

NATIONAL ACADEMY OF SCIENCES OF UKRAINE

BRIEF ANNUAL REPORT

2009

MART Publishers
Kyiv • 2010

Main Results



B. E. Paton,
President of the Academy

In 2009 the National Academy of Sciences (NAS) of Ukraine focused its activities on further advancement of scientific research and participation of scientific teams in dealing with major challenges in nation's life. No doubt, the previous year was extremely difficult, but summarizing its results one can state that it brought about numerous important fundamental and applied research outcomes.

In particular, Academy's scientists obtained a complete solution of the inverse problem of oscillation theory, developed an essentially new model of core dynamic associative memory suitable for real-time operation; discovered the phenomenon of high asymmetry in molecular threads, that could be used to produce molecular rectifiers. Scientific fundamentals of live tissue welding were developed further, which allowed first successful experiments to be conducted in novel types of surgeries. The decisive role of potassium conductivity in the signal function of neuron electrical excitability mechanisms was proved. New high-yield winter wheat varieties were produced with chromosome engineering methods. By the way, last year, 'Favoritka' wheat variety yielded 131.5 centners of grain per hectare – an all-time record in Ukraine.

In economics and socio-humanities, scholars conducted an integrative analysis of the current state and determinant trends in the economy, social, political, legal and cultural spheres of the nation. That resulted in the national report 'Socio-Economic Situation in Ukraine: Implications for the Nation and the State', released late in 2009. It should be stressed that this work was the first in the series of annual reports on the key issues of Ukraine's current progress, planned by the National Academy of Sciences.

Of great significance for the advancement of top-priority fundamental research was the implementation of Academy's targeted integrative programs on nanostructured systems, nanomaterials, hydrogen energy, the development of efficient intelligent information technologies, high-performance computing machines. A major contribution to the R&D support to solving urgent economic problems was made within the framework of targeted applied research programs, in particular those concerned with the development of sensor-based systems for the needs of medicine, environment protection, industrial technologies, the extraction and processing of strategic mineral resources, safe operation and extended service life of structures, facilities and equipment.

In total, over 20 Academy-wide programs were carried out last year, and the outcomes of their imple-

mentations proved high efficiency of such form of research organization in priority science areas.

A lot of concern was given to improving the effect of research results on innovative progress of the country. In the period under review, Academy's institutions introduced the outcomes of over 2100 scientific and R&D studies, concluded over 40 license agreements and contracts both in Ukraine and abroad, secured 725 patents for inventions and utility models. 45 innovative R&D projects selected through competition early in 2009 were finalized successfully. A significant part of the results produced under those projects were introduced to production and some of those were put to series manufacture. Also important is the fact that the implementation of the most important R&D lines, identified in collaboration with the Government, proved that the Academy did achieve major research accomplishments that show promise of broad practical application. Some specimen products developed and introduced by its specialists were presented to the Cabinet of Ministers of Ukraine. Those could significantly accelerate the socio-economic progress of the country and ensure a qualitative rise in the competitive national economy.

To be sure, active science involvement in solving the most challenging problems of this country, establishing close co-operation of the Government with the National Academy of Sciences to address them is a token of effective overcoming of the crisis impacts on the Ukrainian economy. It is the key role of science and innovations that many leading countries now emphasize in their national strategies of post-crisis development.

On 28 October 2009, the Cabinet of Ministers of Ukraine held its enlarged meeting, attended by members of the NAS Presidium. The participants discussed the issue 'On improving the efficiency of scientific research and further advancement of the R&D potential of Ukraine', which is of major importance for increasing the contribution of the national science to socio-economic reforms, for intensifying scientific and R&D activities. The Government supported numerous significant Academy initiatives, in particular, it approved state targeted programs that are important for the establishment of high-tech industries. Say, the implementation of the program to start chemical-metallurgy industry for producing pure silicon in the near future will permit cutting-edge manufacturing facilities to yield 5000 tons of pure silicon annually and ensure the advancement of solar energy and microelectronics in Ukraine. Novel nanosized functional and structure materials, bio-nanotechnologies etc., developed under the 'Nanotechnologies and nanomaterials' program, will find wide application in various economy sectors. Government's decisions adopted at the meeting after a discussion also provide for introducing the engineering designs of Academy's specialists to employ optical energy-saving technologies in construction, the work towards a cardinal increase in hydrocarbon production at domestic oil and gas fields, in technical upgrading of railway transport.

Yet, one has to note that the tasks of innovative development require that a truly efficient governmental R&D and innovation policy should be worked out and implemented. Of utmost importance are the creation of favourable innovation environment, respective amendments to the current legislation, a broad use of economic incentives for innovation activities, setting up an open system of the public registration and circulation of intellectual property.

Last year, NAS of Ukraine, jointly with the State Agency of Ukraine for Investment and Innovation, started their work to set up a whole new type of innovation structures – national innovation clusters as mechanisms for implementing strategic priority lines of innovative activities. Such innovative infrastructure elements would provide opportunities for combining activities of universities, research and industrial facilities of various forms of ownership with those of executive and local government bodies. NAS institutions and organizations that are candidates for participation in national innovation clusters have already been identified. Still, a lot of efforts, first and foremost, those of the state, are to be made for the existing Ukrainian technology parks to become truly powerful centers for the development and wide practical application of innovations.

Besides, Science Centers of NAS and MES of Ukraine have extended their collaboration with regional State Investment Centers to provide innovation environment in respective regions, to prepare and implement innovation projects. Together with local administrations, our science centers have set priorities of their work to deal with pressing regional problems in 2010-2015. Those priority measures were approved by a joint NAS and MES resolution as their main tasks for the coming years.

We also witnessed a further progress in international scientific ties. This was facilitated by a broader practice of holding joint competitions of research projects on conditions of their parity financing with foreign partners. On that basis our scholars took part in research programs of the International Institute of Applied Systems Analysis, the French National Centre for Scientific Research, the Science and Technology Council of the Republic of Turkey, the Ukrainian Center for Science and Technologies.

One of the most important domains of NAS international research activities is the collaboration of its institutions with the European Centre of Nuclear Research (CERN). Founded in 1954 as the first joint research organization of Europe, CERN has become a model of successful international co-operation. Today, nearly half of all world specialists in high energy physics, who represent more than 500 research centers, are working at its unique facilities. Last year, the world-biggest accelerator of particles and nuclei – the Large Hadron Collider – was put into operation. Four major international collaborations will conduct research there, with NAS scientists being involved in their activities. Our scientists proposed, developed, produced and assembled a part of silicon-sensor-based inner track system of the collider,

installed 2200 active elements of hadron calorimeter with a radiation monitoring system. Two grid-clusters were created at the M. M. Bogolyubov Institute for Theoretical Physics and the National Science Center 'Kharkiv Institute of Physics and Technology' to process collider experimental data.

Much attention was given to furthering ties with the Russian Academy of Sciences (RAS). Joint research projects with the Russian Humanitarian Research Foundation and integrative projects with the RAS Siberian Branch were implemented successfully. Based on the results of a joint competition with the Russian Fundamental Research Foundation, 64 projects were carried out in 2008-2009, with scholars of 50 Academy's institutions participating in them. Major efforts were given to the activities of the International Association of the Academies of Sciences. In the near future, the Academy sees its participation in the founding and functioning of the International Innovation Center for Nanotechnologies of CIS countries as an important work to advance inter-academy collaboration. The Center will be hosted by the 'Kurchatov Institute' Russian Science Center and the Joint Institute for Nuclear Research.

Last year the Academy, like before, took a variety of measures to deal with the research personnel problem. The primary concern was given to involving talented young people in scientific research and anchoring them in science. Relying on the experience of their senior colleagues, they can speed up research and enrich future Ukrainian science with new ideas and paradigms. So the addressed support to young research scholars was up-scaled.

Significant efforts were given to ensuring the participation of young researchers in competitions for state prizes, grants and scholarships. In 2009, young scholars of NAS institutions won 28 annual prizes, 32 grants and 82 scholarships for young researchers, established by the President of Ukraine, the Verkhovna Rada of Ukraine, the Cabinet of Ministers of Ukraine, Kyiv Mayor and oblast state administrations. NAS Presidium, taking into account the results of another Academy competition of scientific works, made a decision on providing research grants for young scholars and giving addressed financial support to young researchers who presented their research outcomes at Presidium sittings. Last year, a special quota for young scholars' publications was reserved for the first time within the framework of 'Academic Book' Academy-wide project. Also approved were measures towards extending the NAS interaction with the School Academy of Sciences of Ukraine. In the past, the NAS of Ukraine was an initiator of its foundation, and now the School Academy involves nearly 250 high school students in research activities. In conjunction with the Ministry of Education and Science, NAS prepared a draft Government resolution on improving the training of gifted children in scientific research.

It should be pointed out that due to its persistent efforts the Academy was able to somewhat increase the appeal of scientist profession and intensify

research done by young scholars. This can be seen in the number of young researchers in the Academy. Over the last ten years, the number of young scholars increased more than twice, and the number of young candidates of science rose nearly as much. However, to solve the problem of involving gifted youth to scientific research, the Government is to take a number of measures which would give young scholars, first of all, a realistic promise of getting suitable accommodation for themselves and their families and opportunities for fulfilling their ideas with state-of-the-art scientific equipment.

The election of 30 Full Members and 73 Corresponding Members to the Academy was an important event in its life. The NAS General Meeting elected new members of the NAS Presidium, which focused its activities on more active participation of NAS institutions in the scholarly backup to dealing with major challenges in the nation's progress, better research management and more efficient innovation policy of the Academy.

Now I'll turn to the logistics of scientific research. The State budget allocations to the National Academy of Sciences in 2009 decreased 11% against the previous year. As of the year end, the protected budget items were financed in full, but the improvement of science infrastructure was considerably underfinanced – by nearly 20%. For the second year running, the Academy did not get any State budget finance to provide housing for its scientists. In view of the uncertain projections of the State budget finance for the Academy in the current year, the top priority is to be given to a more purposeful work of its sections, departments and, first and foremost, its institutions to raise more off-budget funds through business R&D agreements and contracts.

Unfortunately, we have to admit that the Academy, unlike in the previous years, was not provided in 2009 with finance for consolidated purchase of the state-of-the-art science equipment from leading foreign manufacturers. Relying on such facilities, we set up a network of 67 centers for the shared use of unique equipment, which also provide services to researchers of universities, institutions and organizations of other ministries and agencies. The Academy brought into service an advanced high-speed optical-fiber data information network, which integrates its regional science centers and 155 institutions. Constructed was the Ukrainian Academy Grid, incorporating at the moment 20 powerful computational clusters of NAS institutes and 3 clusters of universities and institutes functioning under the Ministry of Education and Science of Ukraine. This permits a lot of super-complex problems to be solved in high energy physics, astrophysics and astronomy, biology and biophysics, nanotechnologies, solid state physics and materials science, physics of the Earth, environmental problems etc. Of great significance is the fact that this grid is an efficient means of international collaboration of Ukrainian scientists.

Forming the national grid-infrastructure and providing conditions for wide application of grid-tech-

nologies should, undoubtedly, become a framework for extensive use of cutting-edge computer technologies in all spheres of nation's life, setting up global open research and education systems, a basis for the emergence of breakthrough methods of organizing and conducting scientific research. The Academy initiated the governmental adoption of the state targeted R&D program to introduce and use grid technologies for 2009-2013 and considers its implementation as a top priority.

The previous year was a period of very severe trials for Ukraine, which stemmed from the world financial and economic crisis. And 2010 is to become not merely the year of definitive recovery from the crisis impacts, but also a year to start sustained development for the future. Scholars of the National Academy of Sciences have never been out of touch with the major tasks facing the nation; they have always taken part in advancing science in Ukraine, in providing scholarly backup to technological, socio-economic and cultural progress of the country. As before, Academy's teams of creative intellectuals will not spare efforts to overcome negative processes in every sphere of social life and ensure noticeable improvements in the Ukrainian economy.

Research Based on Principles of Targeted Programs and Competition. Advancement of International Ties



**A. P. Shpak,
First Vice-President of the
Academy**

In the recent years, the National Academy of Sciences of Ukraine has been making a step-by-step transition from research organization mainly on the principle of distributing basic budget allocations among its institutions to the targeted-program framework of shaping research tasks and competitive selection of R&D projects. Now such an approach, which is taken with due regard for priority areas and the necessity of organizing interdisciplinary studies, plays an important part in planning scientific work of the Academy, it has become an important means to improve the efficiency of research and budget spending.

Top priority here is given to the implementation of state targeted programs to ensure the innovative development of economy sectors and deal with major challenges facing the nation. In the year under review, NAS institutions carried out research under 5 state targeted R&D programs. Now one can cite numerous instances of their successful outcomes.

In particular, using the results obtained during the implementation of the state targeted R&D program 'Development and commercialization of microelectronic technologies, organizing large-scale production of devices and systems on their basis', scientists have started new competitive areas of producing cutting-edge science-intensive materials for electronic equipment and instrument-making, relying on domestic technologies. The fulfillment of tasks of the '2004-2010 state program of fundamental and applied research into problems of using nuclear materials, nuclear and radiation technologies to develop economy sectors' resulted in the development and introduction of novel nuclear physics equipment, of scientifically validated recommendations towards improving the efficiency and reliability of nuclear power facilities. A pilot batch of first Ukrainian LED lamps has already been manufactured under the program 'Development and commercialization of energy-saving LED light sources and illumination systems based on them'. The LED lamps emit a uniform light flux, and bright dots as well as gleam are absent. To be sure, a wide introduction of novel 'solid-state' illumination technology to Ukrainian economy will become an important factor of energy-saving.

Of great importance is the fact that the Academy initiated new state targeted programs, which have already been approved by the Government and will be started in 2010. E.g., the fulfillment of the state targeted R&D program on setting up a chemical metallurgy industry to produce pure silicon will permit spe-

cialists to meet the needs of Ukrainian enterprises in high-grade material required for advancing nano-electronics, manufacturing solar energy cells and electronic engineering produce. The implementation of the state targeted program of introducing and employing grid-technologies will permit us to create a national grid-infrastructure, provide science, industry, financial, social and humanitarian spheres with powerful computing resources; it will facilitate the S&T and information integration of Ukraine to the European Union. The implementation of the state targeted R&D program 'Nanomaterials and nanotechnologies' will open up prospects for producing state-of-the-art nanomaterials for mechanical engineering, optoelectronics, microelectronics, car manufacturing, agriculture, medicine and environment protection. It is nanotechnologies that will become a key motive force of high-tech shifts in those areas.

The strategic focus of the NAS Presidium on using increased state financial support to advance targeted-program organization of scientific research enabled the NAS of Ukraine to carry out 20 all-Academy targeted research programs. Their implementation had a significant effect on the progress in priority areas of science and technology. Say, new fundamental knowledge was obtained and promising applied developments in nanomaterials science, nanobiotechnologies and nanomedicine were carried out under the program 'Nanostructured systems, nanomaterials, nanotechnologies'. When implementing the integral R&D program 'Sensor systems for the needs of medicine, ecology, industry and technology', researchers worked out trial versions of optoelectronic biosensors for human blood tests, produced sensor systems that permit the content analysis of various substances in the environment. The program 'Strategic mineral resources of Ukraine' resulted in novel technologies of prospecting, intensified mining operations and extraction of useful components from ores. During the implementation of the integrated research program 'Service life and exploitation safety of structures, facilities and machines' last year, a set of procedures was worked out to estimate the strength and durability of pipelines, as well as a technology to extend the service life of cogeneration plant turbo-units.

It is to be emphasized that priority areas of targeted research have also been identified in all Departments of the Academy, where project competitions have been held and respective scientific programs shaped. Among them are: 'Modern methods of investigating mathematical models in the problems of natural and social sciences'; 'Theoretical fundamentals of developing advanced computer technologies'; 'Priority research into fundamental problems of continuum mechanics and machinery mechanics in the interests of national economy'; 'Fundamental properties of physical systems in micro- and macro-world'; 'Mineral resources of Ukraine and prospects of increasing their reserves'; 'Monitoring of the environment and security of Ukraine'; 'Fundamental issues of producing materials with predetermined properties,

and methods of their joining and treatment'; 'Scientific fundamentals for developing novel energy sources and improving the efficiency of using conventional ones'; 'Fundamental problems in elementary particle physics, nuclear physics and nuclear power engineering' et al.

