THE NATIONAL ACADEMY OF SCIENCES OF UKRAINE

in 2016

SUMMING UP THE YEAR

Dear friends,
2016 was a very strenuous and eventful year both for the country as a whole and for Ukraine's science sphere. We all witnessed a lot of changes. Yet, our desire to conduct research in compliance with high international standards and promote the innovative development of the national economy and social life remains unfailing.

Studying modern problems of fundamental science, Academy researchers continued their proactive efforts in such important areas as energy engineering and energy efficiency, information technologies, new substances and materials, machine building and instrument making, medicine and health care, agribusiness and food security, mineral and raw-material resources, nuclear safety and environment protection. Responding to emerging challenges, we significantly intensified our work aiming at novel developments and technologies to strengthen the defense potential and security of the country.

I'd like to mention some important results of basic research. Specialists in mechanics and mathematics for the first time ever obtained an analytical class of Maxwell equation solutions in the field of a rotating black hole. Cybernetics scientists developed new pioneering high-precision and high-speed technologies for content recognition of large-volume texts. Physicists and chemists found new physical properties of nanocomposites based on carbon nanotubes with polymethine dyes. Carbon honeycombs — a new 3d form of graphene with unique properties — were discovered. Astronomers calculated the probability of Earth collision with potentially hazardous asteroids that could endanger the existence of many life forms. Materials scientists studied the electrical and optical properties of the unique graphene-like semiconductor material — super-thin nanofilms of laminated indium monoselenide crystal. Chemists synthesized a number of new heterocyclic compounds and studied their biological activity. Researchers working in the field of life sciences proposed a new hypothesis of genome instability which explained the nature and frequency of emerging mutations; they also developed basic principles of formulating novel medicines that demonstrated high activity against multidrug resistant strains of tuberculosis. Scholars in social sciences and humanities worked out a methodology to assess socio-economic impacts of implementing Ukraine's international energy and environment commitments as well as their effect on the energy balance of the country; they also substantiated the trends of Ukraine's strategic neo-industrial development. It should be noted that in the previous year major publishing projects were continued, and quite a number of fundamental studies were published, in particular, those prepared to mark the 25th anniversary of Ukraine's Independence, to commemorate the 150th birth anniversary of Mykhailo Hrushevsky, the 160th birth anniversary and the 100th death anniversary of Ivan Franko. The abovementioned facts give convincing evidence that the Academy maintains rather high, and in some areas international, standards of research. That is demonstrated, in particular, by the stable number of papers published by our scientists in high-ranking professional journals abroad and by the number of grants won to do research under international scientific programs.

Besides, a lot of worthwhile results of applied research and development were produced last year.

For one, mathematicians in collaboration with medical scientists worked out a procedure to synthesize algorithms for processing ultrasound images of human carotid arteries. Specialists in cybernetics, using SKIT-4 computer, developed 3d models of archeological excavation sites, metro stations and passages. Land-cover maps of 10-meter resolution were compiled and the radionuclide mapping of the Transcarpathian reserves was carried out alongside with the evaluation of the so-called 'radiation weather' factors, radon distribution in particular. Significant results of materials scientists are represented by the technology of acoustic emission monitoring; it is intended for continuous diagnostics of industrial pipelines of hot reheat steam and for controlling the process of growing profiled single crystals of metals, specifically tungsten and molybdenum. Among noticeable achievements one can also mention the technology for conversion of brown coal from Ukrainian Olexandriya deposit. In 2016 our scientists also developed a number of products for medicine: new antimicrobial polymer composites, a diagnostic test system for quick identification of pneumocystis that causes pneumocystis pneumonia, and a new technique for prognosticating the rate of liver fibrosis progress in patients with chronic hepatitis C. Biologists implemented a pilot project, which is the first in Ukraine and Europe, and created a special site and electronic database of all plant species in gardens, arboreta and parks of this country. Applied achievements of scholars engaged in social sciences and humanities were enriched with recommendations on improving the legal framework of reintegration policy as an element of the state ethno-national policy of Ukraine, and with a technology for compiling the national system of linguistic resources.

It is important that the Academy furthered its defense R&D, namely, technologies, materials and facilities for producing modern armament and military equipment, information protection systems, camouflage coatings, as well as various medical products to meet the needs of both the military and civilians.

One should mention that last year our specialists implemented a number of developments that had already proved their utility and showed a significant actual or expected economic effect. Among them, in particular, was the continuation of long-term works to extend the operation lives of power-generating units of Ukrainian NPPs beyond the designed time. To manufacture parts of aerospace vehicles, wide use is made of state-of-the-art materials with high mechanical properties and performances — heat-resistant and refractory multi-component niobium-based alloys proposed by our scientists. In 2016, a new research-and-production unit of the Ukrainian 'INTERKHIM' pharmaceutical plant was launched in Odesa (in co-operation with NAS O.V. Bogatsky Physico-Chemical Institute). That will allow a four-time increase in the production of domestic medical preparations. Last year our specialists in plant genetics and breeding created 6 new plant varieties; 3 of those received author's certificates. The areas sown with winter wheat varieties amounted to 2 million hectares or 30% of the areas under this crop in Ukraine.

Along with significant achievements of the previous year, one cannot but mention several important events in the life of the Academy. Undoubtedly, that was, first and foremost, the adoption of the new version of the NAS Statutes by the NAS General Meeting. This guideline document contains a number of important innovations introduced to harmonize it with changes in the national legislation (primarily, the new version of the Law of Ukraine 'On Scientific and S&T Activities'), improve the management of the Academy and its institutions, ensure the essential democratization of Academy's inner life. One should also remember that 2016 was rich in jubilees of the national scope, which will make our Academy's history as well. I mean, specifically, the 25th anniversary of Ukraine's Independence (the August jubilee session of the General Meeting of the National Academy of Sciences of Ukraine and national sectoral academies was dedicated to it) and the 25th anniversary of the Referendum on Ukrainian Independence, which was also honored by a Grand Session of NAS General Meeting.

Among other memorable events of 2016 was the decision of the Cabinet of Ministers of Ukraine to establish a higher education institution of a new type within the NAS structure — Kyiv Academy University. Its foundation was initiated by the NAS of Ukraine and the MES of Ukraine. It is to become a true research university, as its education process will be based on the so-called "Phystech system", i.e. its second- or third-year students will take part in actual research. We hope that the foundation of this university will, among other things, strengthen the scientific potential of the Academy and enrich it with young talents. Other measures are taken to involve gifted young people in the activities of NAS institutions, e.g., various forms of support, the financial one included. We do everything we can to stop brain drain and the flight of talented youth from science, though, the decisive role in this undoubtedly belongs to the state.

