponding multiple scattering series of these amplitudes. A full set of the model independent skeleton diagrams for the $\gamma p \rightarrow \gamma'p'$ reaction is presented. Proceeding from the separable model of the πN amplitude, a procedure of construction of the microscopic propagator of the Δ resonance is suggested. This procedure allows one to determine the πN-Δ form factors and Δ propagator as the spin 3/2 particle microscopic propagator explicitly from the πN P_{33} phase shifts. The numerical calculation of the cross-section of the $\gamma p \rightarrow \gamma'p'$, $\gamma p \rightarrow \pi^{0'}p'$ and $\gamma p \rightarrow \gamma'\pi^{0'}p'$ reactions are performed with two different separable models of the Δ propagator and with the propagator of Breit-Wigner shape. *[A.Machavariani. Field-theoretical three-body relativistic equations for the multichannel πN - γN - $\pi\pi N$ - $\gamma\pi N$ reactions. Annals of Physics, V39 (2004) P.49-92; A.Machavariani. Propagator of the Δ resonance and determination of the magnetic moment of the Δ^+ from the $\gamma p \rightarrow \gamma\pi^0 p$ reaction. To be published in Physical Review C.]*

In the framework of the Agreement concluded between the JINR and the University of Cape Town, the particle-like excitations of nonlinear damped systems in various models of condensed matter and nonlinear optics, have been studying. Theoretical and numerical investigation of traveling solutions in the damped driven nonlinear Schrödinger equation has been performed. This equation has a number of applications in the fluid dynamics models, nonlinear optics, ferromagnet theory, etc. New classes of soliton solutions of NLS equation have been analyzed for the cases of parametric and external driving. It is shown that damped driven solitons can form bound states. Conditions of existence of the traveling damped, parametrically driven solitons have been formulated. The continuation scheme for numerical analysis of the traveling damped solitons is developed. It is shown that two or more solitons of parametrically

driven, damped nonlinear Schrödinger equation can form a complex traveling with zero momentum at a nonzero constant speed. *[I.V.Barashenkov, E.V.Zemlyanaya. Traveling solitons in the damped driven nonlinear Schroedinger equation. SIAM Journal of Applied Mathematics, v.64, No.3, p.800, 2004; E.V.Ztmlyanaya, I.V.Barashenkov. Numerical research of multi-soliton complexes in the damped driven nonlinear Schroedinger equation. Mathematical Modelling, v.16, No.10, pp.3-14, 2004].*

For some class of the magnetic systems which are widely used in experimental physics, a new method for a numerical solving of the problem of homogeneous magnetic field formation by varying a ferromagnetic volume was suggested. *[E.P. Zhidkov, V.V. Ryltsov, O.I. Yuldashev, M.B. Yuldasheva. // Bulletin of RPFU, Series Physics. 2004, v.12, N 1. (in press)].*

Creation of numerical methods and software for mathematical simulation of complex physics systems

The solutions of Klein-Gordon equation in the gravitational field of a massive point source in GR were considered for the first time. The basic bounded quantum state and the next few states in the discrete spectrum for different values of the orbital momentum were examined numerically. A novel feature of the solutions under consideration is the essential dependence of their physical properties upon the gravitational mass defect of the point source. It yields a repulsion or an attraction of the quantum levels and to their quasi-crossing. *[P.P. Fiziev, T.L. Boyadjiev, and D.A. Georgieva, Novel properties of bound states of Klein-Gordon equation in Gravitational field of massive point, gr-qc/0406036; Comm. JINR P11-2004-120 (Accepted in JCM&CP)].*