With a view to accelerated development of cutting-edge technologies, introducing the most promising outcomes of applied studies and R&D, the NAS of Ukraine started annual competitions of innovative R&D projects back in 2004. These competitions have allowed us to select large-scale projects, which are attractive for manufacturing industry and whose implementation can yield an appreciable economic effect. Of great importance is the fact that a *sine qua non* for participating in the competition is an interested producer who, in addition to sharing the expenses, assumes liabilities to commercialize the product developed or organize its series manufacture.

Last year, NAS institutions finalized 45 innovative projects selected from more than 200 proposals. Among the examples of significant results are the pilot industrial exploitation of the technology and facilities to substitute producer gas for the natural one in industrial boilers and furnaces, organizing commercial production of up-to-date ultra-high voltage cables (up to 330 kV), the use of biocide nanoparticle (nanodispersed silver) to improve the protective qualities and extend lifetime of anti-viral safety masks.

The recent shift towards targeted-program and competitive principles of organizing research at the Academy has started to play an increasingly more important and, undoubtedly, positive role in improving the efficiency of its international collaboration. Various competitions of collaborative projects financed on-par with foreign partners under respective bilateral agreements are becoming more common.

Those include, in particular, programs of joint projects with the Russian Fundamental Research Foundation, Russian Humanitarian Research Foundation, Ukrainian R&D Center, and the National Center for Scientific Research of France. Under the above-mentioned programs, projects are selected with the participation of expert panels, academic and S&T councils, which makes the selection procedure as impartial as possible.

One should point out that the first cycle of Ukrainian-Russian projects financed by the NAS of Ukraine and the Russian Fundamental Research Foundation was finalized successfully in 2009. It brought about 64 joint studies in 8 science areas. The summing up of their results demonstrated a high level of research outcomes. The first competition of joint projects and seminars with the French National Center for Scientific Research was held in 2009 on the same principles. Positive results of the competitive approach ensure a further fruitful development of such international collaboration.

By and large, the advancement of international co-operation, further integration to the international scientific community is a top priority in Academy's

activities. This is proved by 7 new international agreements concluded in 2009. The majority of them aim at promoting collaboration with foreign partners along specific lines identified as priorities for Ukraine.

In particular, the agreement with Russian 'Kurchatov Institute' Scientific Center, which joined the International Association of the Academies of Sciences (IAAS) as an associated member, was concluded last year, with a view to joining efforts in advancing nanotechnologies, facilitating the establishment of common nanotechnologies area of CIS countries, forming and sharing a united R&D infrastructure of CIS member states. The agreement provides for active participation of NAS science institutions, research teams and individual scientists in the events and projects within the whole range of the activities of the CIS International Innovation Center for Nanotechnologies, set up in 2009. The start of collaborative projects with research institutions of the Russian Academy of Sciences, the Joint Institute for Nuclear Research, Russian 'Kurchatov Institute' Scientific Center, employing educational facilities of this center for training and upgrading specialists in nanotechnologies is the task of utmost importance for NAS of Ukraine in the immediate future.

The advancement of this very research line will be favoured by a tripartite agreement on setting up the Ukrainian-German Research and Training Center for Nanobiotechnologies, signed by the NAS R. E. Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology, T. Shevchenko Kyiv National University and Technical University of Ilmenau (Germany).

No less significant has been the integration of some NAS institutions to major international projects. Of seminal importance was the participation of Academy's scientists in preparing experiments on the Large Hadron Collider of the European Center for Nuclear Research (CERN). Research teams of the Institute for Theoretical Physics and the Research-and-Training Center 'Kharkiv Institute for Physics and Technology' joined the multilateral grid-infrastructure that carries out the analysis of experimental data.

All in all, the targeted-program- and competition-based studies amounted to nearly 26% of the total amount of the research done at the Academy. One can be confident that organizing research activities in the framework of large-scale programs and on the competitive basis ensures a respectable level and high scientific relevance of NAS institutions' research avenues in terms of meeting the national economy needs and complying with the standards of the international scientific and R&D collaboration.

Institutions of the Section of Physical, Engineering, and Mathematical Sciences Are Solving Challenging Interdisciplinary Problems



**A. G. Naumovets,
Vice-President
of the Academy**

At the present stage of science progress, ever greater emphasis is placed on interdisciplinary research.

In 2009, institutions of the NAS Section of Physical, Engineering and Mathematical Sciences, in close collaboration with each other, continued to carry out research in such priority areas as nanostructured systems, nanomaterials and nanotechnologies; service life and exploitation safety of constructions, buildings, and machines; scientific fundamentals of geosystem monitoring on the territory of Ukraine; development of effective intellectual information technologies, high-performance computers and information security facilities; nuclear and radiation technologies, nuclear materials; the Universe structure and composition, hidden mass, and dark energy; strategic mineral resources of Ukraine, etc.

In nearly every of the abovementioned areas, the Academy carried out targeted integrated research programs and obtained important results.

In particular, in the framework of the 'Nanostructured systems, nanomaterials and nanotechnologies' program, a novel technology was developed to produce metal-oxide-semiconductor film nanostructures with quantum dots; it is promising for manufacturing photosensors, nonvolatile memory elements and biosensors.

Technological basis was worked out for fabricating terahertz detectors.

A new effect of spin-electron nature in circular nanostructures was predicted; it induces oscillations of new type, when the electron spin density changes periodically in time while the integral electron density remains constant. Such nano-ring oscillators can find important applications as quantum computer elements.

Scientists proposed methods of mechanic- and hydride-activated synthesis of nanostructured composite powders of copper-, iron- and titanium-based alloys and their application to produce bulk pseudo-alloy specimens with higher density and improved other physical, mechanical and magnetic properties.

They developed scientific fundamentals of welding, relying on nanolayered additives; that served as a basis for novel technologies to produce welded joints of heat-resistant alloys, as well as nickel- and titanium-based intermetallide materials.

The program 'Service life and exploitation safety of structures, facilities and machines' resulted in the development of new strategies, equipment and

respective technologies for estimating and extending the operation life of mission-critical continuous-service elements. To extend the service life of equipment in the railway transport, the technology of rail strengthening was improved by applying a powerful pulsed electric discharge. Steel composition and its thermal treatment regimes were determined for manufacturing high-strength locomotive tires with improved wear resistance. A procedure was proposed to estimate the strength and durability of pipelines on the basis of two-criterion diagram of cracking stimulated by stress-corrosion defect. A national standard was worked out for estimating the residual strength of main pipelines with defects.

Under the program 'Scientific fundamentals and methodological, engineering, and information support to the creation of geosystem monitoring network on the territory of Ukraine', extensive research was carried out to investigate active processes on the Sun, solar wind disturbances and their effect on the Earth ionosphere, natural and man-induced disturbances in the Earth electromagnetic environment and their impacts on human fitness.

In the framework of the program 'Creation of effective intellectual information technologies, high-performance computers and information security facilities', principles and methods of Grid-system construction were elaborated to tackle the problems of space exploration, to develop intellectual information technologies for decision-support systems.

The research outcomes of the program 'Strategic mineral resources of Ukraine' allowed specialists to specify patterns in the formation and location of strategic mineral deposits and formulate prospecting criteria and recommendations; those were approved for further implementation by enterprises of the State Geology Service and by 'Nadra Ukrainy' National Joint Stock Company.

In the domain of nuclear and radiation technologies and nuclear materials application, a state-of-the-art technology of reference specimen rehabilitation was developed and prepared for exploitation. This will provide reliable information on the state of VVER-1000 reactor vessel metal at the nuclear power plants of Ukraine. Novel systems were implemented to monitor radiation loads on VVER-440 reactor vessels at power generating units #1 and #2 of the Rivne NPP.

While stressing on all those achievements, one should still admit that the mechanism of selecting and assessing projects for targeted integrated programs has to be revised. This task is especially timely in view of the scarce allocations from the State budget.

Interdisciplinary studies carried on at the NAS of Ukraine create new opportunities for scientists. In particular, they facilitate setting up new promising study areas, help combine the efforts of experts in various science fields for achieving common goals and accelerate the introduction of research outcomes in industry.

Co-Operation with Young Researchers



**V. D. Pokhodenko,
Vice-President
of the Academy**

The issue of involving talented young researchers in S&T sphere and anchoring them in at the NAS of Ukraine is highly important and timely. It is the youth who are to adopt their senior colleagues' experience, they are able to intensify research and scientific endeavor, enrich future Ukrainian science with new ideas, concepts and thinking. Gifted young scholars are a guarantee of the sustainable economic development in this country.

To meet the abovementioned goals, the NAS of Ukraine proposed to set up a wide system of targeted financial support to talented young researchers both nationwide and in the regions, as well as within the Academy itself. The reporting year saw its further development.

The NAS Presidium, jointly the NAS Committee for Training Young Researchers, gave special concern to the participation of young scholars in various competitions for state prizes, grants and scholarships. In 2009, young NAS researchers won 15 annual prizes of the President of Ukraine for young scholars, 8 prizes of the Verkhovna Rada of Ukraine for the most talented young scientists in fundamental and applied studies and R&D, 6 personal scholarships of the Verkhovna Rada of Ukraine for the most talented young scholars (awarded to 3 doctors of science and 3 doctoral students), 5 prizes of the Cabinet of Ministers of Ukraine for outstanding achievements of youth in the progress of Ukraine (in the nomination 'For Scientific Accomplishment'), 30 grants of the President of Ukraine to support research done by young scholars, 2 grants of the President of Ukraine for talented youth, 5 scholarships of the Kyiv City Mayor for talented youth, over 70 scholarships of oblast State Administrations for young researchers.

Scholarships of the President of Ukraine and NAS for the most gifted young scholars were awarded to 620 researchers of 131 Academy's institutions. According to the results of the scheduled competition for NAS grants to support individual and team R&D work of young scientists, held in 2009, 215 of them won 100 abovementioned grants to do research in 2009-2010, with total financial support amounting to nearly UAH 1 million.

NAS institutions sought out opportunities to establish prizes or scholarships named after prominent scientists – their former researchers. In the year under review, about 60 young scientists were provided with such support.

The NAS Presidium continues its practice started in

2004 to hear the scholarly presentations of young researchers at its meetings. In the year under review, 13 young scholars spoke. In accordance with NAS Presidium decisions, in 2010 each of them will have an opportunity to start an extra agency-level research project based on their presentation and to head the study.

On the initiative of NAS Academic Publishing Board and with the support of NAS Committee for Training Young Researchers, in the framework of the Academy-wide 'Academic Book' project, a first special quota was reserved in 2009 for publications of young scholars (those under 35) and young doctors of science (those under 40). After peer reviewing, 7 works by young researchers were selected to be issued by 'Naukova Dumka' Publishers on the terms of state order for NAS publications.

NAS gave a lot of attention to supervising the work with talented schoolchildren, realizing the fact that the training of would-be researchers is to start at school. The most successful form of work with gifted students is the School Academy of Sciences of Ukraine, which was co-founded by the NAS. The Academy has had long positive experience of fruitful co-operation with its territorial divisions. Say, it kept a watchful eye on NAS institutions' guidance over the activities of 'Doslidnyk' ('Researcher') Kyiv-City School Academy of Sciences. Last November, a NAS Presidium meeting analyzed NAS collaboration with the School Academy of Sciences and proposed a number of measures to extend it. As a step towards that and in order to implement the tasks set in the minutes of the Cabinet of Ministers meeting of 28 October 2009, the NAS and MES of Ukraine jointly prepared a draft Government resolution on improving the work with talented children in the field of scientific research.

Due to NAS efforts and its active co-operation with central bodies of legislative and executive power, it has become possible to somewhat improve the appeal and prestige of researcher profession, as well as brisk up R&D activities of youth.

The progress can be seen in the performance of young research personnel at the Academy. Over the last 10 years, the number of young researchers in its institutions has increased more than twofold, and almost the same progress has been observed in the statistics of young candidates of science.

However, in order to stimulate effectively the involvement of talented youth in research activities, quite a number of governmental measures is to be taken. First and foremost, those are to open up new prospects for young researchers in providing themselves and their families with dwellings (either private or job-related ones), in creating for them opportunities to put into effect their ideas using state-of-the-art scientific equipment and to make a successful career. No doubt, positive shifts in dealing with various urgent problems of talented youth, including the abovementioned issues, would draw young researchers into NAS institutions and anchor them in.

Academy's Socio-Humanities and Modernization of Ukrainian Society in the Context of XXI-Century Challenges



**V. M. Heyets,
Vice-President
of the Academy**

2009 witnessed a dramatic change in research priorities, in the entire system of research organization in the NAS Socio-Humanities Section. The Section's General Meeting adopted and NAS Presidium approved prospective lines of integrative (interdisciplinary) studies, which direct major efforts of research institutions towards theoretical studies of and scholarly support to rapid and comprehensive modernization of the Ukrainian society in the context of overcoming crisis challenges of the XXI century, towards achieving a closer co-operation of scholars with government bodies, public organizations and businesses, educational and cultural institutions.

NAS Socio-Humanities Section prepared (for the first time in academic practice) a fundamental National Report 'Socio-Economic Situation in Ukraine: Implications for the Nation and the State', which became a major contribution of scholars in socio-humanities to understanding the tasks of overcoming the consequences of the current global crisis and Ukraine's transition to cardinal new ways of development. The appreciation of the National Report by the public, politicians and high state authorities has become an incentive for further systematic work on strategic and prognostic documents that are to outline definitive trends, tasks and mechanisms for implementing urgent socio-economic, socio-political and cultural transformations.

Institutions of NAS Economics Department produced important results in validating the ways to minimize and overcome crisis factors in economic development, in determining the priorities of economic and financial policy of the state. Under the leadership of NAS Acad. E. M. Libanova, scholars developed the principles of forecasting the evolution of socio-demographic structures, the concept of regulating the social and economic structure of the Ukrainian society, alongside with state policies on improving the human potential of Ukraine. Of utmost importance is the research into patterns of international-order evolution, into the existing concepts of civilization impacts on present-day integration processes, the analysis of peculiarities of the global spread of current financial and economic crisis, the synthesis of foreign experience in anti-crisis programs and activities at the global, regional and national levels. The studies have been carried out under the guidance of NAS Acad. Yu. M. Pakhomov.

Scholars of the NAS History, Philosophy and Law Department did research into the historical experience of socio-political and social reform and outlined

principal ways to modernize the social, political, legal and cultural advancement of Ukraine. They published numerous summarizing studies of social transformations in the Ukrainian society after 1991 (by NAS Acad. V. M. Vorona), those of the recent political development of the nation (by NAS Acad. Yu. A. Levchenko), as well as the creation of the state and law, progress in legislation, improvements in the national legal system (by NAS Acad. Yu. S. Shemshuchenko).

NAS Department of Literature, Language and Arts Studies under the leadership of NAS Acad. M. H. Zhulynsky carried out research aimed at scholarly backup to the national and cultural revival of Ukraine, analysis and objective description of various stages in the development of Ukrainian culture, national cultural traditions in the past and their development and transformation in today's globalized society.

New prospects for broader participation of Academy research in addressing the challenges of accelerated progress of the Ukrainian humanitarian information area were opened up due to the successful launches of electronic resources in history, culture, ethnology, philology, linguistics, encyclopedic studies and library information. The projects within the integral targeted applied-research program 'Studies of national cultural heritage mementoes and their re-adoption in the spiritual life of today's Ukrainian society' (headed by NAS Acad. O. S. Onyshchenko) are of special importance.

In 2010, efforts of NAS Socio-Humanities Section will zero in on developing a holistic vision of the comprehensive modernization of the Ukrainian society, producing scholarly models, proposals and recommendations to deal with new challenges of rising economy and social sphere, to ensure cultural progress of Ukraine.