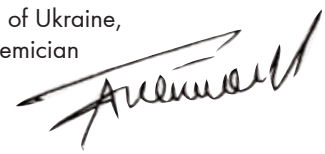
In 2016 the Academy also tested a new procedure for evaluating the performance of its institutions, which was developed relying on German experience (in particular, that of the Leibniz Association — Leibniz Gemeinschaft). We propose that this procedure, which received positive expert appraisals during Peer Review of the Ukrainian Research and Innovation System, should be used in the future — in the public evaluation of research institutions, and its results are to be taken into account by the Ministry of Education and Science.

A very significant event of 2016 was the September meeting of V.B. Groysman, Prime Minister of Ukraine,

with scientists. It addressed the reformation of the science sphere, the advancement of academy science and stressed the necessity of strengthening ties between science and industry, ensuring the progress of national economy. That meeting was of major importance for improving Academy's activities — on 9 November the session of NAS Presidium considered the reformation of NAS activities for effective scientific support to the implementation of priorities of Ukraine's economic development. In accordance with the decision approved by the abovementioned Presidium session, the Academy thoroughly analyzed the potential of its institutions to address concrete scientific, technological and socio-economic challenges in various industries and in the social sphere. Relevant proposals were sent to the Prime Minister of Ukraine.

The successful implementation of all planned R&D projects is, however, extremely complicated, in view of the very scarce public funding. The budget deficit of our Academy in 2017, even if minimum needs are only taken into account, is about UAH 626.6 million. Of that, extra UAH 452.1 million is needed to pay salaries in the full time work schedule. And this is despite the fact that in 2016, to implement Article 28 of the Law of Ukraine 'On the 2016 State Budget of Ukraine', the network of NAS institutions and their structures were optimized and a significant number of workers were laid off. NAS Presidium did not and does not spare efforts towards improving the financial provision of the Academy, it works persistently with relevant parliamentary committees, the Government and its ministries to increase NAS funding when introducing amendments to the Law of Ukraine 'On the 2017 State Budget of Ukraine'.

Still, in spite of numerous problems and hardships, we should look into the future with optimism and believe that positive changes are coming soon. Scientists have always been and will always be a strong support for their Motherland; they are and will be doing everything they can for the prosperity of Ukraine, its accession to the community of developed and civilized nations.

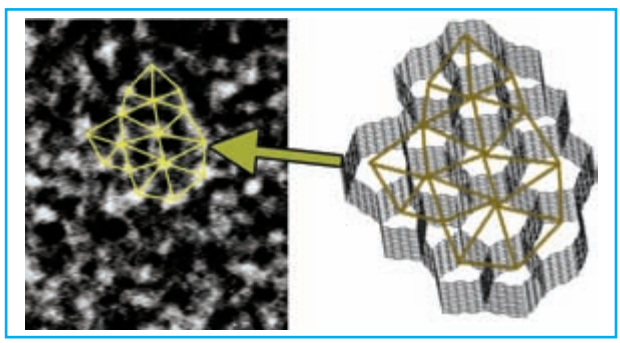
President
of the NAS of Ukraine,
NAS Academician  PATON Boris E.

RESEARCH ACHIEVEMENTS. NATURAL AND ENGINEERING SCIENCES

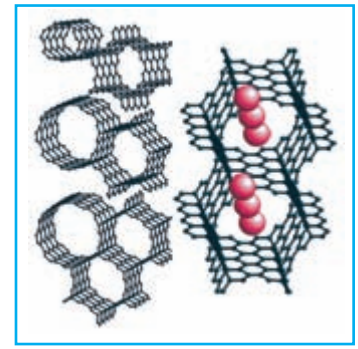
"3d graphene" or "carbon honeycomb" — a new carbon modification

"3d graphene" or "carbon honeycomb" are names of a new carbon modification synthesized at NAS B.I. Verkin Institute for Low Temperature Physics and Engineering by N.V. Krainyukova in collaboration with Ye.M. Zubarev from the National Technical University 'Kharkiv Polytechnical Institute'. This modification got that name due to its shape resembling honeycomb. Structural studies by low-temperature electron diffraction and high-resolution transmission electron microscopy showed that the substance synthesized contained a network of channels whose walls were made of graphene layers. The first graphene honeycomb samples were obtained as films where honeycomb channels form a random lattice. These research results were published in Physical Review Letters.

The discovery received immediate attention as it holds promise for this material to be used as a lightweight and high-capacity storage container for hydrogen fuel. It is the process of hydrogen storage and transportation, in view of its hazards and high energy consumption, which was the key obstacle to using gaseous hydrogen as a renewable energy source in the past. The family of carbon-based materials are principal candidates for the role of such porous material that could trap this gas, safely store it and, if necessary, easily release it. A number of factors, however, made the use of carbon materials difficult, since the access to nanotube storage space is, as a rule, blocked.



Images of random honeycombs obtained with high-resolution transmission electron microscopy (left) and their reconstruction (right)



Symbiosis of honeycomb structures with nanotubes (left), and absorption of metal and gas atoms (right)

And yet, the new structures produced by our scientists have already demonstrated their ability to absorb significant amounts of inert gases (krypton, xenon) and carbon dioxide. The capacity of the new structure to store hydrogen is also much higher than the levels which could be attained in nanotubes even theoretically.

These are not all new useful properties of honeycomb structures. Another of their unique properties is the ability to structure adaptation — symbiosis with other carbon forms. That permits them to be used as a kind of 'construction' material or matrix for multi-component composite complexes. Filling honeycomb channels with metal atoms or with molecules of various compounds can impart unique electric or magnetic properties to the material. Due to this, such honeycomb structures have very good prospects of being used in micro- and nano-electronics

Prediction of new effects and phenomena in the black hole field, based on new solutions of electromagnetic field equations

Scientists of the NAS Ya.S. Pidstryhach Institute for Applied Problems of Mechanics and Mathematics developed a new approach to solving Maxwell equations in the space of complex geometry formed around a rotating black hole — the so-called Kerr black hole. This approach enabled them to predict a new phenomenon caused by the rotating hole and propose a new method to determine its angular momentum.

In 2016, LIGO laboratories provided convincing proofs of the existence of black holes as their scientists recorded gravitation waves emitted at the stage of their approaching and merging. Due to that the task of giving a comprehensive description of black hole's effect on the fields and objects in its vicinity became even more relevant, as the mere proof that somewhere in the space there is a black hole with its only three theoretically determinable characteristics — mass, angular moment and electric charge — would permit a better understanding of their origin and, thereby, a better insight into the origin of the Universe.