A numerical simulation has been performed for static vortices in a long Josephson junction with an exponentially varying width. At specified values of the parameters the corresponding boundary-value problem admits more than one solution. Each solution (distribution of the magnetic flux in the junction) is associated to a Sturm-Liouville problem, the smallest eigenvalue of which can be used, in a first approximation, to assess the stability of the vortex against relatively small spatiotemporal perturbations. The change in width of the junction leads to a renormalization of the magnetic flux in comparison with the case of a linear one-dimensional model. The influence of the model parameters on the stability of the states of the magnetic flux is investigated in detail, particularly that of the shape parameter. The critical curve of the junction is constructed from pieces of the critical curves for the different magnetic flux

distributions having the highest critical currents for the given boundary magnetic field. *[E.G. Semerdjieva, T.L. Boyadjiev, and Yu.M. Shukrinov, Static vortices in long exponentially shaped Josephson junctions, cond-mat/0410048; Low Temperature Physics, v. 30. No. 6 (2004), pp. 610-618.]*

On the basis of the separated form-factor model, parameters of the polydispersed unilamellar DMPC vesicle population are analyzed. The neutron scattering length density across the membrane is simulated on the basis of a fluctuated model of a lipid bi-layer. The hydration of vesicle is described by sigmoid distribution function of water molecules. The results of fitting (Fig.6) the experimental data obtained at the small angle spectrometer SANS-I, PSI (Switzerland) are as follows: average vesicle radius 272 ± 0.4 Å, radius polydispersity 27%, membrane thickness 50.6 ± 0.8Å, thickness of hydrocarbon chain region 21.4 ± 2.8Å, number of water molecules per one DMPC molecule 13 ± 1, area per one
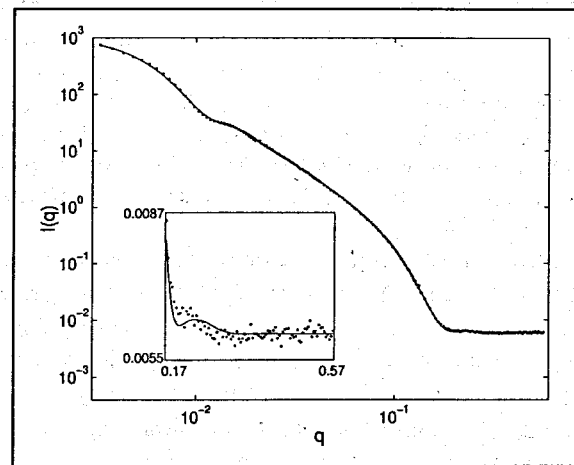

Fig.6: Fitting results of the DMPC vesicle spectrum. Experimental data have been collected at PSI SANS-1 spectrometer. Main panel and inset: points – experiment; solid lines – numerical results. Inset shows the large q case

DMPC 59 ± 2Å^2. The calculated water distribution function across the bi-layer directly explains why the lipid membrane is easy penetrated by water molecules. *[E.V. Zemlyanaya, M.A.Kiselev, A.Vinod. SANS study of the unilamellar DMPC vesicles: the fluctuation model of a lipid bi-layer. Crystallography Reports, Suppl. 1, 2004, pp.S131-S136.]*

Investigated was the influence of hydrotropy on the stability of scaling modes in the model of admixture of a passive scalar in given stochastic matter in a two-loop approximation. Its influence on the anomalous scaling of corresponding structural functions was also studied. A common formula for parametrization of many-loop Feynman integrals has been found. Besides, with the use of various approaches to applying the problem, an analytical form of nontrivial integrals has been

found.*[O.G. Chkhetiani, M. Hnatich, E. Jurcisinova, M. Jurcisin, A. Mazzino, and M. Repasan. // Influence of helicity on anomalous scaling of a passive scalar advected by the turbulent velocity field with finite correlation time: Two-loop approximation. (Phys. Rev. E, in print)].*