Activities of NAS General Meeting and Presidium



**A. G. Zagorodny,
Chief Scientific Secretary of
the Academy**

In the reporting year, NAS Presidium attached top priority to advancing cutting-edge areas of fundamental and applied research; improving research coordination; providing administration, logistics and human-resource support to the activities of Academy's research institutions; increasing the contribution of science to the progress of S&T and socio-economic spheres in the life of the nation.

The annual session of the NAS General Meeting, held on 15 April 2009 and attended by V. A. Yushchenko, the President of Ukraine, V. M. Litvin, the Head of the Verkhovna Rada of Ukraine, presidents of the specialized academies of sciences, representatives of NAS institutions, ministries and agencies, academic community, mass media and foreign guests, summarized the Academy's work in 2004-2008 and outlined measures to improve the efficiency of its further activities. The discussions showed that in the coming years the Academy would be faced with tasks of utmost importance, concerned with the preparation of scientifically valid proposals towards solving socio-economic and R&D problems of very high relevance for Ukraine. Those will address, first and foremost, modernization of domestic production and innovative development of the economy. The significant intellectual potential of the Academy is to be more efficiently used for the good of Ukrainian people.

NAS academician B. E. Paton, the President of the Academy, presented the highest distinction of the NAS of Ukraine – V. I. Vernadsky Gold Medal – to NAS academician V. G. Baryakhtar for his breakthrough accomplishments in solid state physics and statistical physics and to RAS academician V. G. Kadyshevskiy for outstanding achievements in elementary particle theory and quantum field theory. B. E. Paton also presented diplomas to the winners of prizes named after prominent scholars of Ukraine.

The session of the NAS General Meeting, held on 16-17 April 2009, elected by secret ballot the world-famous scientist, NAS academician B. E. Paton the President of the Academy for the next five-year term. It also elected Academy Vice-Presidents, its Chief Scientific Secretary, NAS Presidium members, confirmed the elections of the Academician-Secretaries of NAS Departments.

Of great importance was the session of NAS General Meeting held on 4 February 2009, which, in accordance with the NAS Statute, elected 30 Full Members of the Academy (Academicians), 73 Corresponding Members and 15 Foreign Members.

The session of NAS General Meeting held on 3 July 2009 commemorated the 200-th anniversary of Charles Robert Darwin, an outstanding naturalist, who proposed the theory of evolution and was the author of many other works that have retained their high scientific relevance. The session adopted a decision to join the declaration of the Inter-Academy Panel on International Issues (IAP) in support of the evolution theory and opposing radical creationism.

Last year the international scientific community commemorated the 100-th anniversary of M. M. Bogoliubov, scientist of genius and talented research organizer, prominent research scholar in mathematics, mechanics and theoretical physics. The jubilee session of NAS General Meeting was held on 21 September 2009 and attended by numerous Academy members, Ukrainian and foreign scientists and educationalists.

In 2009, as before, NAS Presidium sittings gave a lot of attention to advancing fundamental research in natural, technical sciences and socio-humanities, to scientific validation of the ways to deal with strategic challenges faced by the nation, to improving the efficiency of NAS institutions' activities. In particular, NAS Presidium listened to academic presentations concerning scientifically valid ways of increasing hydrocarbon resources, R&D problems of radioactive waste disposal, radiological impacts of Chornobyl disaster, current historiography in Ukraine, the ways to stabilize the Ukrainian language orthography, etc.

The enlarged meeting of NAS Presidium, held on 10 June 2009 and attended by heads of Academy institutions, discussed the issue 'On more active participation of NAS institutions in scholarly backup to priority tasks of nation's progress'. The resolution, adopted after a broad discussion, identified a wide range of immediate actions to improve research efficiency and increase its effect on the development of major economy branches and social spheres in Ukraine.

NAS Presidium discussed and approved the national report 'Socio-Economic Situation in Ukraine: consequences for its people and the state', prepared by scholars of the Academy's Socio-Humanities Section. By the way, the enlarged sitting of the Government of Ukraine, which was held on 28 October 2009 jointly with NAS Presidium members, discussed the issue 'On raising the efficiency of scientific research and further advancement of S&T potential in Ukraine'. It entrusted the Academy with a further task to prepare national reports on the major issues of socio-economic, socio-political and cultural progress of Ukraine.

All NAS sections and 13 research institutions reported on their research and research-administration activities. NAS Presidium summarized the implementation of numerous integrated scientific programs, approved a decision to improve the network and efficiency of academic councils, committees, commissions operating under the Academy, and adopted measures towards further selective support to young researchers.

Mathematics



**A. M. Samoilenko,
Academician-Secretary
of the Department**

In 2009, scientists and institutions under the NAS Department of Mathematics carried out important fundamental research and obtained a series of cardinal new results in the major branches of mathematical sciences.

Experts in the field of differential equations and dynamic systems investigated the qualitative behavior of periodic and stationary modes and invariant manifolds for differential equations with regular random perturbations for impulse and stochastic Itô systems. The coexistence of different types of homoclinic and periodic trajectories in one-dimensional dynamical systems was described. For a differential equation of elliptic type in a Banach space, conditions for the existence and uniqueness of almost periodic and periodic solutions bounded on the entire axis were found. New variational problems with fairly general functional restrictions for integral functionals were investigated. The well-posedness of a problem for linear parabolic equations of higher order in a parallelepiped with coefficients depending on space coordinates and with multipoint conditions with respect to the time variable was studied and its solution constructed. The principle of large deviations was established and a description of the support of the solutions distribution was provided for general two-dimensional stochastic hydrodynamic systems.

In mathematical physics and functional analysis, a two-sided infinite Toda chain was integrated by using the inverse spectral problem for block Jacobi matrices. Configurations of subspaces of a Hilbert space related to trees and unicyclic graphs were studied. For the inverse problem of oscillation theory, necessary and sufficient conditions for its unique solvability were obtained. It was proved that, as a result of averaging the Cauchy problem, denseness of charges and currents arises in the system of Maxwell equations in the Minkowski space.

In the field of the theory of functions, it was proved that, for analytic functions, the moduli of continuity in a closed compact domain coincide with limiting moduli of continuity. Parameterization of extremals in the Chebotarev problem was investigated. New regular homeomorphic solutions were found for the degenerate Beltrami equation with two pairs of Lavrentiev characteristics. Properties and estimates were found for generalized Lebesgue constants for partial sums of Fourier–Jacobi series in spaces of functions integrable with weight.

In probability theory and mathematical statistics, mathematical models were constructed for diffusion phenomena in media with membranes. Large deviations

were obtained for measure-valued processes. Limit laws were studied for linear and multi-linear statistics of eigenvalues of a broad class of random matrices with independent elements.

In the field of geometry and topology, it was proved that, for smooth manifolds with semifree circle action, there exist equivariant functions with preassigned types of critical points, and the minimal number of singular circles was calculated. The problem of constructing a submanifold on the basis of a given Grassmann image was solved. For a hypersurface that is a graph over a Riemannian submanifold, the mean curvature flow was studied.

Algebraists established under what conditions the derived category of an algebra with two simple modules or with zero square of a radical is either tame or wild. Bounds were established for the number of solutions of matrix polynomial equations whose characteristic roots are of multiplicity two at the most.

In mathematical problems of mechanics, new systems of higher dimensions were obtained, which describe combination resonances in problems of liquid oscillation in cylindrical tanks. The orbital instability of steady Lagrange motions in a bounded three-body problem was proved. A new theorem on the partial asymptotic stability of nonlinear autonomous systems was proved. The problems of stationary heat conduction and thermoelasticity were solved for a body with heat-active and heat-permeable disk inclusions and cracks. New algorithms and numerical methods were developed to solve the problems of control, which is optimal in terms of speed performance, of nonstationary one- and two-dimensional temperature modes in heat-sensitive bodies of canonical shape.

In mathematical modeling and computational and applied mathematics, a functional-discrete method with controlled superexponential rate of convergence was developed to solve operator differential equations. A mathematical model of thermomechanics was constructed, in which the formation of near-surface phenomena is associated with accounting for the process of centers elastic displacement and some other factors.

In the course of implementing the targeted research program ‘Mathematical Modeling of Physical and Mechanical Processes in Strongly Inhomogeneous Media’, a novel approach was proposed to determining radiation and heat characteristics of bodies of different transparencies during cooling. Specific features of the known models for describing radiation and heat transfer in bodies with different radiation properties were investigated.

Under the guidance of scientists of the Department’s institutions, 11 doctoral-degree theses and 35 candidate-degree theses were defended. 15 monographs and 11 text-books were published. The Ukrainian Mathematical Congress–2009 (marking the 100th anniversary of M. M. Bogolyubov’s birthday) was held, which was attended by 459 Ukrainian scientists and 105 foreign ones.

Information Science



A. O. Morozov,
Acting Academician-Secretary of the Department

Researchers of the Information Science Department obtained a number of new important scientific results. These include the following.

For families of non-stationary linear and some classes of nonlinear discrete systems experiencing limited disturbances, a constructive method was proposed to determine exact boundaries of attainability domains, which allows for effective parallelization. Found were asymptotics conditions under which attainability domains are "absorbed" by dissipation domains.

For the decision-support systems of 'Situation Centers' (SC) type, an "embodied knowledge" concept was proposed. Relying on it, scientists formed a general idea of SC knowledge base and developed models of basic business processes of the Situation Hall (SH), as well as operating prototypes of software to support SH regulatory and organizational procedures.

A method and regulatory algorithms were developed for recursive structural-parametric identification of linear multidimensional and multilinked systems by experimentally obtained input and output data containing additive restricted disturbances and noises.

On the basis of the theory of optimal control of multi-component media states, explicit expressions of discrepancy-functional gradients were constructed for identifying various parameters of axis-symmetrical problems on the strained-deformed state of embedded long cylinders and embedded spheres with internal cavities.

A new analytical-statistics method was developed to investigate probability rates of service system describing some aspects of cellular communication networks operation. An algorithm was proposed for finding non-stationary coefficient of readiness of certain class of reserved systems with recovery, whose behavior cannot be described by Markov or semi-Markov process with a countable set of states.

Estimates of the major national security elements were made, in particular, strategic aspects of military-and-engineering policy were determined; modelling of modern information operations was carried out, alongside with analyzing the protection of Ukraine's information space and some important issues of energy and technological security. A number of new challenges for Ukraine were identified and possible adequate responses to them found; strategic estimates of socio-political and socio-economic development were made. Ways to neutralize negative impacts of

the world financial and economic crisis on Ukraine were determined, as well as prospects of its Euro-Atlantic integration.

Proposed were a concept of open recurrent neural network and a method of its non-iterative training, which radically speeds up the learning process. On the basis of such network, an innovative model of nuclear dynamic associative memory, suitable for real-time operation, was worked out.

Constructive investigation methods and high-precision algorithms for searching approximate solutions were developed for differential-operator inclusions with multi-value Sk-type representations. Also studied were functional-topology properties of the solution operator for such inclusions. The results obtained were applied for a broad class of geophysical processes.

A theoretical apparatus of multi-component programming was developed.

Models of complex socio-economic processes occurring in transition economy during structural and technological changes were constructed, in particular, of those during changes in the production structure for energy-saving purposes.

An information technology was developed to recognize lip mimics during speaking in Ukrainian; it relies on flexible templates represented by uneven basic splines.

Through the use of 3DVAR technology, methods of handling monitoring data in systems of weather and river-flow forecasting were worked out for decision-making support systems in mitigation of catastrophic flooding.

A system part of the software complex, which supports decision-making in modelling of the dynamics of environmental processes causing soil pollution, was developed and implemented on the SKIT-3 computing system.

In accordance with the Euro-2012 preparation plan, a preliminary design of the emergency cover system accessible through 112 single phone number was produced.

Scientists determined basic approaches to the creation of systems for forming circular micro-prism relief and the development of respective control systems for manufacturing refractive micro-relief structures intended for the treatment of complex vision defects in children.

Theoretical fundamentals of hyper-complex numerical systems of commutative and non-commutative types of up to 4-8 orders were refined, and the digital filtration problem, as well as the problem of separating data with improved characteristics, was solved.

A methodology of integrated solution to the problem of durability provision for corporate information-analytical systems was upgraded; hierarchical structuring of methods and means to increase durability was worked out.

Mechanics

A. F. Bulat,
Academician-Secretary of
the Department

In 2009 scientists of the NAS Mechanics Department produced a number of new important results.

The NAS S. Timoshenko Institute of Mechanics proposed a theory of interaction between a liquid and particles in it, caused by radiation forces of the acoustic field. Principal laws of the rigid spherical particle dynamics were studied near liquid boundary under the effect of an acoustic wave propagating in perpendicular to the boundary. Patterns of kinematic or dynamic parameter evolution were found for impact interaction of a rigid body against a hollow surface in elastic media as a function of body mass and its initial velocity for concordant and discordant surfaces. Sufficient conditions were obtained for the stability of large-scale mechanical systems with periodic and quasiperiodic coefficients. The stability of nonlinear pulsed systems described by locally linear approximations was investigated.

At the Institute of Technical Mechanics operating under the NAS and NSA of Ukraine, a hydrodynamic bench was developed and constructed to produce finely dispersed coal-water fuel. Its preliminary tests showed that finely dispersed coal-water fuel obtained with the cavitation-pulse technology proposed is suitable for direct combustion in heat plant boilers. Scientific and methodological back-up to all necessary stages of the aerodynamic designing of compressor grids was developed. It does not have analogs in Ukraine. On the basis of the theory developed and the methodology of nonequilibrium partly dissociative plasma-flow diagnostics, research equipment for the 'Potential' space experiment was developed and manufactured for on-board diagnostics and monitoring of the neutral and charged components of ionosphere plasma at the 'Sich-2' Ukrainian spacecraft.

G. S. Pisarenko Institute for Problems of Strength elaborated scientific fundamentals and a numerical procedure for analyzing coupled acousto-mechanical vibrations in pipelines. Relying on those, scientists investigated vibrations in NPP steam pipings, which are induced by high-speed steam flows around nozzle outlets of the closed auxiliary circuits. Recommendations towards their reduction were implemented. A computational experimental method was proposed to estimate metal service life under cyclic loading in complex stress state, with accounting for in-service defects. The method can be used in design calculations for structures made of such metals.

The NAS N. S. Polyakov Institute of Geotechnical Mechanics worked out methods to specify parameters of geological and geo-mechanical factors that

contribute to the formation of man-induced methane accumulations. These methods are used as a basis of industrial normative document for advance rock-roof degassing that regulates processes of methane extraction from the areas of its accumulation. A system was developed for geo-mechanical monitoring of underground geo-engineering systems represented as various cluster-hierarchy layers.

At the NAS Institute of Hydromechanics, methods were proposed to control the efficiency of sound generation by fluxes in the channels of variable section. Estimates of surface tension and sliding region effect on super-cavitation flow over bodies were made. Proposals towards increasing the distance of non-horizontal super-cavitation inertial body motion were worked out. A generalized mathematical model of transfer processes in the hydrogen membrane of fuel cell was refined, with account being taken of chemical reactions on catalytic layers; innovative approaches to designing bipolar plates of fuel cells were proposed. Recommendations were worked out to assess the stressed state and stability of water-saturated soil slopes. Those were based on numerical solutions of deformation and stressed-state problems and accounted for viscous flows. Proposals were made towards using a specially designed high-flow-rate vertical geotextile-based drain, with a view to protecting deep pits of modern high-rise buildings from high pressure and suffusion soil ejection.

The NAS Institute of Transport Systems and Technologies obtained double-ended estimates for the maximum Lyapunov exponent, alongside with sufficient exponential stability conditions for nonlinear systems with arbitrary time-varying and distributed delays, as well as norm-bounded nonlinear terms. The stability of some nonlinear mechanical and control systems was investigated. The systems for which the estimates obtained cannot be made more precise were identified. Under Institute's academic guidance and due to research efforts of its scientists and specialists of VESTA International Research-and-Production Corporation, a new VESTA INDUSTRIAL LTD science-intensive and state-of-the-art storage-battery plant was built and commissioned. It is one of the best in Europe, manufactures highly competitive products, its capacity being 4 million standard storage batteries a year.

In 2010, the efforts of Department's scientists will be centered on further scientific and R&D support to respective industries of the national economy of Ukraine.