One of the manifestations of black holes' existence and rotation are the so-called jets — relatively thin

Visual reconstruction of the black hole disk and jets it emits (NASA, the European Space Agency, the Space Telescope Science Institute, D. Berry)

A relativistic jet from the M87 Galaxy (a picture of the Hubble Space Telescope)

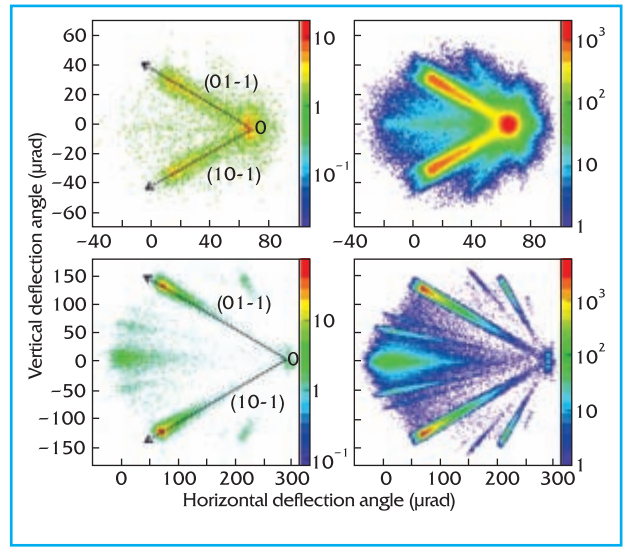
streams of ionized matter moving with velocities close to the velocity of light. These streams are formed due to the energy of black holes' rotation and the magnetic field in their vicinities. The proposed solution permitted a more comprehensive description of the peculiarities of magnetic field propagation in the immediate vicinity of the black hole, without the limiting assumption of that field's weakness and without neglecting its wave nature as Einstein did when he had predicted the deflection of light rays in the Sun's field. That allowed our scientists to find out that the rotation angle of the radiation polarization plane depends on radiation frequency and the angular momentum of the black hole. The confirmation of this effect could be a test whether the object is a Kerr black hole and another verification of the general relativity theory. Besides, the polarization dispersion effect can be used to determine the angular momentum of the black hole.

Observations made from the *Integral* satellite have already detected polarized gamma-radiation; the launch of space vehicles (*GEMS*) is planned in the near future. They will be equipped with X-ray polarimeters of higher sensitivity, which could prove the predicted effect.

Controlling the parameters of ultra-relativistic particle beams

On the initiative of scientists of the O.I. Akhiezer Institute for Theoretical Physics of the National Science Center 'Kharkiv Institute of Physics and Technology', a special experiment was conducted at CERN to discover the theoretically predicted effect of splitting the ultra-relativistic proton beam into several beams when it is channeled through a bent crystal.

The analysis of the experimental results proved the principal theoretical predictions. The results obtained open up new prospects in controlling the parameters of



The angular distribution of 400 GeV after passing through a bent silicon crystal with curvature radius of 30.3 m (top distributions) and 6.9 m (bottom distributions). Left – CERN experiment, right – the theory. Color shows the intensity of angular distribution

beams of high energy particles by means of bent crystals, relying on the stochastic mechanism of particle dispersion on bent chains of crystal atoms.

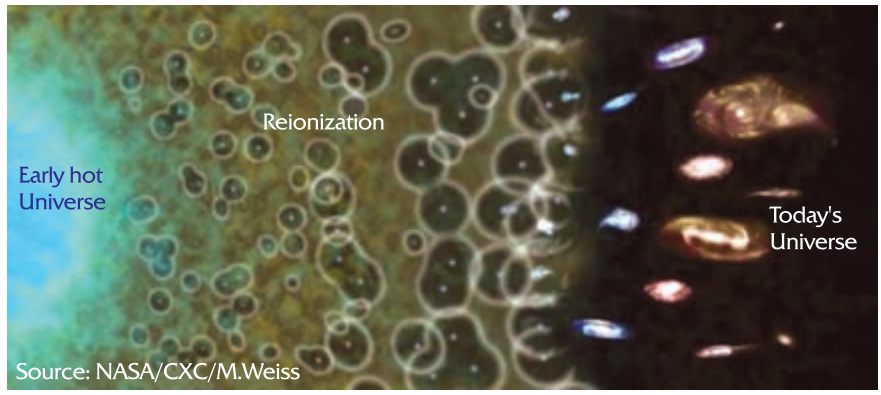
It was shown that this mechanism of particle beam deflection resulted in a more stable pattern of angular distributions of the dispersed particles than other techniques of beam deflection by a bent crystal that rely on particle reflection by bent crystal's atomic planes and the effect of planar channeling.

New experiments at CERN are planned to carry out the comparative analysis of various mechanisms of the deflection of high energy particle beams by bent crystals.

3.5 keV line, sterile neutrinos and reionization in the Universe

The nature of Dark Matter — the fundamental gravitating substance that determines the formation of gravitationally bound structures in the Universe — still remains obscure. In 2014, scientists of NAS M.M. Bogolyubov Institute for Theoretical Physics, Leiden University (the Netherlands) and the Federal Polytechnic School of Lausanne (Switzerland) discovered a possible evidence of the decay of dark matter particles — a weak 3.5 keV emission line.

A possible explanation of the line observed is dark matter decay in the form of sterile neutrinos — hypothetical particles whose mass is larger and interaction strength weaker than those of regular neutrinos. In 2005, it was shown that the Standard Model of particle physics, if just three sterile neutrinos are added, permitted physicists to explain *three principal observed phenomena beyond* the Standard Model — *neutrino oscil-*



Reionization in the Early Universe – gas ionization by the first radiating objects, such as galaxies

lations, dark matter and the observed asymmetry between matter and antimatter in the Universe.

Does the detection of the 3.5 keV line mean the existence of dark matter made up of sterile neutrinos? A recent work of scientists of NAS M.M. Bogolyubov Institute for Theoretical Physics was an attempt to answer this question. The work for the first time ever analyzed the effect of dark matter composed of sterile neutrinos — the very neutrinos that would have formed the observed decay line — on the process of Universe reionization. As the authors showed in the framework of their simplified semi-analytical "bubble" model, in the sterile neutrino model the reionization starts later and occurs faster (as compared to the conventional "cold dark matter" (CDM) model). This better agrees with the available observation data. Further detailed studies of the duration of Universe ionization will permit a better determination of the sterile neutrino effect on the process of Universe ionization and facilitate the definitive solution of the dark matter problem.

Classification of resonant surface waves for arbitrary 3d periodic disturbances of large-capacity industrial containers

Scientists of the NAS Institute of Mathematics, in collaboration with physicists and engineers of the Norwegian University of Science and Technology (Trondheim) conducted research to classify resonant liquid waves in cylindrical large-volume tanks that are widely used in launch vehicles, ocean-going tankers, nuclear reactor coolers, water and oil reservoirs, and marine fish farms. Resonant waves result in extreme loads on tank walls and bottom; that demands reliable evaluation of structures' strength and identification of an adequate strategy of their motion control.