A role of a nonlinear (both self-induced and induced by a scalar field) spinor field in creating anisotropic cosmological models with no singularities was studied. Influence of ideal liquid and a cosmological term on the behavior of solutions obtained both numerically and analytically, has been investigated. A role of viscous fluid in the evolution of Universe of a Bianchi type was analyzed in an analytic way. In the framework of the plain symmetry geometry, investigated was a possibility of obtaining the particle – like configurations for nonlinear scalar and spinor fields in the theory of relativity. At present, some cosmological models with dark energy and viscous fluid as well as a role of time in OTO, an atom's soliton model, a role of super-energy and Bell's super-tensor in the Taub-NUT geometry are under consideration.*[Saha, Bijan and T. Boyadjiev. Bianchi type-I cosmology with scalar and spinor fields. // Physical Review D 69, 124010 (2004) (E-print:gr-qc/0311045);Saha Bijan. // Nonlinear Spinor Field in cosmology. // Physical Review D 69, 124006 (2004), // E-print:gr-c/0308088);Saha Bijan and Shikin G.N. // Plane-symmetric solitons of spinor and scalar fields. Chezkoslovak Journal of Physics, 54 (6), 597-620 (2004)]*

Algorithms and codes have been developed for constructing stationary regular solutions to the Yang-Mills-dilaton system and obtaining unstable eigenmodes of those solutions. Corresponding problems (boundary value problem and Sturm – Leouville matrix problem) were solved on the basis of the continuous analogue of Newton's method. The obtained solutions are used as initial conditions when studying the decay of stationary solutions in the evolution process. An effective algorithm has been developed and a program complex has been designed for solving a system of nonlinear wave equations. A parallel version of the program complex was realized on the language MPI -Fortran. *[O.I. Streltsova, E.E. Donets, E.A. Ayrjan, D.A. Georgieva, and T.L. Boyadjiev. // Unstable even-parity eigenmodes of the regular static. SU(2) Yang-Mills-dilaton solutions. // E-print: gr-qc/0408060, Preprint JINR, E11-2004-151, 2004, Submitted to JCMP.]*

The nonlinear decay problem of unstable spherically symmetric static solutions in the Yang-Mills – dilaton system, which is a coupled system of two nonlinear evolutionary hyperbolic type equations, has been investigated. For the problem to be solved, adaptive algorithms have been proposed that allow one to investigate adequately the evolution of solutions both on very small and very large spatial and time scales. With the purpose of decreasing the calculation time, a parallel computing with using a multiprocessor computing system was applied. In order to solve three diagonal systems of linear equations arising from the finite difference approximations to the original problem, a parallel realization of Thomas algorithm was applied, which is quite effective for solving on two processors, and a partition method of system on p parts that allows one to solve it in parallel on p processors. Parallel computing with using the message passing interface (MPI) was done on cluster with p=1,2,3...7 processors. The numerical experiment has shown the accelerating of calculations is of the order of p/2. *[Hayryan E. A., Busa J., Donets E. E., Pokorny I., Streltsova O. I. Numerical studies of perturbed static solutions decay in the coupled system of Yang-Mills-dilaton equations with use of MPI technology. Preprint JINR, P11-2004-183. (Submitted to "Mathematical Modelling")].*

In cooperation with the Technical University of Cosice (Slovak Republic) and the Laboratory of Computing and Statistic Physics (Academia Sinica, Taiwan), research was in progress on mathematical simulation of formation of 3D protein structures. In order to study the thermodynamic properties and 3D structures of macromolecules of a protein type, an effective algorithm is required for computing the solvent accessible surface area and the volume of macromolecules deposited in solvent. A method of constructing a special closed surface area made of triangles that allows one to determine if the given point is inside the molecule or else outside of it, has been developed. A new analytic method earlier proposed for finding the macromolecules' square and volume, was adapted for calculation with accounting a possible existence of intramolecular cavities.*[Shura Hayryan, Chin-Kun Hu, Jaroslav Skrivanek, Edik Hayryan, Imrich Pokorny. // A New Analytical Method for Computing Solvent Accessible Surface Area of Macromolecules and its Gradients, // Journal of Computational Chemistry (in press);Jan Busa, Jozef Dzurina, Edik Hayryan, Shura Hayryan, Chin-Kun Hu, Jan Plavka, Imrich Pokorny, Jaroslav Skrivanek, Ming-Chya Wu. // ARVO: A Fortran package for computing the solvent accessible surface area and the excluded volume of overlapping spheres via analytic equations. // Computer Physics Communications (in press)].*