Physics and Astronomy



V. M. Loktev,
Academician-Secretary of
the Department

In 2009, scientists of the 20 institutions functioning under NAS Department of Physics and Astronomy, numerous universities and industrial research institutes continued their research in topical areas of physics and astronomy.

2009 was a special year in the life of the Department. On the initiative of UNESCO, the year 2009 was declared the International Year of Astronomy to celebrate the 400th anniversary since Galileo's first telescopic observations of the stellar sky. We are pleased to note the high international level of the achievements of Department's astronomers. In particular, in the reporting year they compiled radio source catalogues, which were used to construct new ICRF2 celestial coordinate system approved by the International Astronomical Union to be a standard from 1 January 2010. Synchronous observations in decimetre and decimetre wave ranges revealed sporadic radio-frequency emission of two new active stars.

Major progress was also achieved in other areas of physics research. E.g., a discovery in the field of fundamental interactions showed that a cosmic string induces circular current and magnetic field around it in vacuum.

In solid-state physics, a photon crystal with a negative refraction coefficient in the millimetre wave range was synthesized on the base of a lamellar structure of the 'doped manganite – insulator' type. Basic physical principles were developed for high-speed volumetric heat-strengthening of rail steels, which contributes to their strength, as well as those for producing structured steels intended for biocompatible implant manufacture.

In low temperature physics, the resistivity of superconducting tin film was found to decrease substantially when exposed to microwave radiation.

Pilot versions of domestic 3 and 6 Wt LED tubes were produced in the field of optics. Now they are manufactured commercially. Another important development was a multichannel optical rotary connector, which won a medal and a diploma of the V 'Optics Expo – 2009' International Forum.

In nanophysics and nanotechnologies, researchers discovered high asymmetry of electric conductivity of oxyphenyl-naphthylimide-based molecular threads, which can be used in producing molecular rectifiers.

Scientists in radio physics and electronics investigated a new class of electromagnetic excitations propagating along the Josephson vortex in 2D super-

conducting interfaces.

A kinetic model of the formation of photo-induced current through a single molecule was developed in the field of soft-matter physics. A formula was derived to determine the value of such current, allowing for the neutral, charged and photo-excited states of the molecule.

In 2009, the Department succeeded in organizing major scientific forums. In particular, the NAS M. M. Bogolyubov Institute for Theoretical Physics and NAS Institute for Condensed Matter Physics took an active part in the events commemorating the centenary of M. M. Bogolyubov, the outstanding physicist and mathematician who played the key role in the foundation of the Institute for Theoretical Physics, later named after him. This date was celebrated nationwide. The Department arranged a number of events in compliance with the Decree of the President of Ukraine 'On Celebrating the Centenary of Mykola Bogolyubov's Birthday' and the respective resolution of the Cabinet of Ministers of Ukraine, namely: the International Conference 'Statistical Physics – 2009' was held in Lviv, the Ukrainian Mathematical Congress and International Bogolyubov Conference 'Current Problems of Theoretical and Mathematical Physics' were held in Kyiv, the commemorative plaque was placed on the Red Building of Taras Shevchenko National University in Kyiv, and special issues of scientific journals and transactions dedicated to this date were published. Similar celebrations attended by NAS representatives were also held in the Russian Federation.

The B. I. Verkin Institute for Low Temperature Physics and Engineering hosted the International Conference 'Low Temperature Physics', commemorating the 90th birth anniversary of Prof. B. I. Verkin, a full member of the NAS of Ukraine, who had founded the Institute and had headed it for 28 years.

Much consideration was given to the training of research staff. In the year under review, Department's scientists defended 15 theses for the doctor-of-sciences degree and 64 theses for the candidate-of-sciences degree.

Studies of Department's researchers won a due recognition. Research associates of the Institute of Physics and Institute for Physics of Mining Processes of the NAS of Ukraine won the State Prizes of Ukraine in Science and Technology. The V. I. Vernadsky Gold Medal was awarded to V. G. Baryakhtar, a full member of the NAS of Ukraine, for his prominent achievements in science. Researchers of the Institute of Physics and Institute for Condensed Matter Physics won the Prizes of the President of Ukraine for Young Scientists.

Despite current problems and difficulties, the principal efforts of Department's institutions, as before, will be focused on improving the efficiency of their research activities, supporting science and preserving its human potential, attracting young scientists, and finding new off-budget finance sources.

Earth Sciences

**V. M. Shestopalov,
Academician-Secretary of
the Department**

In 2009, researchers of the NAS Department of Geosciences produced a number of significant results in their fundamental and applied research. Some of those were honoured with awards and prizes. The examples of such major achievements are as follows.

The "Atlas of the Antarctic Deep Structure, Based on Gravimetric Tomography Data" was compiled and published; it includes models of the deep structure of the Antarctic and Southern Ocean regions.

The high promise for prospecting high-grade ores of the rare earths, yttrium and zirconium, was validated for the areas of syenite occurrence within the Pivdenno-Kalchitskiy massif and the southern margin of the Korsun-Novomirhorodskiy pluton. A geological model of gas emission for north-west part of the Black Sea was developed. According to this model, the major ingress of gas is confined to the shelf zone within 50-200m depth range. The most powerful pulsed gas emissions, however, are located at great depths and are associated with deep degassing of the Earth interior, being confined to zones of tectonic activation.

The 'Space Map' software was developed to perform automated interactive processing of geophysical object images, carrying information of closed areas, for Cartesian coordinate system. The software was tested for actual objects located within the Voronezh crystalline massive, Dnieper-Donets depression and Donbas region.

The «Atlas of Extreme Wind Waves in the Black Sea» and «Atlas of the Wind Energy Potential in the Crimea Region» were compiled and published.

An electronic atlas of the oceanologic characteristics of the Azov-Black Sea basin was created; it includes six chapters and over 500 maps.

The «Environmental Atlas of Ukraine» was published, which includes 116 maps, texts and diagrams.

In the framework of international collaboration under DOBRE-4 Project, researchers of the S. I. Subbotin Institute of Geophysics carried out field seismic observations with up-to-date seismic stations within south-west part of Ukraine (Northern Dobruja), using deep seismic sounding. Key geophysics specialists of Western Europe took part in the field experimental studies. They represented the University of Copenhagen (Denmark), the Technological University of Vienna (Austria), the University of Helsinki (Finland), the Geophysical Institute of the Polish Academy of Sciences (Warsaw), and the Free University of Amsterdam (the Netherlands). Exploration of the regions

crossed by the profile is of great interest because of their good potential for oil-and-gas resources; that was confirmed by discovering several gas fields within the north-west shelf of the Black Sea and Dobruja.

Leading scientists of the Department (NAS academicians V. M. Shestopalov, V. I. Starostenko, E. F. Shniukov, P. F. Gozhik, V. I. Ivanov, L. G. Rudenko) visited Finland, where they concluded preliminary agreements with Finnish scientists on collaboration between institutions of the NAS Department of Geosciences and the Academy of Science of Finland in the fields of geology, geophysics, geography, geoecology, oceanology and marine geology.

In the framework of the national plan of actions towards implementing the Kyoto Protocol to the Frame Convention of the United Nations on Climate Change, the Fifth National Communication of Ukraine on Climate Change was prepared. This communication cites data on: the situation in Ukraine concerning greenhouse gases emission and absorption, greenhouse gases cadastre, measures to restrict and reduce greenhouse gas emissions and increase their absorption, as well as projections of greenhouse gas emission volumes. Besides, the assessment of vulnerability of economy sectors to climate change was given, alongside with the results of studies and systematic observations of the climate system in Ukraine.

The Second International R&D conference 'Mining Geology, Geomechanics and Mine Survey' was held. It marked the 80th anniversary of the foundation of the Ukrainian State R&D Institute of Mining Geology, Geomechanics and Mine Survey, which operates under the NAS of Ukraine.

Scientific conference 'Marine Hydrophysical Institute – 80 Years: Its Past, Present and Future' was held to celebrate Institute's anniversary.

2009 State Prizes of Ukraine in Science and Technology were awarded to the studies carried out by researchers of the Institute of Geography, the Institute of Geology and Geochemistry of Combustible Minerals and the Department of Marine Geology and Sedimentary Ore Formation.

In the near future, Department's scientists will focus on advancing fundamental and applied research in priority areas of geological science. The Department will give special attention to coordinating research which complies in the maximum degree with new realities of today and ensures a more efficient use of budget finance and material resources by its institutions. Besides, in the future we plan an increase in the amount of research concerned with the environment, the development of technological automated systems for processing and interpreting geophysical data and creation of various scientific data banks.

Physical-and-Technical Problems of Materials Science



I. K. Pokhodnya,
Academician-Secretary of
the Department

In 2009 the efforts of scientists of the NAS Department of Physical-and-Technical Problems of Materials Science were aimed at the development of novel materials with advanced physico-mechanical and chemical properties to meet the needs of various sectors of Ukraine's economy, as well as methods of their production, joining and treatment. A number of substantial scientific results were produced.

A special tool was developed and, using high-frequency electric welding, successful experiments were conducted for the first time on retina attachment by welding alongside with other kinds of surgeries in ophthalmology. A system to record electric parameters in high-frequency welding of live tissues was developed and the effect of parameters and process control algorithms on the quality of welded joint was analyzed, in particular, directly in clinical conditions. The results obtained are the basis for developing new equipment and control systems. The processes occurring during single-step welding of hollow organs were investigated, which was the basis for developing fundamentals of colon welding technology. Hospitals of Ukraine mastered new kinds of operations relying on electric welding in oncology, mammology, urology, otolaryngology and pulmonology, in abdominal and other surgeries.

A technology of automated flux-cored wire welding of position butt joints of pipes with programmable control of welding process parameters was developed. Flux-cored wire and a pilot version of the equipment were produced. Pilot production trials demonstrated that the new technology meets the requirements to welded joints of the main pipelines made of X80 high-strength low-alloyed steels.

Structural-phase mechanism of the destructive hydrogenation of Ti_2Cu intermetallic was discovered. It consists in selective titanium hydrogenation through $\beta-TiH_y$ (bct - bcc) $\rightarrow TiH_{1.92}$ (fcc) pathway and successive formation of new titanium vs copper stoichiometric ratios according to Ti-Cu constitutional diagram. The main feature of Ti_2Cu destructive hydrogenation mechanism is direct formation of tetragonal titanium at the temperature of 373 K. The kinetics of Ti-Cu destructive hydrogenation showed that ingot compaction accelerated the process of destructive hydrogenation as compared to other technological factors.

Researchers of NAS I. M. Frantsevich Institute for Problems of Materials Science carried out a cycle of heat exchange studies during water boiling on surfaces with different conditions of capillary-porous structure contacts. It was shown for the first time that

capillary structures pressed to heating surfaces have high heat-transfer coefficients, this being important for the development of high-efficiency heat exchange devices for power saving and heat recovery systems. A prototype of solar collector based on heat pipes was developed and tested, forming the basis for a system of hot-water supply to living, service and production premises. Collector and water supply system passed full-scale trials. Heat pipes were tested at 'Pivdenne' Special Design Bureau. Scientific equipment consisting heat pipes is ready for flight testing at the 'Alpha' International Space Station.

A novel procedure was developed to determine mechanical properties of materials by nanolevel indentation. It was shown that during nanoindentation of a wide range of single crystals to the depth of about 30 nm, an elastic-plastic transition occurs, which is due to the homogeneous initiation of dislocations in the imprint. The shear elasticity limit is close to theoretical shear strength, and the average contact pressure in the imprint is equal to the hardness limit of the single-crystal.

Using injection technologies, scientists proposed a calculation model to evaluate the strength of structural materials with damage of the type of cracks filled with another material. This model served as the basis of developing methods for optimizing injection materials to restore the performance of damaged building structures and extend their reliable service life.

It was theoretically validated and experimentally proved that deep treatment of aluminium melts by a plasma jet in the reaction zone leads to intensive transformation of oxides from gamma-structured state into a high-temperature alpha-modification, which does not absorb hydrogen. As a result, plasma refining provides a more effective, as compared to other methods, degassing of aluminium melts from hydrogen, even at a considerable concentration of oxide inclusions in them.

Stable colloid solutions of luminescent nanoparticles based on rare-earth orthosilicates and orthovanadates were synthesized and tested in a real experiment with live cells. Such solutions could be applied as fluorescent probes for advanced luminescent technologies in biology and medicine. The effect of nanoparticle shape, size and microenvironment on their ability to interact with cells of various types was studied.

A theory of thermoelectric generators using heat of car-engine exhaust gases to produce electric power was worked out. Object-oriented computer methods were used to develop programs for optimizing such generator designs. 200-800 W generators were developed to replace car dynamos. Generator characteristics are superior to those of their analogs made in Japan, Germany and the USA. The expected fuel saving due to the introduction of such generators could amount to 5-10%.

In 2009, two studies carried out with the participation of Department's scientists were awarded State Prizes of Ukraine in Science and Technology.

Physical-and-Technical Problems of Power Engineering

B. S. Stogniy,
Academician-Secretary of
the Department

In 2009 the efforts of scientists of NAS Department of Physical-and-Technical Problems of Power Engineering (PTPPE) were focused on fundamental and applied studies of energy issues.

A section 'Increasing the reliability and extending the operation life of power facilities and systems' within 'Operation Life' NAS targeted integrated research program was completed successfully. The work is going on under NAS integrated research programs 'Bio-fuel' and 'Fundamental problems of hydrogen energy'.

NAS scientists, in collaboration with specialists of the Ministry for Housing and Public Utilities of Ukraine, developed and started the implementation of the State targeted economic program of modernizing municipal heating systems for 2010-2014, which was approved by the Cabinet of Ministers of Ukraine in November 2009.

In 2009, scientists of the Department produced a number of major fundamental and applied research results.

A modified RNG $k-\epsilon$ model of turbulence for non-stationary processes in a macro-porous environment was developed. It allows calculations of heat-and-mass exchange and hydrodynamic processes in nuclear reactor cores with stratified filling.

A mathematical model and a numeral method were developed to calculate aero-resilient vibrations of shovel vehicles of axial turbines and energy losses in the spatial stream of viscid gas, with account being taken of the interaction of two contiguous stages and flows in radial gaps.

Correlated structures of Ukrainian Power System and Ukrainian Heating System were developed and investigated. It was shown that the full-scale employment of heat-accumulating regulator users would allow specialists to increase the precision of frequency adjustment in the United Power System of Ukraine to meet the requirements of EU grids due to them performing the functions of outdated adjusting circuits of the existent heat power station units.

Relying on the analysis of experimental data obtained over more than two decades after the accident at Chornobyl NPP, scientists provided an analytical description of interaction kinetics of long-lived ^{90}Sr and ^{137}Cs radionuclides in soil and their accumulation in plants. A model for predicting radionuclide concentration in agricultural products was developed, all its parameters were determined and a respective algorithm and program produced.

Models of thermal and hydrodynamic processes in two-phase heat carriers of solar collectors and photovoltaic batteries were developed. The models, in particular, take into account the processes of evaporation and condensation of dispersed liquid phase in hydraulic highways of sun collectors and photovoltaic batteries with composite heat transfer units.

A method was proposed to control the external magnetic field of engineering facilities in closed systems. It is based on the division of the magnetic field measured on the facility surface into that of internal and external sources and closing the control system with respect to the internal magnetic field component. This permits high quality control to be achieved when external magnetic interferences are present.

Operative methods were developed to solve the problems of parametric diagnostics of dynamic systems described by ordinary integral-differential equations. They are based on approximative representation of the functions of system's response to the input action of forming an operative model of the respective inverse problem.

An information system was developed to determine the current technical status of high-voltage inputs of power transformers, autotransformers, reactors and electric current transformers by the parameters of their basic isolation checks. The system was commercialized at powerful 750 kV 'Kyivska' substation.

A technology of burning the mixture of anthracite and gas coal as a substitute for lean coal was tested on power unit #1 of Trypilska HPP and power unit #8 of Zmiyivska HPP. It eliminates the need of the so-called "illumination" for hard-fuel burning and reduces carbon content in flue ash.