This task cannot be solved through conventional experimental and computing approaches, as there is an infinite number of wave formation scenarios, i.e. resonant liquid motions cannot be numerically modelled in a finite interval of time. Using nonlinear analysis methods, researchers were able to solve the relevant boundary-value problem with free surface, which enabled them to qualitatively and quantitatively describe all physically possible extreme resonant waves for arbitrary 3d periodic disturbances of a cylindrical tank and investigate their stability. The proposed analytical approaches and methods can be applied to a wide class of large-volume industrial tanks, including those of complex shapes. These methods allow a theoretical extension to the case of surface waves in laboratory containers that are typically used in medico-biological research and pharmaceutics.

The mathematical results obtained were tested by comparing them with the experimental data of Norwegian, French and American research engineers.

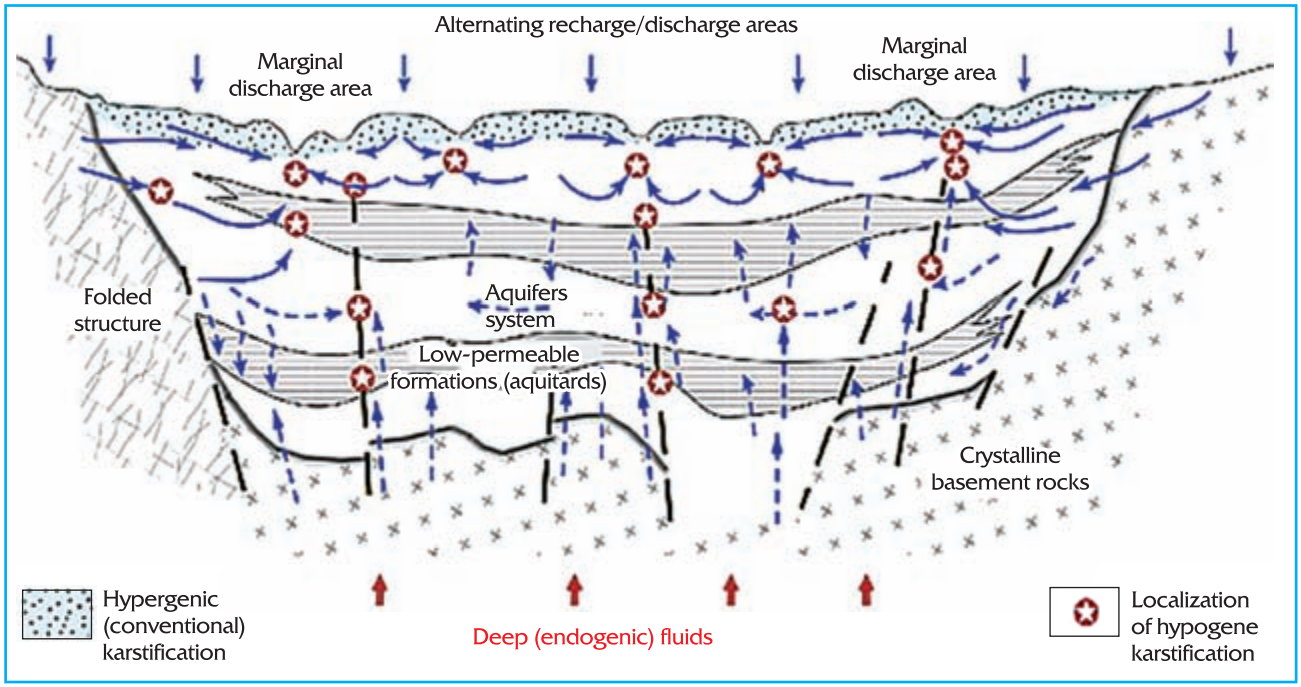
There is information about hundreds of accidents due to inadequate evaluations of resonant liquid wave movements in tanks. E.g., the failure of several tanks with environmentally hazardous liquids during an earthquake in Turkey in 1999 caused local environment disasters. This shows the importance and high relevance of the results produced by mathematical scientists for both various engineering branches and the safety of humans and the environment.

The application of the methods proposed to solving some problems of pharmacology, experimental biology, chemistry and medicine also seems quite promising.

Hypogene karstification theory

The development of karst (i.e. the formation of macro porosity and anomalously high permeability in the geological media through dissolution) affects various spheres of practical human activities. Karstification was traditionally associated with the effect of infiltrated meteoric water on soluble rocks exposed to the surface or occurring in the shallow subsurface. Karst manifestations recorded at great depths were considered as paleokarst that had been formed in the previous epochs of exposure and buried beneath younger rocks.

Scientists of the NAS Institute of Geological Sciences developed a theory of hypogene (deep) karstification caused by the upward discharge of con-



A conceptual scheme of hypogene karstification localization in the groundwater flow systems of a cratonic artesian basin

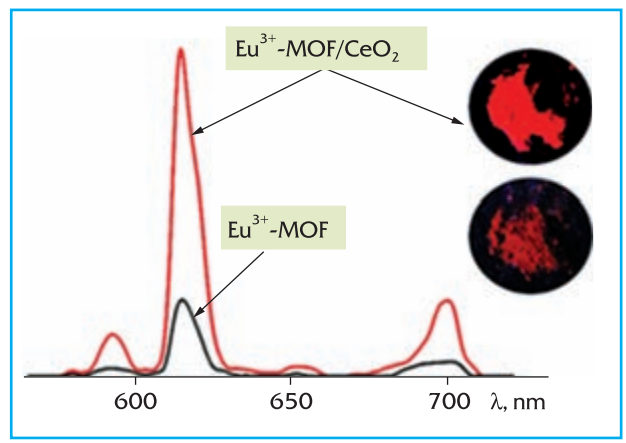
fined ground waters and deep (endogenic) fluids; they also carried out a global generalization of its manifestations and patterns. According to this theory, hypogene karstification develops along structural and lithological heterogeneities in a wide range of reactive rocks, producing a network of effective fluid migration conduits and macro-cavities in the Earth crust in both continental and oceanic settings. It plays an important role in organization of the upward fluid discharge, mass transfer processes and formation of numerous deposits of fluid-generated ores and hydrocarbons.

The hypogene karstification theory has won international recognition, led to a change in the general paradigm of karst and a revision of the ideas about karst origins in many regions of the world. It has formed a new basis for assessing the karst role in prospecting and exploration of hydrocarbons (including unconventional ones) and fluid-generated ore deposits, geological sequestration of radioactive and toxic waste, mitigation of natural hazards, prospecting and using geothermal and deep-water resources, including mineral waters.