The linear response of a spherical Coulomb cluster is modelled by coupled equations of solid mechanics and dielectric induction. Analytic estimates have been obtained for the frequency of dielectric spheroidal and torsional shear modes showing that the dielectric response

is of relaxation nature *[S. I. Bastrukov, I. V. Molodtsova, D. V. Podgainy // JCMSE, 2004, in press.]*

Based on the principles of classical hydrodynamics and Newtonian gravity, the theory of hydrogravity formulated in the manner of hydromagnetic theory has been developed to provide constructive account of the gravitational effect of global pulsations of a neutron star on the motions of ambient gas-dust interstellar medium. Particular attention was given to gas-dynamical oscillations generated by a pulsating neutron star in an unbounded spherical shell of gas and dust promoted by circumstellar gravitational stresses and damped by viscosity of the interstellar matter. Computed in the long wavelength approximation, the periods of these gravity driven shear mode, referred to as quasistatic modes of hydrogravity, are found to be proportional to periods of the gravity modes in the neutron star bulk. *[S. I. Bastrukov, I. V. Molodtsova, D. V. Podgainy, et al. // JETP 99 (2004) 449-459; S. I. Bastrukov, I. V. Molodtsova, et al. // Int. J. Mod. Phys. A, 2004, (in press).]*

In the framework of Green's function formalism at finite temperatures, superfluidity of nuclear matter with *np* pairing correlations was studied. *[A. A. Isayev, S. I. Bastrukov, J. Yang // Nucl. Phys. A734 (2004) E112-E115; A. A. Isayev, S. I. Bastrukov, J. Yang // Phys. Atom. Nucl. 67 (2004) 1840-1845.]*

On the basis of a linear two-temperature model of thermal peak, results have been received on the numerical solving of finitely - difference equations for calculation of temperatures of electronic gas and crystal lattice by energy of 5 MeV/n and the value of specific ionizing losses of energy $S_{ine}10 = 73$ keV/nm, processes can take place caused by phase transitions: solid - liquid (melting of nickel) and solid - vaporous state (evaporation of nickel) with a subsequent hardening of the target material, when cooling and dissipating the heat released by a uranium ion (Fig.7).

Based on the obtained results, it is possible to extract the characteristic sizes of the areas with phase transitions. At constant values of thermodynamic parameters, such as specific thermal capacity and heat conductivity, the received profiles of temperatures of the electronic gas and the crystal lattice reproduce the initial dependences of specific ionization losses of the heavy ion energy. The received temperature dependences for the crystal lattice, exceeding the temperatures of melting and evaporating, should be used to estimate the influence of pressure which will arise at temperature growth. *[I.V.Amirkhanov, E.V.Zemlyanaya, I.V.Puzynin, T.P.Puzynina, N.R.Sarkar, I.Sarkhadov. Numerical modeling*
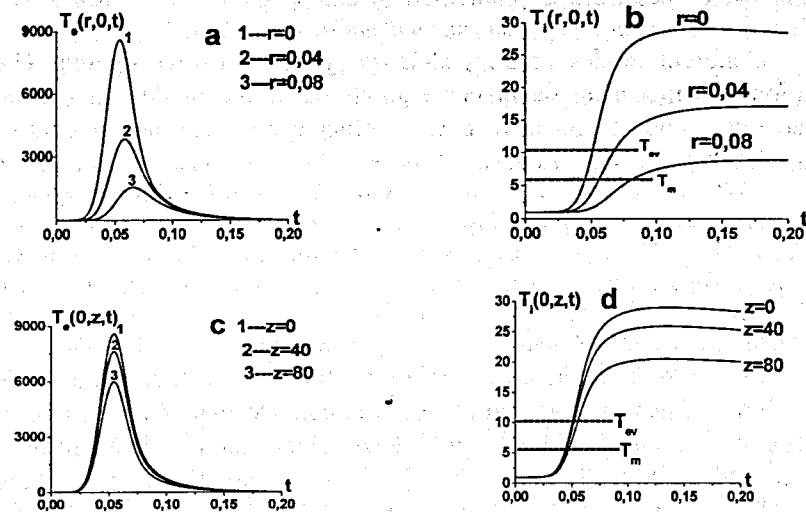