A software system for modeling the Ukrainian Power System was developed. It takes into account dynamics of electric power and fuel resource streams, dynamics of power sector performance, simulation of cash-flow distribution between generating companies and 'Ukrenergo' National Energy Company, exercised by 'Energorynok' State Company, alongside with cash indicators of the generating companies.

Several works with contribution of Department's scientists were highly appraised.

NAS corresponding member A. O. Tarelin and NAS corresponding member A. L. Shubenko won the 2009 State Prize of Ukraine in Science and Technology.

NAS corresponding member B. I. Basok, NAS corresponding member A. O. Avramenko and A. I. Nakorchevskiy won NAS V. I. Tolubinskiy Prize.

V. A. Zhovtyanskiy was awarded with the Order 'For Services' II Class. A. I. Pyatnichko and I. Ya. Sigal were awarded with the Order 'For Services' III Class. B. E. Gasparyan and R. A. Pilipenko were awarded with the Medal 'For Labour and Victory'.

N. I. Dunaevska was awarded with a diploma of Verkhovna Rada of Ukraine.

Nuclear Physics and Power Engineering



I. M. Nekludov,
Academician-Secretary of
the Department

In 2009, scientists of the Department obtained a number of new significant research results.

Relying on the statistical mechanism of nuclear disintegration, they determined for the first time the average angular momenta of ^{90}Rb , $^{129,130,132}\text{Sb}$, $^{131,133}\text{Te}$, $^{134,136}\text{I}$ and ^{135}Xe fission fragments resulting from photofission of ^{235}U and ^{239}Pu radioactive nuclei by bremsstrahlung gamma-quanta of maximum energy 9,6 and 9,8 MeV, respectively.

Probabilities and exclusion factors of alpha-transitions between the ground state of the mother nucleus and excited states of the daughter nucleus were calculated.

The thermal-field theory of collective motion in nuclei was developed. Expressions for collective mass parameter, deformation energy and friction factor were derived, where the thermal motion of particles is modeled in terms of temperature-dependent Hartree-Fock equations.

The predicted stochastic mechanism of positively- and negatively-charged particle deflection by bent crystals was confirmed experimentally.

A new phenomenon, viz., energy and pulse channeling during plasma instability excitation by energetic ions, was discovered. It can cause drastic changes in the radial plasma-heating profile and give rise to time variations in the instability frequency.

It was demonstrated experimentally for the first time that the transition to the H-like mode of confinement in the toroidal magnetic trap can be initiated by a loss of fast ions; experiments also confirmed the theoretical prediction of radial plasma density redistribution in the RF source in the presence of magnetic field.

Fundamentals of radioactive isotope transmutation with the use of powerful beams of combined radiation (electrons, photons, neutrons) were developed.

In the framework of the nonlocal thermoelastic peak model for the analysis of radiation damage processes that occur under neutron irradiation in reactor materials, an approach was proposed to determine the temperature of brittle-to-ductile transition. It provides a description of the principal relationships between temperature and carbon content, grain size, quenching temperature, etc.

It was shown that during ion implantation into crystals the presence of thermal vacancies and an excess of interstitial atoms as compared to radiation vacancies, are to result in the emergence of vacancy-depleted region beyond the implanted ion path lengths. At the region boundary, a peak in the gener-

ation of implanted atom and vacancy complexes occurs.

A nuclear combustion wave was found feasible in the safe fast-neutron reactor employing a mixed thorium-uranium-plutonium fuel cycle at realistic volume ratios of fuel, structural materials and coolant.

Hafnium studies and tests were carried out to validate the processes of manufacturing neutron-absorbing products with specified structure and corrosion performance. Determined were basic conditions for the operation of combined Hf-B₄C-type absorber elements in the WWER-1000 reactor core.

Novel systems for monitoring the radiation load of the WWER-440 reactor vessel were introduced at power units 1 and 2 of the Rivne NPP to determine systematically the irradiation conditions, as well as continuous-flow and accumulated neutron fluences.

The efficiency of employing thermovision methods was validated to assess the state of reinforced concrete structures of NPPs and peak power facilities.

An experimental model of automated system to monitor handling of nuclear-radiation materials successfully passed pilot trials.

The program of decommissioning WWR-M research nuclear reactor at the NAS Institute for Nuclear Research was developed.

Large-scale landscape-geochemical mapping was performed, and the conditions of the migration and accumulation of radionuclides associated with uranium production waste were determined at the site of the former Pridniprovskii Chemical Plant.

Migration characteristics of buffer materials were determined and mathematical models developed to describe thermal and migration processes in the deep geological storage for spent fuel and long-lived radioactive waste.

The State Prizes of Ukraine in Science and Technology were awarded to researchers of the National Science Center 'Kharkiv Institute of Physics and Technology' O. O. Zheltukhin, V. O. Soroka, O. Yu. Nurmagambetov, I. A. Bandos, V. D. Gershun, D. V. Volkov, A. I. Pashnev as co-authors of a series of works 'Discovery and development of super-symmetry and super-gravitation principles and their use in constructing a unified theory of fundamental elementary particle interactions'.

In October 2009, the Department, in collaboration with 'Energoatom' National Nuclear Energy Generating Company and the Ministry for Fuel and Energy of Ukraine, organized the second Ukrainian-Russian panel workshop 'Advancement of nuclear power engineering in Russia and Ukraine as a factor of sustainable inter-state co-operation'. Collaboration with international and national science and R&D centers and organizations has been developed steadily, in particular, that with CERN (Switzerland), Euroatom Association, Nuclear Energy Corporation of the South African Republic, the British Closed Nuclear Centres Program.

Chemistry



V. V. Goncharuk,
Academician-Secretary of
the Department

Scientific research in the field of chemistry is carried out at 11 institutes and 2 their divisions by nearly one thousand of highly skilled scientists. Among them are 13 NAS academicians and 27 NAS corresponding members.

In 2009, the efforts of scholars of the Chemistry Department's institutions were aimed at fundamental studies in chemistry development, at using research outcomes in various branches of the national economy, improving science management and training young researchers.

A number of major fundamental research results were obtained, which meet the highest international standards:

The process of aniline polymerization under ultrasonic emission was shown to induce the formation of polyaniline single crystals with increased chain unbending (NAS Acad. V. D. Pohodenko).

For the first time ever, scientists proved the possibility of high-yield homogeneous catalytic processes of polyoxybenzole polyfluoroalkylation by freon $\text{BrCF}_2\text{CF}_2\text{Br}$ with the use of sulfur dioxide as the mediator of electron and organic base transfer, producing polyoxybenzoles fluoroalkylated into the aromatic ring (NAS academician V. G. Koshechko).

Specialists produced optical structures on the basis of WO_3/Pt electrodeposited films, employing the surface plasma resonance effect, which, when exposed to hydrogen, is sensitive to changes in the film chemical structure. Relying on those findings they designed a trial version of optical hydrogen-control sensor with high sensitivity (0.01% of H_2 in the air) (NAS academician C. V. Volkov).

A number of new ligand systems that are based on functionalized hydroxamic acids containing additional chelating groups were produced. The ligands studied were shown to be highly effective chelating agents for transition metal ions. Coordination polymers based on pyridylhydroxamic acids were synthesized and their molecular structure studied, alongside with their spectral and magnetic properties (NAS academician V. V. Skopenko).

It was discovered that the reaction of 1-alkyl-5-benzoyl-6-methylthio-3-ethoxy-carbonyl-1,2-dihydropyridine-2-ones with nitrogen-containing 1,4-dinucleophils-o-phenylenediamine, o-aminothiophenol, diaminoethane – runs as recyclization, whose products, depending on the initial reagent ratios, are bicyclic derivatives of 3-alkyl-carbamoyl-5-benzoylpyridine-2-on (NAS academician M. O. Lozinsky).

Oxides, salts and dispersed metals were found to affect the kinetics of synthesis reactions due to their chemical interactions with inorganic components of organic-inorganic systems, which is an additional regulating factor to increase their thermal, mechanical and electrical characteristics (NAS academician E. V. Lebedev).

A method was developed to produce floating granulated photocatalysts for effective decontamination of natural basins and waste waters from ecotoxins under exposure to sunlight. These photocatalysts, being made of eco-friendly natural materials, lose their floating ability and form harmless bottom sediment after the expiration date (NAS academician A. F. Popov).

A biotesting method was proposed to assess the quality of both drinking water and aquatic environment; it determines water samples toxicity at the cell level. The method of cytotoxicity determination employs blood corpuscles – lymphocytes, monocytes, stab neutrophils, segmented neutrophils, basophils and eosinophils – as biomarkers. Its use provides high sensitivity and sufficient information on water medium cytotoxicity (NAS academician V. V. Goncharuk).

Relying on the results of studying structure – property relationships for indolequinoxaline derivatives, molecular design and synthesis of highly effective interferon inducers and antiviral agents was carried out. PCI 0908 compound was recommended for pre-clinical trials (NAS academicians S. A. Andronati).

New members of functionalized phosphonomethylglycines group were synthesized, and studies of their biomedical properties were started. The synthesis method proposed will make available a wide range of bioactive substances with significant potential as inhibitors of natural enzymes (NAS acad. V. P. Kuhar).

An environment-friendly sol-gel technology was developed to produce spherically granulated sorbents in air counterflow. Granulated specimens of zirconium and silicon dioxides and those of titanium and zirconium phosphates were produced in the novel pilot facility constructed (NAS academician V. V. Strelko).

The decomposition kinetics of complexes of crown-ethers (CE) with potassium diperoxy-chlorochromate $n\text{CE} \cdot \text{KCrO}_5\text{Cl}$ into respective $n\text{CE} \cdot \text{KCrO}_3\text{Cl}$ ($n = 1$ or 2) complexes were studied for the first time. A compensatory effect of activation parameters was discovered and a reaction mechanism proposed (NAS academician G. I. Kamalov).

The presence of cobalt vacancies in complex perovskites was shown to promote the processes of their sublattice cationic 1:2 ordering due to the structuring of $5 \div 10$ nm domains. The ordering of $\text{Ba}(\text{Co}_{1/3}\text{Nb}_{2/3})\text{O}_3$ structure is accompanied by the formation of coherent-concretion phases with structures of $\text{Ba}_8\text{CoNb}_6\text{O}_{24}$ layered perovskites, which are localized on grain boundaries (NAS academician A. G. Bilous).

Biochemistry, Physiology and Molecular Biology



S. V. Komisarenko,
Academician-Secretary of
the Department

In 2009, research efforts of the NAS Department of Biochemistry, Physiology and Molecular Biology were zeroed in on solving fundamental problems in biology, medicine and ecology. A special emphasis was placed on studies aiming at deeper insights into complex physico-chemical processes occurring in a live organism both in the normal conditions and under the effect of pathologic processes. A lot of attention was also given to applied developments and their introduction. Department's researchers produced quite a number of important scientific results of the international level.

When studying the expression and functioning of nicotine acetylcholine receptors (nAChR) and proteinase-activated receptor 3 (PAR-3) on immune cells, scientists of the O. V. Palladin Institute of Biochemistry showed that nAChR receptors containing $\alpha 7$ -subunit regulate negatively the activation of murine B-lymphocytes affecting the processes of signaling of CD40 co-stimulatory molecules. Antibodies against PAR-3 neutralize the inhibiting effect of thrombin on vital functions and activation of murine B-lymphocytes and are a powerful activating agent for B-lymphocytes.

The O. O. Bohomolets Institute of Physiology demonstrated that TRPV1 channels take an active part in the regulation of calcium homeostasis in primary nociceptive neurons and that way they are involved in determining the functional state of those neurons, which affects the sensitivity to pain stimuli.

Researchers of the D. K. Zabolotny Institute of Microbiology and Virology isolated sulphidogenic microbial associations from natural and technogenic ecotopes, and determined taxonomic positions of their representatives – of 5 strains of sulphate-reducing bacteria and 6 strains of their heterotrophic satellites. They also determined corrosion activities of mono- and associative cultures which are the elements of sulphidogenic association.

Scientists of the Institute of Molecular Biology and Genetics found that A2 oncogen isoform of the translation factor of elongation 1 has high ability to interact with SH2 and SH3 domains of the components of cell signal paths. It was shown that the system of innate immunity, in particular IFN α and IFN1 expression, is specifically activated in response to partial hepatectomy and inhibited in response to laparotomy and exhibits cell-specific nature.

Scientific workers of the R. E. Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology

for the first time revealed certain differences in the ultra structure of tumour cells, which emerge due to the exposure to ferromagnetic and are related to their different sensitivities to antitumour drugs. A characteristic feature of the cells that are sensitive and resistant to 'Cisplatin' preparation, when cultivated with stabilized Fe₃O₄ dispersion, is the disorganization of cytoskeleton elements of active and cytokeratine series; cells that are resistant to 'Doxorubicine' preparation demonstrate intensified functional activity of cell oranelles.

Researchers of the Institute of Cryobiology and Cryomedicine showed that the nature of cryopreservation process effect on membrane properties in more differentiated hemogenic precursors can be seen in the changed distribution topography of marker proteins and protein complexes in the membranes of these cells, in the changes of their physico-chemical properties, as well as in the reduced phagocyte absorption activity.

A special genome library of *Pichia pastoris* methylotrophic yeast DNA was created for dihybrid system by specialists of the Institute of Cell Biology. Two partner proteins for interaction with Atg28 protein of *P. pastoris* were identified in the yeast dihybrid system. Mutants with deleted genes which code CAY67399 and RDi 1 partner proteins were constructed.

Some peculiarities of HAMA quantum release in inhibiting synapses of rat spinal cord neurons under local electric stimulation were investigated and analyzed at the International Centre of Molecular Physiology. Its researchers described basic kinetic properties of induced postsynaptic currents, which were identified as HAMA-induced Cl⁻ currents.

In the field of medicine, a clinical-pathogenetic system was developed for diagnostics and therapy of patients with hypertrophic cardiomyopathia. Medical scientists also studied the properties of proliferative signal networks in adrenal cortex cells, they also developed methods to predict radio-sensitivity of sinus malignant tumours by estimating the degree of tumour vascularization, worked out new methods of non-adjuvant therapy in patients with malignant tumours of thoracic organs, proposed a novel method of synthesizing biologically-active benzoin-dolysins, and elaborated a scientifically validated strategy of preventing flu pandemic in Ukraine.

In 2009, Department's institutions carried on NAS integrated target programs of scientific research: 'Novel Medical and Biological Problems and Human Environment', 'Fundamentals of Genomics and Proteomics', 'Nanostructured Systems, Nanomaterials, Nanotechnologies', 'Sensor Systems for Medical, Ecological, Industrial and Technological Purposes', 'Biomass as Fuel Raw Material', 'Fundamental Problems of Hydrogen Energy'. Conferences to report the research outcomes of those programs were organized. VII Parnassus international scientific conference in biochemistry and molecular biology 'Fundamental and Applied Aspects of Present-Day Biochemistry' was successfully held.

General Biology



V. V. Morgun,
Academician-Secretary of
the Department

In 2009 the efforts of scientists of the NAS General Biology Department were focused on solving urgent fundamental and applied problems of biology, including physiology, genetics and biotechnology, research into molecular and cellular principles of living system functioning, biodiversity inventory and conservation and efficient use of biological resources.

For the first time ever, the mechanism of epigenomic processes involvement in plant adaptation was revealed, which is of considerable interest for further advancement of the evolutionary theory and for practical improvement of plant resistance.

A methodology of maize monitoring for transgene presence was developed. Its use proved for the first time the occurrence of alien genetically modified organisms (GMO) on the territory of Ukraine and their uncontrolled propagation. New edible transgenic plants were produced, which can be used as animal fodder to prevent virus diseases and tuberculosis, as well as transgenic barley lines producing human lactoferrin. Unique homologues of human serine-threonine protein kinases involved in cytoskeleton regulation were identified in higher plants. A technology to obtain a nutrient medium from marine products was developed; it is intended for cultivating microorganisms. A method was worked out to increase the regeneration ability of wheat callus lines resistant to take-all disease (caused by *Gaeumannomyces graminis*).