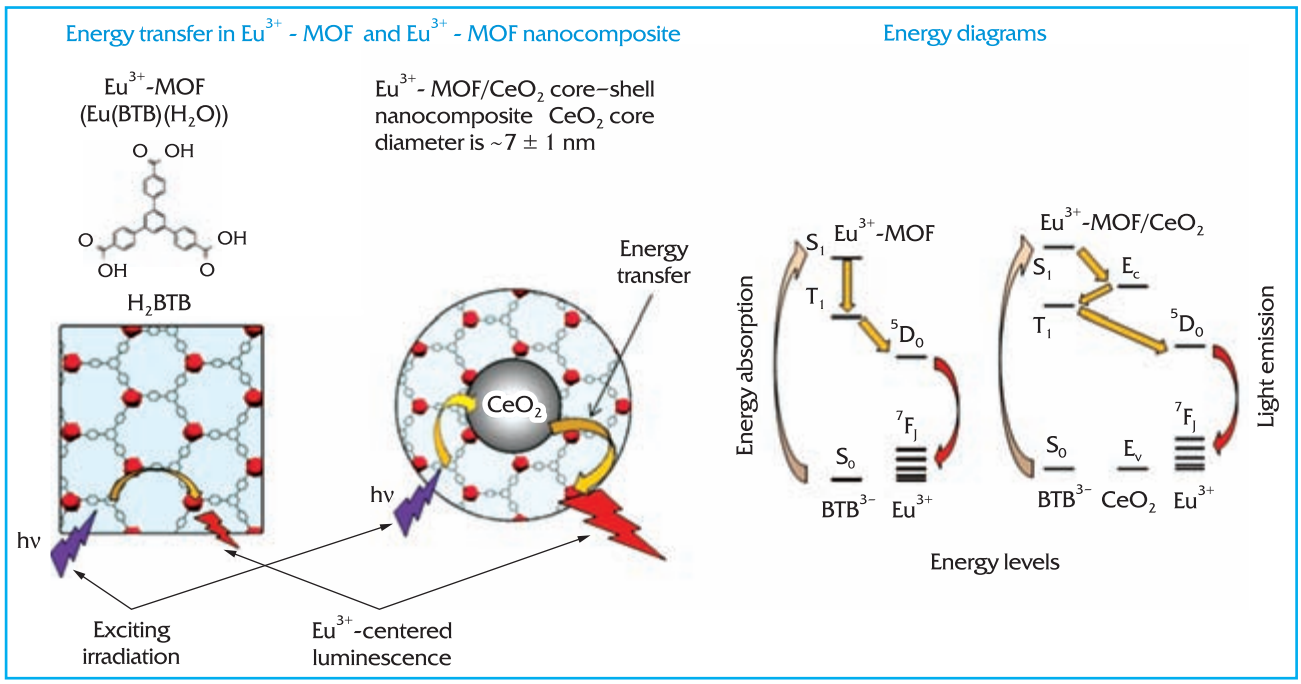
The abovementioned practical aspects of the hypogene karstification theory are now used and further developed in the USA, Canada, Brazil, Germany, France, China and other countries.

New ways to improve luminescence efficiency

NAS L.V. Pisarzhevsky Institute of Physical Chemistry developed new ideas concerning the possibility to improve luminescence quantum yield through the use of metal oxide nanoparticles as mediators of electron transport from excitation energy absorption centers to light-emission centers in hybrid core-shell nanocomposites. The effectiveness of this approach was demonstrated for nanocomposites of lanthanide coordination complexes, metal-organic frameworks in particular, which find numerous applications as active components of emitting layers in LEDs, luminescent screens, lasers, biological markers etc., and CeO_2 nanoparticles. A hybrid nanocomposite was produced; in it the nanoparticle core of cerium dioxide (the component that improves the efficiency of energy transfer to emitting centers — Eu^{3+} ions) was covered with europium-containing coordination polymer (EuBTB(H_2O), BTB-1,3,5 benzenetricar-



Normalized luminescence spectra and sample photographs



boxylic acid) of the metal-organic framework (MOF) — (the emitting component).

An increase (more than 4-fold) of quantum yield in the Europium-centered luminescence in the hybrid nanocomposite as compared to the initial coordination polymer was achieved due to involving electron levels of CeO_2 (Ec) as transition ones in the process of excitation energy transfer. That resulted in a more effective "delivery" of excitation energy to light-emitting centers (Eu^{3+} ions), if CeO_2 particles were used as "mediators" of such transfer.

The design of core-shell nanocomposites opens up new ways to the directed synthesis of high-luminescence lanthanide-complex materials that are intended for advanced equipment as active components of emitting layers in electronic devices, reactants for express diagnostics and theranostics in medicine, etc.

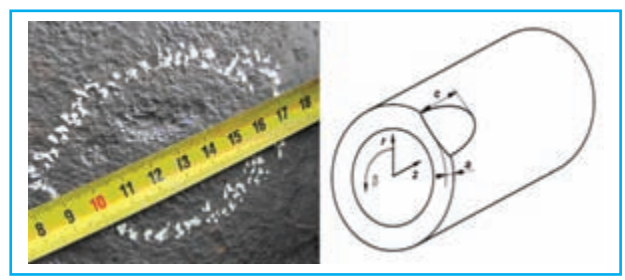
New methods and algorithms to determine the stability of critical welded structures with discovered defects

One of the major tasks of today's science is to develop methods for non-destructive testing, determine the residual life and operability of critical structures, and make informed decisions concerning the extension of their safe exploitation. To this end, scientists of NAS V.M. Glushkov Institute of Cybernetics worked out methods and algorithms to solve computational problems with large data arrays, relying on multiple parallel processors. Such problems emerge in the analysis of the stressed deformed state of welded structures with discovered defects.

The importance of the results obtained stems from the fact that a significant increase in the design quality and performances of welded structures can only be achieved through the use of radically new 3d models and by ensuring high reliability of mathematical modelling results.

To meet these requirements, large data arrays are to be processed, though the computing power of today's personal computers and workstations is not sufficient for that purpose.

The innovative methods developed by our scientists rely on computers of novel hybrid architecture with multi-core processors and graphic accelerators (in particular, computers of the *Inparcom* family, collaboratively developed by V.M. Glushkov Institute of Cybernetics and 'Electronmash' State Research and Production Enterprise), and on unique mathematical models worked out at E.O. Paton Electric Welding Institute. The use of the abovementioned methods and equipment to solve numerous practical problems and analyze the stability of critical welded structures permitted a significant reduction in the computation time (20—60-fold).

