Summaries of All Articles

E. P. Velikhov

Energetics in 21st century global economy

Based on the analysis of global trends in world economy, a century-long foresight of the development of energy technologies is presented. It is shown that conventional energy technologies cannot fit economic demands, with the only realistic alternative being nuclear energy. Its contribution will gradually increase in nearest decades. New programs in nuclear technologies should be initiated shortly, while in the long-term perspective we will encounter the necessity of the full-scale modernization of the nuclear power industry, in particular, to complete its transition to the closed fuel cycle.

Key words: energetics, world economy, nuclear technologies, future forecast

M. V. Kovalchuk

Interdisciplinary approach concept

We discuss the concept of an interdisciplinary approach to the system of science and education organisation. We consider, as an example, the education program of convergent nano-, bio-, information and cognitive technologies.

Key words: specialization in science and education, interdisciplinary, convergence of sciences and technologies, nanotechnologies, biotechnologies, cognitive sciences.

V. F. Razumov, M. V. Alfimov

Advances in research and development of organic and hybrid materials for nanophotonics

In the current survey, main attention is given only to two areas of nanophotonics, viz. the investigation and development of solar cells as well as electroluminescent devices. The basic ingredients of these devices are new electroconducting polymers, fullerene derivatives, carbon nanotubes and graphenes. Semiconductor nanoparticles and metals produced by colloidal synthesis, when they are combined with the above organic materials, give new unique properties to these materials.

Key words: nanophotonics, electroconducting polymers, nanoparticles, metamaterials.

N. N. Kudryavtsev, I. N. Groznov

Development strategy for MIPT in the area of living systems

This paper is devoted to the analysis of the current position of the Institute and its contribution to the research area known as “living systems”. Educational activity is described in detail according to the current concerns of modern medicine and pharmaceutics. The newly formed scientific subdivisions and their main research goals are mentioned. Main attention is given to the perspectives of the new building construction for the needs of biopharmaceutics and the research in the framework of the “Pharma 2020” program of the “Northern” Biopharmaceutical Cluster housed by Moscow Institute of Physics and Technology (MIPT). The structure of relations of the Institute with its strategic partners in the area of living systems, viz. the Russian Academy of Sciences (RAS) and the Russian Academy of Medical Sciences (RAMN), is analyzed along with the interaction principles for international partners, new management structures for science, and MIPT business environment. Strategic directions of the institute development in the living systems research according to the mission of highly qualified personnel training and status of the National Research University are established in conclusion.

Key words: MIPT, Biopharmcluster “Northern”, National Research Institute, development strategy, business environment, living systems.

A. S. Koroteev

New stage of development of space and rocket technologies

Analysis of the experience of MIPT participation in the development of national space technologies is made and the main directions of its cooperation with companies by industry are defined.

Key words: space technologies, energy efficiency, liquid rocket engine, hypersonic ramjet.

Yu. I. Zhuravlev, K. V. Rudakov, I. Yu. Torshin

Algebraic criteria for local solvability and regularity as a tool for studying the morphology of amino acid sequences

In the algebraic approach to the synthesis of correct algorithms, the construction of the pattern recognition algorithms is based, inter alia, on the fundamental criteria for solvability and regularity of the related problem. In this paper, we analyze criteria for the local solvability and regularity of one of the bioinformatics problems—the so-called problem of protein secondary structure prediction. It is shown that the regularity (and hence solvability) of the local form of the problem is determined by irreducible sets of the most informative motifs of a given dimension and length. We give the results of experiments conducted on a sample of all currently known amino acid sequences. The established irreducible sets of motives ensure the regularity of the local form of the problem for an arbitrary set of precedents.

Key words: pattern recognition, classification, algebraic approach, correct algorithms, solvability, regularity, locality, amino acid sequences.

B. N. Chetverushkin

Structure of numerical algorithms and their adaptation to super high performance computer architecture

The paper discusses the correlation between the structure of numerical algorithms and possibilities of their adaptation to super high performance computer architecture. As an example of logically simple and efficient algorithms, we demonstrate the original kinetic schemes and give examples of application of the original hybrid type supercomputer K–100 to the simulation of different kinds of problems.

Key words: super high performance computer, numerical algorithms, kinetic schemes.

S. N. Garichev

Department of Radiotechnology and Cybernetics — the basic lines of short-term faculty development

The article considers the basic lines of short-term faculty development, viz. providing a high quality faculty admission, developing the basic training system for Master's program, restructuring the functions of the faculty subdepartments. Examples of concrete research projects are given.

Key words: faculty development, admission, research projects.

M. R. Trunin and V. V. Lebedev

Researches at Faculty of General and Applied Physics of MIPT in Dolgoprudny

The Faculty of General and Applied Physics (FGAP) of MIPT opened the World Scientific Educational Center—(SEC) "Bionanofizika", where researches are centered on two cutting edge directions—molecular biophysics and physics of nanostructured materials. "Brain's kernel" of SEC is the Department of Nanostructure Physics and Technology (NPT), where about 80 students of FGAP receive training in exact sciences. The leading Russian specialists and the eminent scientists of scientific centers in Germany, France, the USA, Japan are engaged in scientific work of SEC "Bionanofizika" and NPT. SEC laboratories are located in Dolgoprudny. The molecular processes in heart cells and methods for constructing the artificial fragments of heart tissue, which can be used as implants for substituting the injured parts of the heart, are studied at Laboratory of Prof. K. I. Agladze of Kyoto University (Japan), a graduate of FGAP. The new methods of the expression and crystallization of membrane proteins are developed at Laboratory of Prof. G. Buldt, director of the Institute of Complex Systems in Julich (Germany), which is of great importance for understanding the processes of organism aging, developing heavy diseases in it, and constructing methods of their cure. Simultaneously with providing SEC laboratories with up-to-date facilities, the exchange students and post graduate students of NPT attend special courses in Julich, Grenoble, Dallas, Kyoto, Copenhagen. They gain experience that can be immediately used in their researches at MIPT. The successful development of SEC "Bionanofizika" and NPT makes us hopeful that the themes of scientific work are sure to be extended.