The phenomenon of fast granum repacking in chloroplasts exposed to heat pulse via the aggregation of several grana was first discovered. Fundamentals were worked out for investigating winter wheat ionome and the concept of its regulation was developed; a collection of nodule soybean bacteria re-isolates was collected; a technology of integral use of herbicides for efficient crop protection against weeds was developed. The regulatory role of diurnal rhythm expression of water-channel proteins – aquaporines – in metabolome was determined.

Considerable progress was achieved in inventory studies and biodiversity conservation. In particular, 148 new species of lower and higher plants, fungi, invertebrates and vertebrates, including fossils, were first described. The unique 3rd edition of the Red Data Book of Ukraine (plant and animal kingdoms) and 2nd edition of the Green Book of Ukraine were published. A prodromus of Ukraine's vegetation was composed. In the framework of the international BRAHMS program, a nomenclature database of vascular plants of Ukraine was produced. Concepts of

horticultural and park landscape architecture were developed, alongside with ways to prevent the destruction of parks in the forest-steppe zone. Single-genus gardens of lilac (*Syringa*), magnolia (*Magnolia*) and conifers were created.

Basic natural-history preconditions of geosociosystemic organization of the Beskydy region were clarified. The structure of model biocoenosis systems of natural complexes in the ecological network of the West Buh, Dniester and Tisza rivers was studied. Principles and methods were developed to use a number of biochemical, physiological and population parameters of model plant and animal species for indicating the status of soil, terrestrial and aquatic ecosystems.

Scientists determined the parameters of biogenic and lithogenic sedimentation of pollutants in freshwater and marine ecosystems, the critical levels of chromosomal mutagenesis in natural hydrobionts populations; they found inhibited spawning of Antarctic krill under the effect of heavy metals and Antarctic glaciers melting. Prognostic scenarios of alterations in the Black Sea flora due to global climate change were proposed.

The Chornobyl exclusion zone remains highly contaminated. As of today, no trends of mutational variability reduction are observed. The frequency of visible mutations in winter wheat plants has remained practically the same for 20 years after the accident.

Considerable progress was achieved in genetic improvement of cereals, fruit and ornamental plants. Employing chromosome engineering methods, scientists produced new winter wheat cultivars, with rye-wheat translocations in their genome and high environmental plasticity and grain quality. The development of such cultivars is a way to increase the yield of high-quality wheat.

31 plant cultivars were created, which were recognized as new breeding achievements. In Cherkasy Region on the area 136 ha, 'Favoritka' wheat cultivar produced a record-breaking yield in the centuries-old Ukrainian history – 131.8 c/ha.

Scientific innovations secured 43 author's certificates and 14 patents. 1860 license agreements on cultivars use in agricultural production were issued and validated, which is a substantial contribution to the food security of Ukraine. 178 partner agricultural businesses were assigned to the institutions of the Department by a joint resolution of the Ministry of Agrarian Policy of Ukraine and the National Academy of Sciences of Ukraine, with a view to extending their production base.

Leading scientists of the Department were honoured with Ukrainian and international awards and honorable distinctions. Young scientists were awarded with the prizes of the President, Verkhovna Rada and the Cabinet of Ministers of Ukraine.

Further efforts of Department's scholars will go to developing novel areas of biology and aiming applied studies at innovation, with a view to increasing research competitiveness.

Economics



E. M. Libanova,
Academician-Secretary of
the Department

In 2009 the efforts of researchers of the NAS Department of Economics were focused, primarily, on studying present-day global economic processes; identifying the origins of global financial and economic crisis and ways to overcome it, as well as means to minimize its negative impact on Ukraine's economy; validating the priorities of economic policy.

A number of significant results were produced. Department's researchers disclosed the system of interrelations between macro-instability factors and the potential of endogenous development. It enabled them to reveal indicators of destructive processes and forecast them; to determine the impact of globalization on the development of the country in the interaction of international and national development, using cooperation stratagem. They also substantiated their approaches to singling out destabilization factors of the economic development.

Relying on the systematization of factors and pathways of the spreading financial and economic crisis in Ukraine, economic scientists validated the conceptual framework of governmental economic policies to minimize the effects of the crisis in industry. They advanced theoretical and methodological grounds for shaping financial policy and the interrelations of the main leverages of its implementation on the basis of the chosen model of economic development.

They obtained new research results on economy stabilization in terms of the shocks experienced: in particular, the concept of economy adaptability was defined as its ability to respond adequately to internal and external shocks and to restore effectively its optimal functional parameters and sustainable development. For the first time, scholars proposed economy adaptability factors, which include market size and efficiency, its adaptability to fluctuations of external conditions, framework for business, the ability to innovate, structural adaptability, financial stability, adaptability to climate change and existing regional disparities. Principles were determined to classify price shocks by certain commodity groups according to their impact on the macroeconomic situation.

Department's researchers elaborated a methodological framework to predict the development of complex social and demographic structures. They prepared a long-term forecast of changes in the sex-age structure of the population and in the distribution of population in terms of education, economic-activity and social status. Our scholars developed a concept of regulating the socio-economic structure of the Ukrainian society, which defines the principles, guidelines and ways of regulating this process.

Besides, they proposed methodological approaches to estimating the efficiency of implementing the strategy aimed at improving the population quality, developed recommendations towards its implementation and substantiated public policy measures to improve population quality. They validated recommendations to refine the available mechanisms of influencing the population quality and providing new ones, taking into account the prospects of demographic development and the current economic situation.

Department's institutions provided an estimate of the existing and potential risks and challenges in innovative strategies and innovation development of Ukraine and its regions in terms of its economic, natural and technological security. Researchers grounded the current system of limitations and risks for the formation of human capital and the development of regional settlement; they developed basic strategic principles of environmental protection through macroeconomic regulation of investment processes and put forward a general concept of security environment.

Issues of climate change forecasting were explored and the approaches to statistical analysis and forecasts of the possible impact of these changes on key sectors of the Ukrainian economy were validated. The effects of parameters of the weather-climate regime were estimated and predictive models developed to forecast its possible manifestations due to the action of expected changes in the planetary climate on the national economy.

Economic scientists determined major challenges facing the agricultural sector in the economic crisis and the associated risks for food production. They classified current mechanisms of crisis management and protection of national agricultural and food markets alongside with validating priority state measures to promote the development of Ukraine's agricultural sector affected by crisis.

Scholars developed a value-based approach to interpreting the world-history process and issues of civilization identity; formulated basic ideas concerning evolution patterns of the international order; summarized and systematized the main concepts that determine civilization factor in the analysis of present-day integration processes.

They also revealed the major external factors and specific features of the mechanism of current global financial and economic crisis spreading. Generalized were characteristics of anti-crisis programs, and some anti-crisis proposals were developed at the global and regional levels.

In the near future, the efforts of scholars will zero in on studying profound social and economic processes of the economic reform to create a new state order which should take into account general patterns of market development in the world as well as Ukraine's peculiarities, and would ensure a balance of economic liberalization values with the interests of the society and the state.

History, Philosophy and Law



O. S. Onyschenko,
Academician-Secretary of
the Department

In the year under review, research institutions of the Department aimed their efforts at a comprehensive analysis of trends and determinants of economic, social, political, legal and cultural progress of Ukraine in the light of the threats and risks of crisis processes in today's world. Scholars of Department's institutions prepared the socio-humanitarian part of the fundamental work «Socio-Economic Situation in Ukraine: Implications for the Nation and the State: the National Report» (by NAS Acad. O. S. Onyschenko, V. A. Smoliy, Yu. A. Levenets, V. M. Vorona, M. V. Popovych, Yu. S. Shemshuchenko; H. V. Boriak, O. M. Mayboroda et al.).

NAS Institute of Sociology published academic writings: «Ukrainian Society in 1992–2009. Dynamics of Social Changes» (by NAS Acad. V. M. Vorona, M. O. Shulga), «Social Changes in Ukraine and Europe» (by Ye. I. Golovakha), «Socio-Economic Behaviour in Ukraine in Terms of Institutional Changes» (by T. O. Petrushyna).

Scholars of NAS I. F. Kuras Institute of Political and Ethnic Studies published their books: «Modern Ukrainian Politics. Analytical Reports of NAS I. F. Kuras Institute of Political and Ethnic Studies» (edited by NAS Acad. Yu. A. Levenets).

NAS Institute of the History of Ukraine published the monographs: «Bohdan Khmelnytsky: Socio-Political Portrait» and «Ukrainian National Revolution of the XVII Century. (1648–1676)» (by NAS Acad. V. A. Smoliy), «History of Civil Service in Ukraine. Essays» and the first two volumes of «History of Civil Service in Ukraine. In 5 Volumes» (by NAS Acad. V. A. Smoliy, S. V. Kultshytsky, O. S. Rubliov), and «Administrative-and-Territorial System of Ukraine» (by Ya. V. Vermenych).

Scholars of NAS V. M. Koretsky Institute of State and Law published: «Flagship of Ukrainian Law Sciences. 60 years of NAS V. M. Koretsky Institute of State and Law. 1949–2009» (edited by NAS Acad. Yu. S. Shemshuchenko), «Institution of Legal Responsibility in Democratic Law Systems» (by N. M. Onishchenko), «Codification of Labour Law of Ukraine» (by N. M. Chutorian), «Legal Framework for Innovation Development in Ukraine's Agriculture» (by NAS Corr. Memb. V. I. Semchuk).

NAS Acad. L. V. Gubersky published his writings: «Philosophy: Textbook (From Origins to the Present Day)», «Philosophy: Manual» (co-authored by NAS Corr. Memb. V. P. Andrushchenko). NAS Acad. V. H. Kremen published the fundamental monograph

«Philosophy of Humanocentrism in Strategies of Educational Space».

Scholars of NAS H. S. Skovoroda Institute of Philosophy published the monographs: «Culture: Illustrated Encyclopedia of Ukraine» (by NAS Acad. M. V. Popovych), «Morning Reflections» (by S. B. Krymsky), «Natural History and Humanities» (by V. S. Lukyanets), «Phenomenon of Socio-Natural Systems» (by M. M. Kyseliov).

Researchers of NAS M. S. Hrushevsky Institute of Ukrainian Archeography and Source Studies prepared and published their works: «Ukrainian Personal Seals of XV–XVII Centuries» (by O. A. Alfiorov and O. A. Odnorozhenko), «Ukraine on Ancient Maps. Atlas of Reproductions» (by Ya. R. Dashkevych), «Petro Kalynshevsky and his Times. Collection of Documents and Materials» (by V. V. Hrybovsky and V. I. Milchev).

Researchers of NAS I. Krypiakevych Institute of Ukrainian Studies issued the books: «Historical Myths and Stereotypes and Ethnic Relations in Contemporary Ukraine» (by L. O. Zashkilnyak), «West Ukrainian People's Republic. 1918–1923. Governments. Figures» (by NAS Acad. Ya. D. Isaievych, M. R. Lytvyn).

V. I. Vernadsky National Library of Ukraine published the studies: «Library Science in Ukraine in the Twentieth Century» (by NAS Acad. O. S. Onyschenko and NAS Corr. Memb. L. A. Dubrovina), «Library as a Center for Preserving Information Resources» (by V. A. Kopanyeva), «Library and Archives of O. Z. Popilnytsky» (by L. M. Denysko).

Scholars of NAS Institute of Archeology prepared and published their writings: «Ukraine: Development Chronology. Ancient Slavs. Kyivan Rus. Vol. 2» (by NAS Acad. P. P. Tolochko; NAS Corr. Membs. H. Yu. Ivakin, O. P. Motsya), «Chronicle of Archeological Studies in Khersonese–Kherson» (by V. M. Zubar).

Achievements of leading scholars of Department's institutions were honoured with high awards. NAS Acad. L. V. Gubersky got the 'Hero of Ukraine title and the Order of the State. NAS Acad. Yu. S. Shemshuchenko and NAS Acad. V. Ya. Tatsiy received the awards of the President of Ukraine – the Order of Prince Yaroslav the Wise III Class, V. P. Horbatenko – the Order of Prince Yaroslav the Wise V Class. NAS Acad. V. A. Smoliy, NAS Corr. Memb. V. P. Andruschenko, V. B. Averyanov got the Order 'For Services' I Class; NAS Corr. Memb. V. B. Yevtuch – the Order 'For Services' II Class; NAS Corr. Memb. O. I. Kopylenko, NAS Corr. Memb. V. F. Kolesnyk, V. P. Nahrebelny, O. M. Kostenko and A. B. Hrechlyo – the Orders 'For Services' III Class. O. S. Zabuzhko was awarded with the Order of Princess Olga III Class.

In 2010, the efforts of the Bureau and institutions of the Department will be focused on further search for new forms and methods to put to better use the creative potential of socio-humanities in the interests of economic, social, spiritual and cultural progress of the Ukrainian society.

Philological Studies, Art Criticism, Ethnology



M. H. Zhulinsky,
Academician-Secretary of
the Department

As before, in the year under review, scholars of the NAS Department of Literature, Language and Art Studies addressed fundamental and applied issues of the development of literature, language, arts criticism, traditional every-day culture, computer linguistics, at dealing with major challenges related to the scholarly backup of the national and cultural revival of Ukraine, with unbiased analysis of various stages in the development of Ukrainian spiritual culture in the past and its status at the beginning of the XXI century.

The practical outcome of the abovementioned tasks was the publication of 173 collective and individual works by Department's scholars, including 96 monographs and collections of writings, 14 study textbooks and manuals for university students and schoolchildren, 26 reference books and dictionaries, 42 academically treated and commented belles-lettres texts, nearly 1500 publications in collected academic works and periodicals.

The high academic level of Department's researchers was proved by awarding the 2009 State Prize of Ukraine in Architecture to Ya. M. Taras for his writing «Sacral Architecture of Carpathian Ukrainians: Cultural Tradition Aspect», the NAS F. I. Schmit Prize to arts scholar H. V. Vrochynska for her work «Ukrainian Folk Woman Decorations of XIX – Early XX Centuries», NAS O. O. Potebnia Prize to NAS corresponding member H. P. Pivtorak and O. I. Skopenko for their «Byelorussian-Ukrainian Dictionary». For outstanding achievements in the advancement of Ukrainian science, arts scholar V. A. Ovsyichuk was honoured with the Order of Yaroslav the Wise V Class, NAS academician V. H. Donchyk – with the Order 'For Services' II Class, literature scholar N. R. Mazepa – with the Order of Princess Olga III Class.

Department's literature scholars carried on their research into literature theory, the history of the Ukrainian and foreign literatures, current state of belles-lettres, preparation of encyclopedic and academic publications of literary heritage. A number of fundamental works were published: «Ukraine through the Eyes of the West» by NAS corresponding member D. S. Nalyvaiko, «Creative Work of Yuliusz Slovacki and Ukraine. Problems of Ukrainian-Polish Comparative Literature Studies» by S. K. Nakhlik, «Emergence of Word: Discourse of Early Ukrainian Modernism» by NAS corresponding member T. I. Hundorova, «Immensity of Yevhen Pluzhnik as Poet» by M. P. Kodak, «Ukrainian Polymeric Poem» by N. I. Havryliuk, «Artistic Discourse of the Ukrainian Poetry of Late XIX

– Early XX Centuries» by O. A. Kaminchuk. The «Reference Volume to I. Franko's Collected Works in 50 Vols. Index of Omissions» was published alongside with commented selected writings by T. Shevchenko, I. Franko, V. Stus and numerous foreign authors.

To implement the Decree of the President of Ukraine 'On the Development of the National Dictionary Base', Department's linguistics scholars completed the preparation and issued 10 thousand copies of the laser disk «Integrated lexicographic System 'Dictionaries of Ukraine' version 4.0» with the register of 275 thousand items, they produced and put to practice a new version of virtual lexicographic system «Dictionary of the Ukrainian Language», developed the conceptual model and technological principles of «Taras Shevchenko» electronic encyclopedia. 3 new-generation dictionaries were published, alongside with such fundamental works as «Historical Typology of Slavic Languages», «Essays on the History of Ukrainian Word Formation (-ина suffix)» by NAS corresponding member V. V. Nimchuk and P. I. Bilousenko, «Linguo-Esthetical Signs of Ukrainian Culture» by NAS corresponding Member S. Ya. Yermolenko, «Ukrainian Language in Internet: Extra-Linguistic and In-Structure Processes» by S. H. Chemerkin etc.