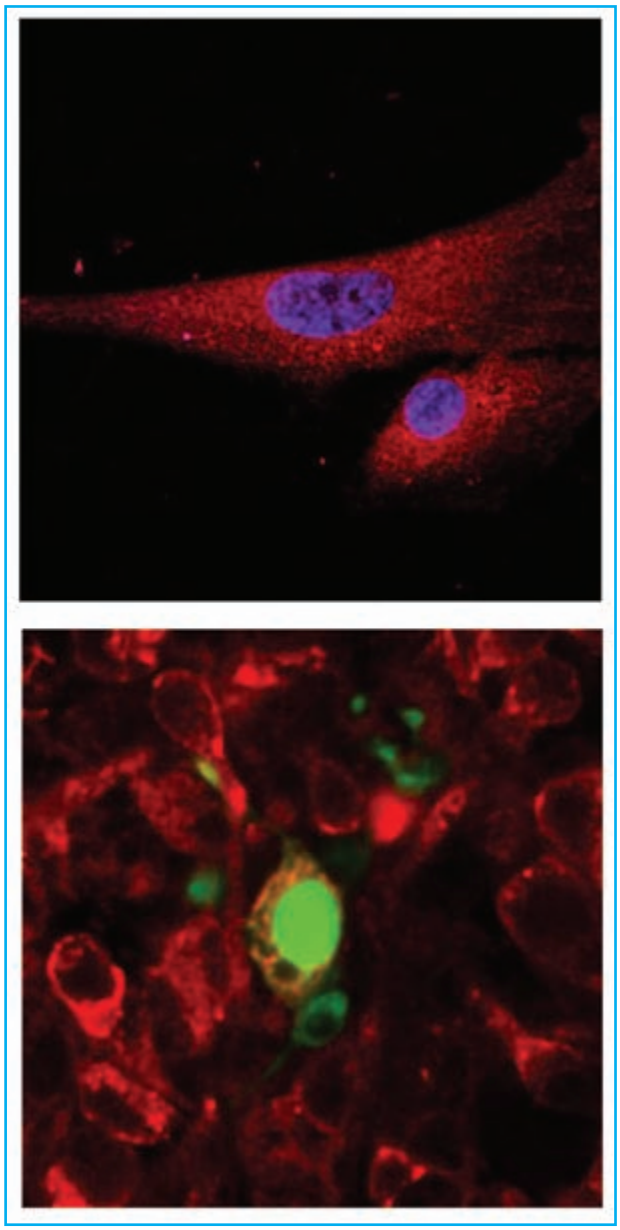


The photograph and diagram of the defect caused by corrosion-induced local metal loss in a pipeline segment

The proposed methodological approach to numerical modelling is unique in the world and is used by specialists of NAS E.O. Paton Electric Welding Institute in nuclear power industry and in pipeline transportation.

Important link in the regulation mechanism of intracellular signaling networks, intercellular and intermolecular interactions

Nicotinic acetylcholine receptors (AChRs) are ligand-dependent ion channels that mediate rapid synaptic transmission in neuromuscular synapses and autonomic ganglia and control the release of cytokines and neurotransmitters, survival, cell proliferation and adhesion in the brain and numerous non-excitable cells. Studying AChRs is of great importance for understanding cholinergic mechanisms of the regulation of cell vital functions, particularly in neurodegeneration.



Expression of α7 subtype of nicotinic AChRs (red coloring) in mesenchymal stem cells (top) and induced pluripotent human cells (bottom), including those differentiated into dopaminergic neurons (green coloring). Blue coloring shows cell nuclei

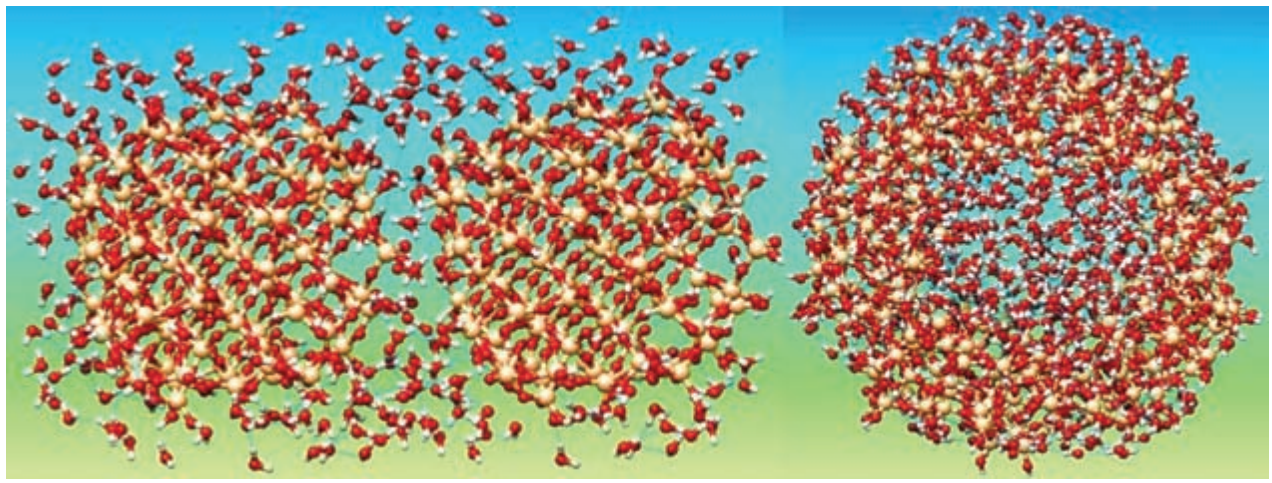
Earlier, scientists of NAS Palladin Institute of Biochemistry had discovered the presence of those receptors in intracellular organelles (mitochondria) and demonstrated their involvement in regulating the inner pathway of apoptosis — the programmed cell death in unfavorable conditions. In 2016 it was found that they protect mitochondria from the apoptotic action of amyloid peptide 1—40, which appears in the brain during the development of Alzheimer's disease. Their new subtypes (α9α10 and α7α10) were detected in mouse brain and their ability to compensate the absence of α7 or α10 subunits in knockout mice was shown. The presence of α3, α7 and α9 of nicotinic AChRs was demonstrated in mesenchymal stem and induced pluripotent cells, which correspond to the earliest development stages of mammal cells and can differentiate into brain cells. It was found that the expression level of these receptors changed during cultivation *in vitro* and affected the production of anti-inflammatory cytokines by stem cells.

The data obtained emphasized the important role of nicotinic acetylcholine receptors in supporting the viability of brain cells, in Alzheimer's disease in particular, and for the first time ever identified the presence of α9- and α-10-containing nicotinic AChRs in mouse brain. They also demonstrated the importance of cholinergic regulation at the early stages of cell differentiation, which should be taken into account in preparing stem cells to transplantation.