Key words: "Fiztech" system, FGAP departments, SRU MIPT, SEC "Bionanofizika" of MIPT, K. Agladze's Laboratory and G. Buldt's Laboratory.

P. A. Todua

Nanometrology—the key link of nanotechnologies infrastructure

We consider the methodology for accuracy and reliability assurance of the measurements of nanotechnology materials, objects and structures parameters based on the length unit standard in the nanometer range, reference materials of composition, structure, size and properties ensuring the traceability of each concrete measurement result to the physical quantity standard.

Key words: nanometrology, nanotechnology, standard, reference material, traceability, reliability, accuracy.

S. M. Bosnyakov, V. V. Vlasenko, A. R. Gorbushin, S. A. Glazkov, I. A. Kursakov, S. V. Mikhajlov, J. Quest

Mathematical model of European Transonic Wind Tunnel (ETW) and experience of its using

This paper briefly describes a numerical technology for supporting the experimental investigations of ETW (Germany), a leading wind tunnel of European Union. Most of the used algorithms are developed by TsAGI's researchers that are MPhTI's professors, teachers and post graduate students. The mathematical formulation and special boundary conditions are briefly discussed. An approach for creation of a blocked grid with a special block for an aircraft model and for supporting devices is described. The results of technology implementation in ETW are presented and some possibilities of its future development are discussed.

Key words: numerical approach, turbulence model, structured grid, test section of wind tunnel, mixing zone, plenum chamber, aircraft model, sting.

A. L. Stasenko

Physical aspects of multiphase flows in aerodynamics, flight engineering and aviation ecology

We give a brief review of the physico-mathematical models of high-speed flows, their numerical and experimental investigations carried out by collaborators of MIPT–DAFE (Moscow Institute of Physics and Technology — Department of Aeromechanics and Flight Engineering) and TsAGI (Central Aerohydrodynamic Institute) during more than forty years, with account taken of the specific aspects of flight technology (a wide range of pressures and temperatures of the carrying gas, electrization and heat radiation of the particles, their rebound from the flown-around bodies, droplets spinning and break-up). A wide circle of concrete applications is discussed — from cryogenic wind tunnels and aircraft icing to fire extinguishing by a flyer, from rocket starting to the enter in the dusted planet atmospheres, from vortex-wakes visualization in the vicinity of an airport to the dusty flow in a comet head.

Key words: multiphase nonequilibrium flow, dispersion of sound, particle rebound, spinning, electrization and optics, aerophysical experiment, aircraft icing, trailing vortex hazard, fire extinction with flyer, jets in vacuum, enter into atmosphere.

A. M. Rajgorodskiy

Some problems of combinatorial geometry and graph theory

In this paper, several current research trends in combinatorial geometry and graph theory are discussed. Basic problems are emphasized, and the most important areas of investigation are described.

Key words: graph, random graph, distance graph, web graph, chromatic number, Ramsey theory, hypergraph.

D. Sadkov, A. Tovb, G. Tsipes

Magistracy education—a quick start to a professional career

IBS, the biggest Russian IT system integrator and consulting company, as a project oriented consulting company, requires a large amount of advanced specialists with high level of competences in all areas of IT, consulting and management, particularly, in project management. To provide such specialists, IBS establishes its own Magistracy with Masters Education program in cooperation with Moscow Institute of Physics and Technology. To meet specific requirements of IBS project and product portfolios, not only the master's course on project management but also a wider context of all Masters Education program is developed. Special topics of project management are included in various disciplines of the program on information, finance, strategic and operational management.

Key words: project management, consulting, masters education program, accreditation, certification.

M. I. Lugachev, V. N. Babeshko

Modeling of financial flows providing the university training program with business customer participation

In this paper, we discuss financial planning problems in the realization of higher education training programs in the business and education partnership model. We consider the principles of formation of budgets, investments assessment methods, and financial flows calculation. The proposed approaches are illustrated by the example of magistracy programs realization at IBS Magistracy corporation departments in MIPT and MISIS.

Key words: budget, magistracy, financial flow, business customer, employer.

K. I. Agladze

MIPT Biophysics—the experience of 220th Program implementation

The current theoretical and experimental approaches to the problem of anti-arrhythmic cure and the creation of reparation patches built by induced pluripotential cells and biodegradable polymers are discussed in this paper. Specific topicality of this agenda is to set up a new laboratory in MIPT under author's scientific guidance, which is equipped with cutting edge experimental facilities aimed to solve the mentioned problems.

Key words: heart, stem cells, tissue engineering, arrhythmia, photocontrol.

V. M. Pentkovskiy

Development of problem oriented architectures and applications for exaFLOP computing in biology and pharmaceutics

The article considers problems arising during the optimization of computing systems cluster architectures for solving the applied problems of bioinformatics. A multiprocessor computer model is built on the basis of the distributed parallel simulator system Graphite. The status and immediate plans for developing "Laboratory of HPC technologies in bioinformatics" are also described.

Key words: computer architectures, high performance computing, computer system models, bioinformatics.