Relying on the outcomes of research into multifaceted phenomena of traditional culture, arts and folklore scholars, ethnologists published 56 collective and individual writings: «History of Ukrainian Arts» (vol. 1), «History of Ukrainian Theatre» (vol. 2), «History of Decorative Arts in Ukraine» (vol. 3), «History of Ukrainian Music» (vol. 2), «Icon Art: Rome, Byzantium, Ukraine» by D. V. Stepovyk, «Theory of Nation in Ukrainian Political Thought» by O. I. Hryniv and O. O. Shyprykevych, «Formation of Ukrainian Culture Determinants» by I. M. Yudkin, «Revived Masterpieces» by T. V. Kara-Vasilieva and H. F. Kovalenko, «Hetmans' Graves» by S. P. Sehedra, ethnologic works by P. P. Chubinsky, F. K. Vovk and O. O. Rusov etc.

The most important research-management activities of the Department in the reporting year were directed towards developing new scholarly concepts and research programs, carrying out national and Academy projects to implement a number of Presidential decrees and Government assignments, towards preparing and holding 39 international and all-Ukrainian academic conferences, as well as advancing international collaboration of Department's institutions with foreign academic centers and strengthening their ties.

Activities of State Commission for Academic Degrees and Titles of Ukraine and its Co-Operation with National Academy of Sciences of Ukraine

V. F. Machulin,
Member of the Academy
Presidium

Head of State Commission for Academic Degrees and Titles of Ukraine

In 2009 the State Commission for Academic Degrees and Titles (SCADT) of Ukraine, in collaboration with the basic entities of research and education staff attestation, held 6 sessions of its Presidium, which set up and extended the terms of office for 324 specialized academic boards, approved their decisions of issuing 6,200 candidate-of-science certificates and over 800 doctor-of-science certificates, as well as those of 437 senior research associates and 64 PhDs. In 2009 the SCADT of Ukraine approved new versions for 22 descriptions of research specializations, held 316 sessions of specialized academic boards and 2 regional meetings on improving the certification process, it drew up and adapted 25 regulatory documents on the improvement of research-and-educational staff certification and considered over 5.700 letters and applications from individuals and companies on issues that are within its jurisdiction.

In 2009 the SCADT co-operated with the NAS of Ukraine as the leading organization for training and certifying high-qualification research personnel in Ukraine. Early in 2009, the Ministry of Justice of Ukraine registered a joint order issued by the SCADT of Ukraine and the NAS of Ukraine concerning the procedure of submitting electronic versions of printed specialized academic editions to the National V. I. Vernadsky Library of Ukraine for deposition. This document has been the core of Commission's activities towards re-registering and ordering the list of specialized academic editions via setting up a respective depository. In 2009, 565 of such editions were re-registered, which significantly improved the mechanism of publishing dissertation results. This work is to be continued in the future, especially towards identifying the body of leading specialized academic editions that would be equal in terms of quality to internationally recognized editions.

A special approach has been provided for placing prepaid editions on the National Library's website, those making up 4-5% of the total number of editions. A respective agreement fixes a 6-24 month delay in the open public access to those editions.

The statistics of using the depository information resources proves their popularity. As of today, the daily number of both Ukrainian and foreign users, visiting the depository, amounts to 20,000 – 25,000, this being 5-6 times more than in 2008.

Following the decisions of the Presidential Council

of the academies of sciences Ukraine, the SCADT of Ukraine developed and submitted draft documents, to be discussed by the academic community, on organizing the activities of coordination boards that are to plan and coordinate dissertation research subjects, advance co-operation of research institutions with state power bodies of various levels, with a view to a more rational use of public money in solving the problems facing applied scientific studies of both regional and national scales. Those draft documents were discussed by the session of Academic-Community Council, functioning under the SCADT. The National Academy of Sciences of Ukraine is represented in it by 6 scholars.

Still, the co-operation between the SCADT and the NAS of Ukraine in 2009 was based on mutual efforts in search for ways to improve the training of researchers and to incorporate Ukrainian science to the European and global science areas. These activities were significantly promoted by some draft laws and draft Cabinet decisions, which were elaborated by the Ministry of Education and Science of Ukraine, the SCADT of Ukraine and people's deputies of Ukraine. This concerned, primarily, the draft laws 'On amendments to the law of Ukraine 'On higher education'', 'On certification of highly qualified research-and-education personnel', and the draft Cabinet resolution 'On approving the regulations and criteria of the activities of research universities in Ukraine'.

Since every abovementioned draft law and Cabinet resolution, if approved, might produce a significant and not always foreseeable impact on the current system of training and certification of highly qualified research personnel, the SCADT and the NAS of Ukraine agreed that a thorough public discussion of those documents was necessary, alongside with a strictly legitimate procedure of their adoption.

So, at the request of the President of the NAS and the Head of the SCADT, the Cabinet of Ministers of Ukraine set up a respective task group formed of representatives of the National Academy of Sciences of Ukraine, state specialized academies, the State Commission for Academic Degrees and Titles of Ukraine, and the Association of Ukrainian Universities Presidents. In October – December 2004, the task group discussed and edited draft documents. That work should be continued.

Quite a number of the issues mentioned above were often raised during international contacts of the SCADT of Ukraine, in particular, within the framework of the International Association of Official Certification Agencies, whose active member Ukraine is. The XI session of the Association is scheduled to be held in Kyiv in the summer of 2010. We hope this would result in a deeper involvement of Ukrainian scholars, first and foremost, NAS representatives, in Association's activities. No less efficient collaboration between the NAS and the SCADT is to be achieved through the incorporation of leading Academy's scholars into Commission's expert boards. The next rotation of expert boards' membership is scheduled for 2010.

Environment Preservation and Sustainable Development



**P. H. Kostiuk,
Advisor of the Academy
Presidium**

In 2009, significant research efforts were aimed at studying current trends of nature protection in Ukraine, developing scientific principles of rational nature use and integrated nature-resource management, alongside with ensuring ecological security, particularly in the field of wastes utilization.

Those activities were coordinated by the NAS Academic Council for Environment and Sustainable Development, as well as the National Committee of Ukraine for 'Man and Biosphere' UNESCO Program.

In the period under review, NAS scientists elaborated drafts of the National concept of implementing and advancing more environment-friendly and green technologies of wastes disposal for 2010 – 2014, and the concept of Targeted integrated interdisciplinary program of NAS research into sustainable development, rational nature use and environment protection. NAS scientists were engaged in research and science- administration activities under numerous targeted state programs, in particular, those concerning integral flood-control measures in the Dniester, Prut and Siret river basins, the integrated development of Ukrainian Danube area for 2004 – 2011 etc., as well as NAS targeted integrated research programs 'Biomass as Raw Fuel', and 'Environment Monitoring and Ukraine's Ecological Security'.

NAS scientists contributed to scientifically validated proposals towards practical solution of some nature protection tasks in Ukraine, in particular, those related to the security of nation's water resources and measures to provide its population with high quality drinking water; forming Ukraine's attitude to the global agreement on climate change for the period after 2012; draft conclusions and recommendations of the Committee on Implementation of UN Convention on Environmental Impact Assessment in the Transboundary Context (Espoo Convention) concerning Ukraine's communication on the negative impacts of Romania's economic activities, etc.

During the reporting period a number of significant research results were obtained. Scientists worked out the conceptual and methodological bases of the institutional framework for using nature resource potential, as well as theoretical and methodological approaches to determining efficient ecological security policy under globalization. A methodology and information database were developed for the energy analysis of technologies to produce and use alternative fuels from plant and animal biomass, alongside with scientific approaches to developing natural-water monitoring systems and technologies to

intensify self-purification processes in natural water basins. An automated heating system relying on solar collectors was produced. A pilot version of the Ecological Atlas of Ukraine was published. Studied were the impacts of the main economic activities on physical, chemical and biotic characteristics of soils and organic carbon reserves. The third edition of the Red Book of Ukraine (plant and animal world), and the second edition of the Green Book of Ukraine were prepared and published.

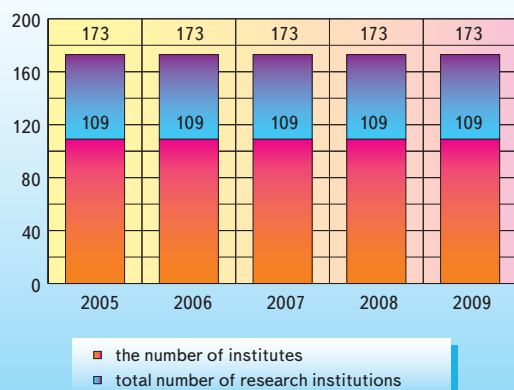
In the international collaboration domain, NAS scientists attended the 35th UNESCO General Conference, the 21st session of the International Coordinating Council for the 'Man and the Biosphere' UNESCO Program (MAB), the 'EUROMAB – 2009' international conference, the 17th Meeting of the Committee on Implementation of Espoo Convention, the XV Conference of Parties to the UN Framework Convention on Climate Change, the V Meeting of Parties to the Kyoto Protocol, and the Ukrainian – USA Workshop 'Climate Change, Regional Impacts and Control'.

In the near future, research efforts will be aimed at approving the concept of Ukraine's transition to sustainable development, creating and advancing environment-friendly industries, as well as elaborating relevant state programs on their basis; developing the strategy and tactics of Ukraine's participation in the Kyoto Protocol mechanisms and research into climate change; working out steps towards adaptation to and mitigation of possible negative impacts of such changes. Of utmost importance still is the problem of using biosphere reserves as the key territories for sustainable development, raising the level of ecological awareness and knowledge, with a view to providing the administrative bodies and population with an insight into the peculiarities of 'man – environment' interaction, the necessity of their active involvement in the processes of sustainable development management at regional and local levels, protection and development of natural and cultural assets.

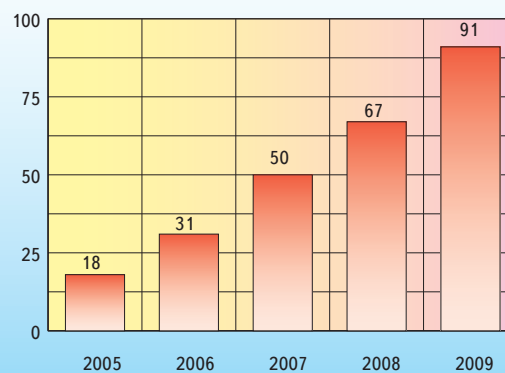
Regional Structure of the National Academy of Sciences of Ukraine



Total number of research institutions



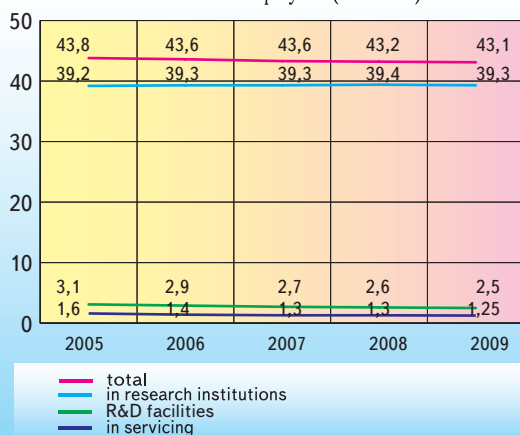
Number of the Centers for shared use of scientific equipment



NAS of Ukraine 2009

Total number of employees	43066
including:	
in research institutions	39297
in R&D organizations	2519
in service organizations	1250

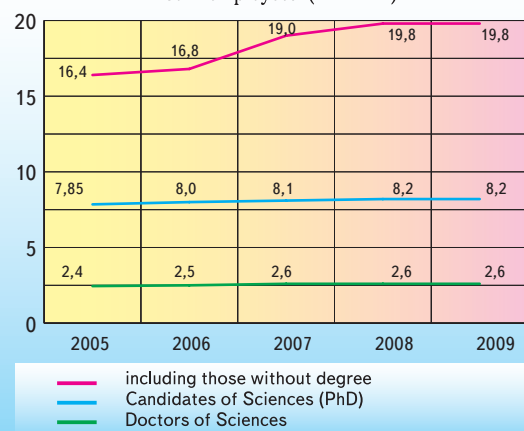
Number of employees (thousand)



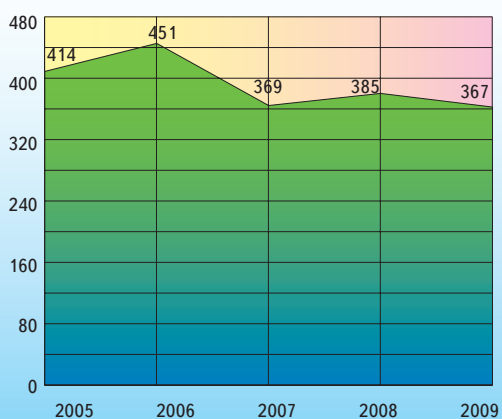
Statistics

R&D employees	19782
including:	
Doctors of Sciences	2619
Candidates of Sciences (PhD)	8200

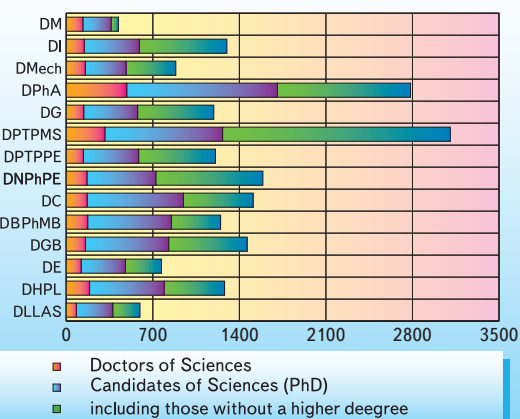
R&D employees (thousand)



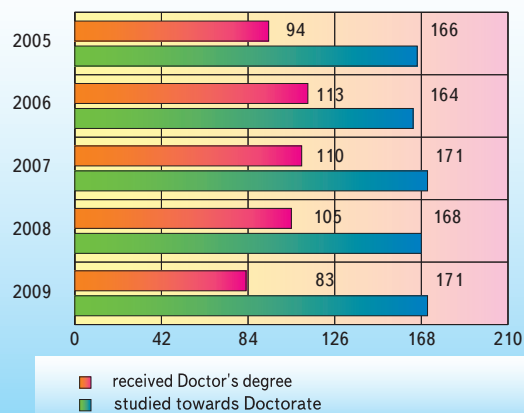
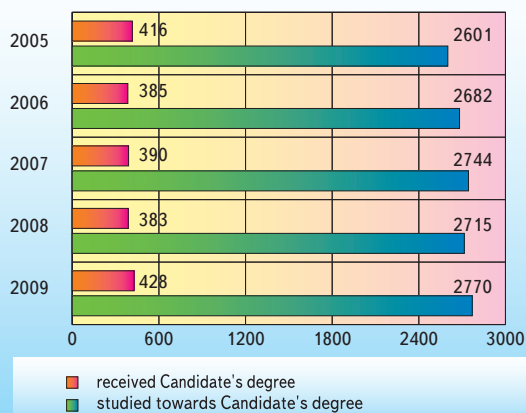
Recruitment of university graduates