Fig.7: Time dependence of the temperature of electron gas (a) and lattice (b) on the surface (z=0) of nickel irradiated with uranium ions for various distances from the track axis. Time dependences of temperatures of electron gas (c) and lattices (d) in the place of passing a uranium ion through a surface (r=0) for different depths z in the target. The shaded straight lines on fig. 7 (b, d) show the temperatures of melting T_{melt} and evaporation T_{evap}

of evaporation of metals exposed to pulsed ion beams. Crystallography Reports, V 49, Suppl.1 2004, pp. S118-S123; I.V.Amirkhanov, E.V.Zemlyanaya, I.V.Puzynin, T.P.Puzynina, N.R.Sarkar, I.Sarkhadov. Numerical modeling of influence of viscosity on the distributions of thermo-elastic waves in a sample of the metal irradiated with pulsed ion beams. "The Surface" Journal, No.10, 2004; I.V.Amirkhanov, A.Yu.Didyk, E.V.Zemlyanaya, I.V.Puzynin, T.P.Puzynina, N.R.Sarkar, I.Sarkhadov, V.K.Semina, Z.A.Sharipov, A.Hoffman. Numerical calculation of temperature effects in materials irradiated by high-energy heavy ions high in the framework of the equations of heat conductivity for electrons and lattices. JINR Preprint P11-2004-165, Dubna, 2004 (submitted to Nucl. Part. Let.)]

A FORTRAN program is presented which solves a system of nonlinear simultaneous equations using the continuous analog of Newton's method (CANM). The user has the option of either to provide a subroutine which calculates the Jacobian matrix or to allow the program to calculate it by a forward-difference approximation. Five iterative schemes, using different algorithms of determining adaptive step size of

the CANM process, are implemented in the program. *[A. Abrashkevich,, I.V. Puzynin. // Computer Physics Communications 156 (2004), P.154-170].*

Coherent modes of trapped Bose gases were investigated. The conditions of appearing resonance excitations of the modes have been figured out. The results have been published and reported at conferences.*[V.I. Yukalov, E.P.Yukalova. // Coherent Nuclear Radiation, Phys. Part. Nucl. 35, 348–382 (2004); V.I. Yukalov, K.-P.Marzlin, E.P.Yukalova. // Resonant Generation of Topological Modes in Trapped Bose Gases. // Phys. Rev. A 69, 023620–16 (2004);V.I. Yukalov, K.-P.Marzlin, E.P.Yukalova. // Multiple Coupling of Topological Coherent Modes of Trapped Atoms. // Laser Phys. 14, 565–570 (2004); V.I. Yukalov, E.P.Yukalova. // Stratification of Moving Multicomponent Bose-Einstein Condensates. // Laser Phys. Lett. 1, 50–53 (2004).]*

Research on the inverse problem for the two-dimensional discrete Schroedinger equation was continued. One can see that if found matrix reserves the symmetry of the original basic eigenvectors, the eigenfunctions can be prolonged "smoothly" from the rectangular to the whole plain. All these symmetries follow a part of them, the chosen conditions. It was proved that the chosen symmetries imply symmetry of the found matrix and all its blocks with respect to both diagonals (persymmetry). *[S. I. Serdyukova, Numerical Investigation of Breather-Type Solutions by Using REDUCE, Programming and Computer Software,Volume 30, Issue 2, March - April 2004, PP. 118 – 119; 2. S.I. Serdyukova "Potential reconstruction for two-dimensional discrete Schroedinger equation"Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment Volume 534, Issues 1-2 , 21 November 2004, Pages 304-308 Proceedings of the IX International Workshop on Advanced Computing and Analysis Techniques in Physics].*