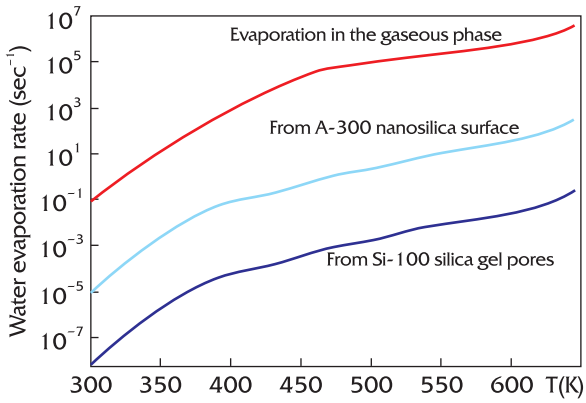
Theory of interface phenomena

Researchers of NAS O.O. Chuiko Institute of Surface Chemistry, using quantum chemistry methods and kinetic gas theory, developed theoretical fundamentals for calculating the evaporation of low molecular weight compounds (under 500 Dalton) from a liquid medium (micro- and nanodrops, adsorption layer) into a gaseous one. Their calculations proved that the evaporation of liquids and condensation of gases depend on liquid types, molecule structures, sizes and structures of clusters or liquid drops, surrounding particles (free, adsorbed on an open surface or localized in pores), the presence of dissolved compounds or co-adsorbents, flow parameters, temperatures and pressures. All these parameters are taken into account in the models for the evaporation of free microdrops and the adsorption layer on the surface or in the pores of solids.

Theoretical studies of liquid evaporation from the surface of pyrogenic silica nanoparticles (Fig.1, *a*) and



a *b*



c

Fig. 1. *Models of adsorbed water on the nanosilica surface (a), in silica gel pores (b), and theoretical calculations of the evaporation rate of water microdrops in the gaseous phase and for adsorption on the silicas (c)*

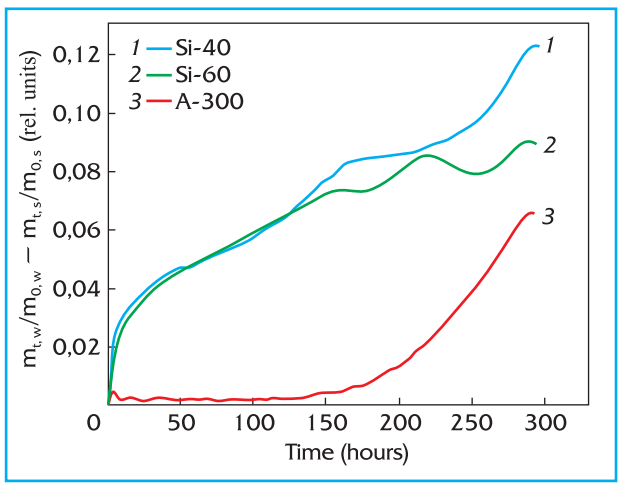
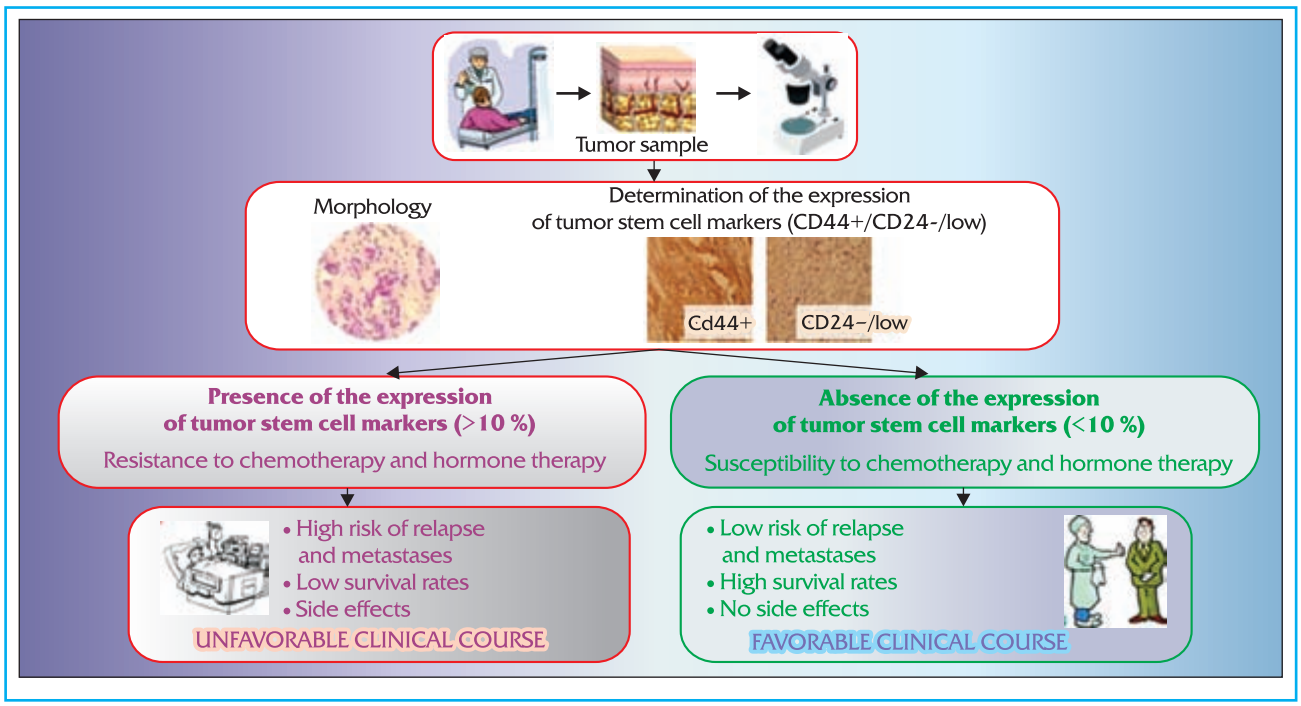


Fig. 2. *Experimental kinetic data concerning changes in the evaporation of bound water as compared to free one*

from the pores of silica gel particles (Fig.1, *b*) showed significant differences of the process (Fig.1, *c*), which was much faster in the case of non-porous nanoparticles (Fig. 2, curve *3* — the difference from the gaseous phase only appeared for strongly bound water after 150 hours of evaporation at 293 K) than in porous ones (curves *1* and *2* — a significant difference is seen even at the beginning). The proposed theoretical approach enabled scientists to predict the behavior of different liquids, taking into account the effects of limited space, adsorbent morphology, surface type, liquid composition, temperature, partial pressure, etc. That is of high relevance for both fundamental science and numerous practically important activities: calculations of optimum regimes for internal combustion engines, studying processes in medicine, chromatography etc.