Distribution of scientists by departments

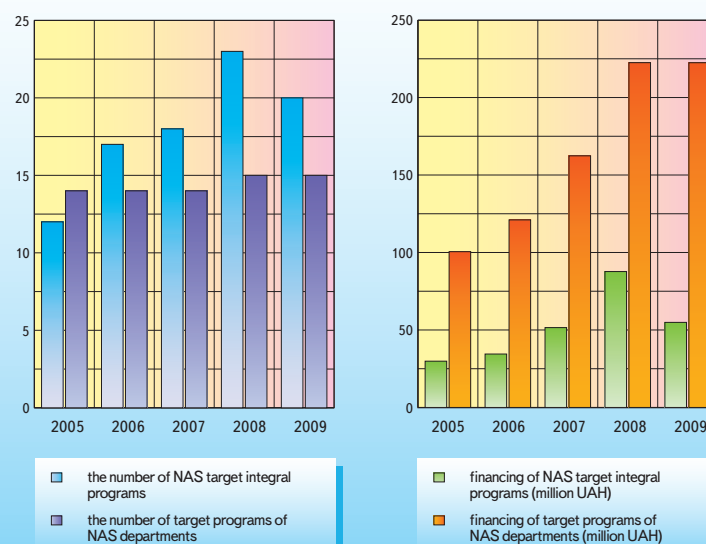


Training of research personnel

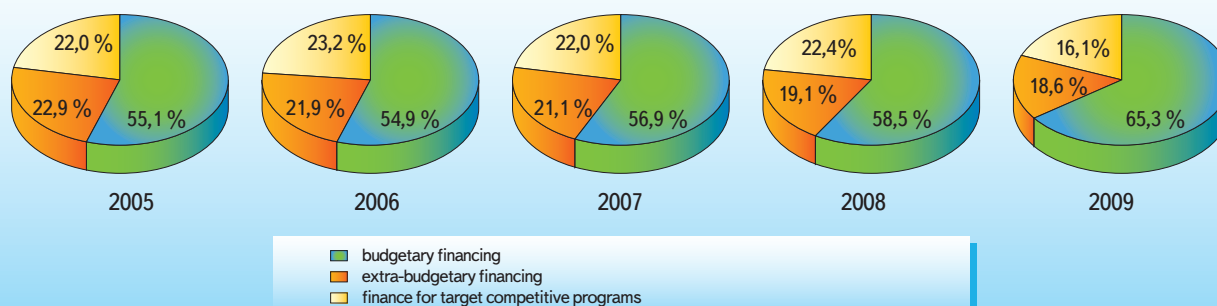


Budget	thousand UAH
Total expenditures	2254941,3
Basic funding from the State budget	1446432,5
Target programs finance	362022,5
Budget finance for personnel training	7915,2
Budget finance for health protection	19567,9
Extra-budgetary revenues	419003,2
Expenditures on wages	1656709,0
Expenditures on equipment and instruments	49999,9
Expenditures on capital construction and reconstruction	6335,2
Expenditures on utilities	140583,5
Other expenditures	402698,9

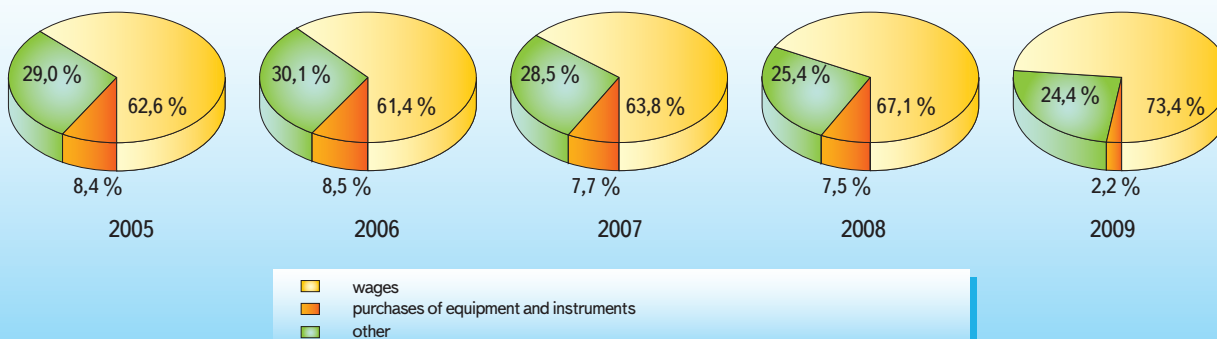
Target programs subjects



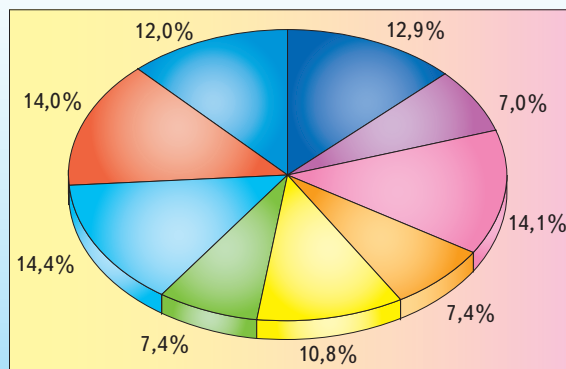
Distribution of finance by sources



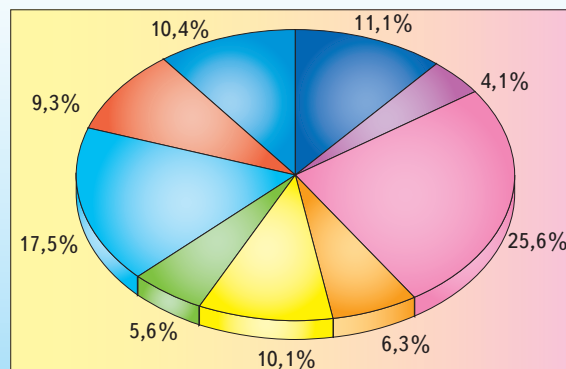
Distribution of expenditures by principal items



Distribution of basic budgetary finance

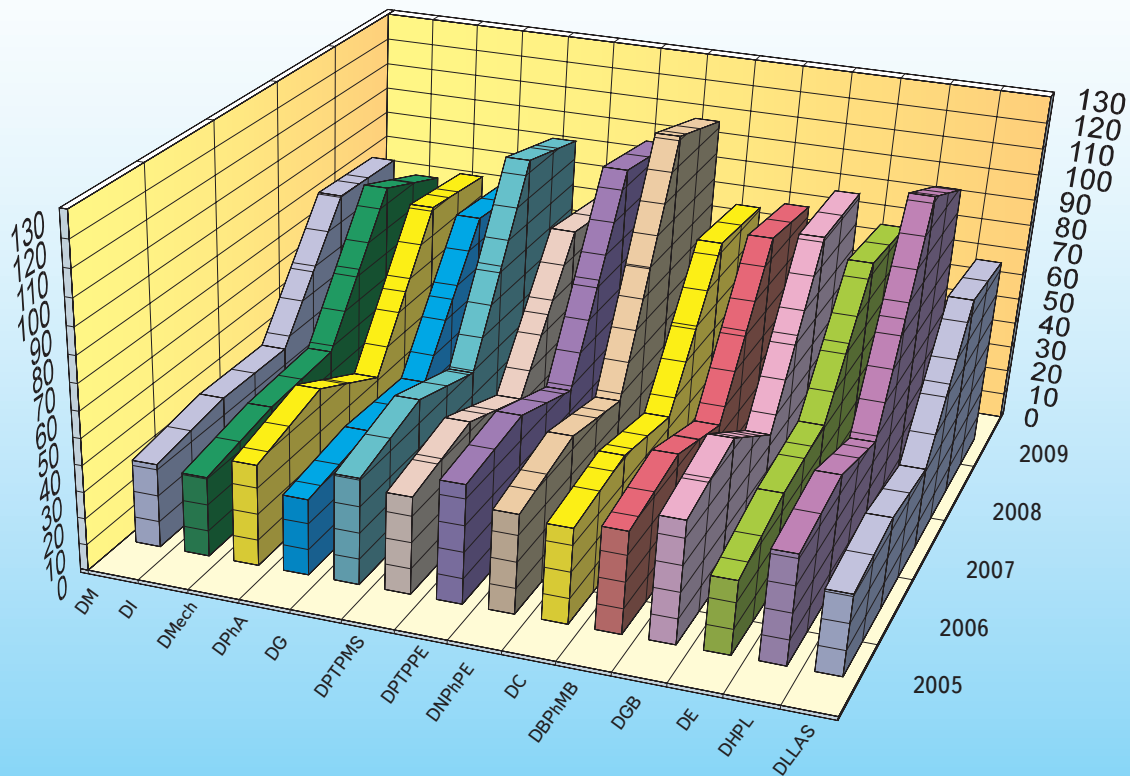


Distribution of extra-budgetary finance



■ Mathematics, Mechanics, Informatics
 ■ Earth Sciences
 ■ Power Engineering
 ■ Chemistry
 ■ Social Sciences and Humanities
■ Physics and Astronomy
 ■ Materials Sciences
 ■ Nuclear Physics and Power Engineering
■ Biological Sciences

Distribution of budget finance per 1 researcher among Departments (thousand UAH)

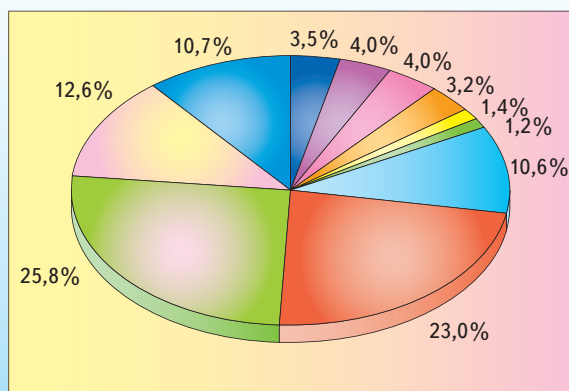


Publication of Academic Materials

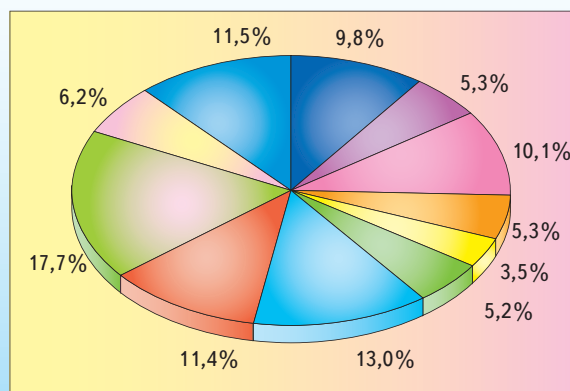
In 2009, publication of journals was started

«Mathematical Machines and Systems»
«Radio Physics and Electronics»
«Chemistry, Physics and Technology of Surfaces»
«Ethnology Notebooks»

Monographs

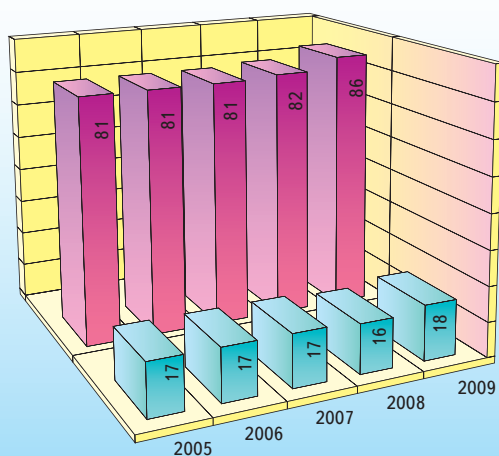


Papers



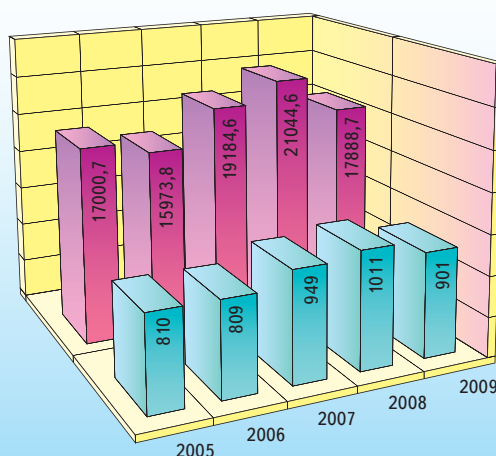
■ Mathematics, Mechanics, Informatics ■ Earth Sciences ■ Power Engineering ■ Chemistry ■ Economics ■ History, Philosophy and Law
 ■ Physics and Astronomy ■ Materials Sciences ■ Nuclear Physics and Power Engineering ■ Biological Sciences ■ Literature, Language and Art Studies

Academic Periodicals



■ total number of periodicals
 ■ including: the number of publications translated abroad

Publication of Academic Books

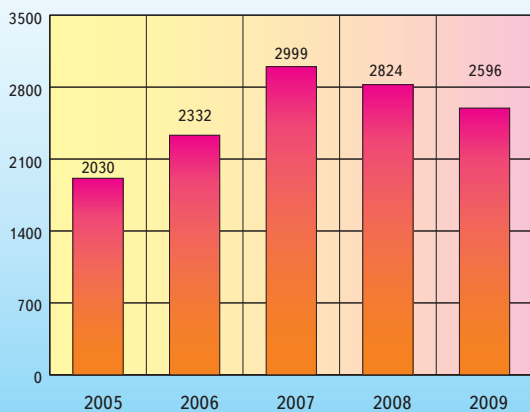


■ volume
 ■ the number of titles

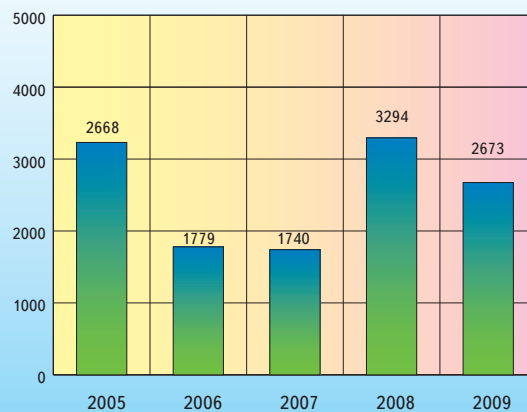
International Contacts of the National Academy of Sciences of Ukraine with Foreign Institutions



Foreign Scientists Received in Ukraine



Ukrainian Scientists Sent on Mission Abroad



Contents

Main Results	3
<i>B. E. Paton, President of the Academy</i>	
Research Based on Principles of Targeted Programs and Competition.Advancement of International Ties	6
<i>A. P. Shpak, First Vice-President of the Academy</i>	
Institutions of the Section of Physical, Engineering, and Mathematical Sciences Are Solving Challenging Interdisciplinary Problems	8
<i>A. G. Naumovets, Vice-President of the Academy</i>	
Co-Operation with Young Researchers	9
<i>V. D. Pokhodenko, Vice-President of the Academy</i>	
Academy's Socio-Humanities and Modernization of Ukrainian Society in the Context of XXI-Century Challenges	10
<i>V. M. Heyets, Vice-President of the Academy</i>	
Activities of NAS General Meeting and Presidium	11
<i>A. G. Zagorodny, Chief Scientific Secretary of the Academy</i>	
Mathematics	12
<i>A. M. Samoilenko, Academician-Secretary of the Department</i>	
Information Science	13
<i>A. O. Morozov, Acting Academician-Secretary of the Department</i>	
Mechanics	14
<i>A. F. Bulat, Academician-Secretary of the Department</i>	
Physics and Astronomy	15
<i>V. M. Loktev, Academician-Secretary of the Department</i>	
Earth Sciences	16
<i>V. M. Shestopalov, Academician-Secretary of the Department</i>	
Physical-and-Technical Problems of Materials Science	17
<i>I. K. Pokhodnya, Academician-Secretary of the Department</i>	
Physical-and-Technical Problems of Power Engineering	18
<i>B. S. Stogniy, Academician-Secretary of the Department</i>	
Nuclear Physics and Power Engineering	19
<i>I. M. Nekludov, Academician-Secretary of the Department</i>	
Chemistry	20
<i>V. V. Goncharuk, Academician-Secretary of the Department</i>	
Biochemistry, Physiology and Molecular Biology	21
<i>S. V. Komisarenko, Academician-Secretary of the Department</i>	
General Biology	22
<i>V. V. Morgun, Academician-Secretary of the Department</i>	
Economics	23
<i>E. M. Libanova, Academician-Secretary of the Department</i>	
History, Philosophy and Law	24
<i>O. S. Onyschenko, Academician-Secretary of the Department</i>	
Philological Studies, Art Criticism, Ethnology	25
<i>M. H. Zbulinsky, Academician-Secretary of the Department</i>	
Activities of State Commission for Academic Degrees and Titles of Ukraine and its Co-Operation with National Academy of Sciences of Ukraine	26
<i>V. F. Machulin, Member of the Academy Presidium</i>	
Environment Preservation and Sustainable Development	27
<i>P. H. Kostiuk, Advisor of the Academy Presidium</i>	
Statistics	28