The problem of a classification of the *E.coli* promoters with respect to their electrostatic potentials was studied at LIT in cooperation with the Institute of Theoretical and Experimental Biophysics and the Institute of Cell Research of RAS (Puschino). The classification of promoters and other functionally important genome fragments according to their nucleotide sequences and physical-chemical properties is a key factor for understanding gene transcription, replication, recombination and their regulation. The classification of genome promoters is usually performed on the basis of analysis of their primary structures. However, this approach does not allow one to receive a simple answer because it is the physical-chemical properties of DNA that control the process of gene transcription and its regulation. Electrostatic interactions comprise an essential component of those processes. This work presents the approach that allows computation of electrostatic potentials of long nucleotide sequences of DNA for both procaryotic and eucaryotic species. The electrostatic potentials of *E.coli* promoters and periodic sequences were calculated. The electrostatic characteristics of the genome promoters together with the primary structure are expected to provide their reliable classification. *[R.V. Polozov, V.S. Sivozhelezov, V.V. Ivanov and Yu.B. Melnikov: On a Classification of E.coli Promoters According to Their Electrostatic Potentials, "Particles & Nuclei, Letters" (in press).]*

In cooperation with the International Solvay Institute for Physics and Chemistry, Brussels, Belgium, the Department of Mathematics, Aristoteles University, Thessaloniki, Greece, and Moscow Engineering and Physical Institute, Moscow, Russia, the efficient resources distribution in economics based on entropy has been investigated. The approach developed in previous work on the efficient resources distribution in economic systems with a small number of elements based on entropy was generalized. In order to take into account the asymmetric resources distribution, a new set of two-parameter interpolating functions was introduced. It is demonstrated that the maximal value of entropy is reached only in case of asymmetric distribution of resources. First results on application of the generalized approach to the analysis of incomes distribution for Sweden and Russia populations have shown that the new scheme allows efficient estimation of the state of the analyzed system and control over the resources distribution process. *[I. Antoniou, V.V. Ivanov, A.V. Kryanev, V.V. Matokhin and M.V. Shapovalov: On the Effcient Resources Distribution in Economics Based on Entropy, Physica A 336 (2004), pp. 549-562.]*

The results of recent studies on the development of new statistical models of stock market data were presented. On the basis of the analysis of a large number of stocks of various companies it is shown that for some stock market data the statistical distribution of closing prices normalized by corresponding traded volumes (the index called by the authors as "Price/Volume ratio") fits well a log-normal law. For most stocks such a correspondence is reached with no additional detrending procedure. For other stocks, the distribution has a more complicated character and in most cases is described by a weighed sum of some functions of the log-normal distribution. However, after application of a detrending procedure all considered data can be described by a single log-normal distribution. *[I.Antoniou, V.V. Ivanov, Valery V. Ivanov and P.V. Zrelov: On a Log-Normal Distribution of Stock Market Data, Physica A 331 (2004) 617-638.]*

The problem of stable extraction of trend and chaotic components from stock market time series was considered. The proposed methods also allow one to extract a part of the chaotic component, the so-called

anomalous term, which is caused by the transient short-time surges with high amplitudes. This provides more accurate determination of the trend component. The methods are based on the M-evaluation with decision functions of Huber and Tukey type. The iterative numerical schemes for determination of trend and chaotic components are briefly presented, that is resulting in a desired solution within a finite number of iterations. The optimal level for extraction of the chaotic component is determined by a new numerical scheme based on the fractal dimension of the chaotic component of the analyzed series. The forecasting scheme that uses the realized part of the analyzed series and a priori expert information was discussed. *[I. Antoniou, P. Akritas, D.A. Burak, V.V. Ivanov, A.V. Kryanev and G.V. Lukin: Robust Methods for Stock Market Data Analysis, Physica A 336 (2004) 538-548.]*

Development of methods, algorithms and software of computer algebra

A traditional two-day Workshop on Computer Algebra was held in Dubna on 25-26 May, 2004. The workshop was dedicated to the memory of the outstanding Russian physicist and organizer of science M.G.Mescheryakov. He was the first director of LCTA (LIT presently) who strongly supported the development of new scientific trends, such as computer algebra, at JINR.

It was the 8-th of the joint seminars on Computer Algebra conducted by JINR, the Faculty of Computing Mathematics and Cybernetics and SRINP MSU. The participants from Moscow, St.-Petersburg and Dubna delivered 20 reports. Main topics covered algorithms and computer systems and their applications in mathematics and physics.

An efficient parallelization of algorithms for computing involutive polynomial bases of Janet type and with integer coefficients of unbound length was demonstrated. Apart from Janet bases, the parallel version of the algorithm can be also applied for computing reduced Groebner bases. In so doing, there are no needs in extra reductions, since reduced Groebner bases form internally fixed subsets of involutive bases. *[V.P. Gerdt, D.A. Yanovich. // In: Computer Algebra in Scientific Computing / CASC 2004, Garching, 2004, P.185-194.]*

It was argued that the most general and universal algorithmic approach to reduction of multi-loop Feynman integrals to basic integrals was based on computation of Groebner bases for recurrence relations derived from the integration by parts method. In this connection one considers generic recurrence relations when propagators have arbitrary integer powers treated as symbolic variables (indices) for the relations. *[V.P. Gerdt. // Nucl.Phys.B (Proc. Suppl.) 135, 2004, pp.232-237.]*

A number of discrete algorithms for symbolic computation of topological phases in optical interference microscopy were designed and analyzed. These algorithms have been implemented as Maple and Mathematica packages. *[V.A. Rostovtsev et al. // Computer Algebra in Scientific Computing / CASC 2004, Garching, 2004, pp.233-241.]*

The problem of solving the Schroedinger equation for bound states in space of dimension D was investigated for the central potentials of a polynomial type and the coefficients dependent of 2q of arbitrary constants. By a numerical - analytical solving of the algebraic system of equations that is equivalent to the Schroedinger equation (the Magjari system), some interesting laws in distribution and behaviour of the roots of that system were found out depending on value D. In particular, at great enough values of D, the energy spectrum gets equidistant. *[M. Znojil, D.Yanovich. New Type of Exact Solvability and of a Hidden Nonlinear Dynamical Symmetry in Anharmonic Oscillators . Proc. of Inst. of Math. of NAS of Ukraine, Vol. 50, Part 2, 2004, pp.1010-1017.]*

With the help of the program, implementing an original algorithm, cohomologies of the limited Lie algebras of Hamiltonian vector fields were investigated. Such algebras (or Lie p-algebras) of vector fields are finite-dimensional analogs, determined over fields of positive characteristic p, of corresponding classical algebras. Their finite-dimensionality removes a number of difficulties, arising at calculation of cohomologies of classical Lie algebras of vector fields. *[V.V.Kornyak. Modular algorithm of computing cohomologies of Lie algebras and superalgebras. Programming, v.30, issue.3, 2004, pp.52-60.; V.V.Kornyak. On the Structure of Cohomology of Hamiltonian p-Algebras. In: "Computer Algebra in Scientific Computing / CASC 2004", V.G.Ganzha, E.W.Mayr, E.V.Vorozhtsov (Eds.), Institute of Informatics, Technical University of Munich, Garching, 2004, pp. 307-311].*

For a Yang - Mills model with SU (2) of gauge symmetry, its formulation in terms of initial gauge-invariant variables has been given. It is shown that after exclusion of all bounds the given model can be presented in the form of a non-local model of interaction of particles of spin 2 and spin 0. *[A.M.Khvedelidze. On the Hamiltonian formulation of gauge theories in terms of physical variables. Journal of Mathematical Sciences 119(4), 2004, 513-555.]*

An analytical formula for a two-loop QCD correction to the amplitude of the decay $H \rightarrow 2\gamma$ has been received. For calculation of master - integrals contributing to the given correction, a special algorithm re-

minding by its form a classical Riesz algorithm for computing integrals from elementary functions has been developed. *[J. Fleischer, O.V. Tarasov, V.O.Tarasov. Analytical result for the two-loop QCD correction to the decay $H \rightarrow 2\gamma$. Physics Letters B (2004) 294-297.]*