Studies of the expression of tumor stem cell markers for specifying the characteristics and predictive prognosis of prostate cancer

NAS R.E. Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology investigated the expression of tumor stem cell markers (CD44+/CD24–/low) for specifying the characteristics and predictive prognosis of prostate cancer clinical course. The largest number of positive tumors was detected in prostate



cancer patients at stage III (79 %) as compared to patients at stage II (65 %). It was shown that elevated (>15 ng/ml) prostate-specific antigen (*PSA*) values in the serum of prostate cancer patients were associated with a higher level of the expression of tumor stem cell markers. The dependence of these markers expression on the relapse-free survival rates of prostate cancer patients was determined. It was found that in patients with CD44+/CD24–/low phenotype the relapse frequency was 3.5 times higher than in patients without the expression of those markers.

The data obtained provide evidence that the presence of tumor stem cells in the neoplastic tissue correlates with the aggressiveness of prostate cancer clinical course and could be used as an independent risk factor of recurrence. That could become a basis for developing new diagnosticums and improving current strategies for anti-tumor therapy.

RESEARCH ACHIEVEMENTS. SOCIAL SCIENCES AND HUMANITIES

On 16 March 2016, the National Report ***"Policy of Integrating the Ukrainian Society in the Context of Challenges and Threats of the Events in Donbas"*** was presented at a meeting of NAS Presidium, which was attended by representatives of the Administration of the President of Ukraine and the Council for National Security and Defense of Ukraine. The report was prepared by a team of NAS specialists led by Academician E.M. Libanova, Director of NAS M.V. Ptukha Institute for Demography and Social Studies.

The events in Donbas create major threats to the socio-economic development of Ukraine but, at the same time, open up opportunities of building a whole new state with modern economy and well-formed civil society. The central idea of the report is that the integration of the Ukrainian society must dominate the state policy, and the idea of sobornist (the unification of all ethnic Ukrainian lands in a single independent state) is

Academician E.M. Libanova speaking at a meeting of NAS Presidium on 16 March 2016

Presentation of the book at the session of the Academic Council of the Institute of the History of Ukraine on 30 June 2016. Academician V.A. Smolii is speaking

and will remain dominant both among people and Ukrainian political circles. The report briefly considers the historical background to the formation of the socio-cultural phenomenon of the Donbas tragedy, analyzes country's socio-economic losses due to the recent events in Donbas, identifies threats, risks and potential of Ukraine's development in the economic and socio-political spheres, outlines priorities as well as socio-economic, institutional and socio-humanitarian dimensions of the policy of Ukrainian society integration. The report emphasizes that the integration of the Ukrainian society is to bridge the split caused by different attitudes to the events in Donbas, clearly specifies the steps towards choosing the European direction of development and popularizing them properly. To persuade the people in the importance of their personal choices and the inevitable liability for it as opposed to state paternalism is also necessary.

To the 25th anniversary of Ukraine's independence, scholars of the NAS Institute of the History of Ukraine, which marked its 80 years in 2016, prepared the fundamental work ***"25 Years of Indepen-dence: Essays on the History of Nation and State Formation"*** (with Academician V.A. Smolii as its editor-in-chief) that presents a new view of the Ukrainian history after 1991.

The book is a significant contribution to comprehending the recent historical experience of Ukrainian state formation. It considers the recent period from the viewpoint of the Ukrainian society activity, whose peaks fell on three revolutions: the Revolution on Granite (October 1990), the Orange Revolution of 2004 and the Revolution of Dignity of 2013—2014 (in total, over one third of the 800-page work is dedicated to these three crucial events of our modern history). Each of these revolutions gave a powerful impulse to the development of the state. The readers can follow complex processes that led to the disintegration of the USSR; they have the opportunity to realize the hardships of the first years of the new Ukraine and the cause of sinking into the overall systemic crisis of the 1990s and 2000s; get an insight into the forming of the oligarchic system and its negative impact on the socio-political processes, which still is an obstacle in the way of reforms needed by the country. Shown is the ripening of the political crisis after 2010 that led to a revolutionary change of power in 2014. Finally, for the first time in academic historiography, the authors showed the post-revolutionary political and socio-economic dynamics as well as Ukraine's struggle against the Russian aggression (these are shown in the concluding chapter of the book). In general, the facts, interpretations, concepts presented in the book allow an interested reader to re-assess the experience of the last two and a half decades of the Ukrainian history.

Besides, the NAS Institute of the History of Ukraine, in collaboration with central state archives, prepared an extremely interesting collection of documents and materials ***"Crimea under Socio-Political Transformations (1940—2015)"***.

The book contains documents and materials of Soviet state security bodies that show the deportation policy of the Stalinist leadership in the 1940s and

demonstrate the struggle of the Crimean Tatars in the 1950—1980s to return to their historical homeland.

The book is unique (its total volume being in excess of 1000 pages) as it, relying on a new corpus of archive sources, presents unknown pages of Crimea's post-war history, covers economic and cultural aspects of the Crimea accession to Ukraine, discloses the problems of repatriation, adaptation and integration of Crimean Tatars to the Ukrainian socio-cultural and political area.

In 2016, a significant event occurred in the culture and arts sphere of Ukraine: specialists of the NAS M.T. Rylsky Institute of Art, Folklore Studies and Ethnology, guided by Academician H.A. Skrypnyk, completed the publication of the 5-volume ***"History of Decorative Art of Ukraine"***, which had started back in 2007.

This fundamental scholarly work is based on a radically new concept of systemic description of the Ukrainian decorative art from the earliest times to the present; it embraces a number of varied artistic types and trends in folk art, handicraft, artistic industry as well as works of professional artists in their close interrelations. All types and genres of decorative art are considered from the viewpoint of the evolution of art styles in various periods of Ukrainian history.

Each of the five volumes of this exquisitely decorated and highly professional edition emphasizes the peculiarities of artistic life in Ukrainian regions and the formation of local artistic traditions, analyzes active interrelations and mutual influences of the Ukrainian art with the West European and Oriental artistic traditions, and demonstrates the organic place of the Ukrainian culture in the world art context.

Late in 2016, the 1-st volume of the ***"Franko Encyclopedia"*** was published to commemorate the 160th birth anniversary of I.Ya. Franko — an outstanding Ukrainian poet, writer, scholar, and public figure. That is a fundamental 7-volume publishing project implemented by NAS T.H. Shevchenko Institute of Literature (Kyiv) and NAS Ivan Franko Institute (Lviv) under the guidance of NAS Academician M.H. Zhulynskyi and NAS Corresponding Member Ye.K. Nakhlik. This edition is the second, after the "Shevchenko Encyclopedia", personal encyclopedia in Ukraine. It should be mentioned that fundamental scholarly literature works of this genre are not very numerous in the world. The first volume of the encyclopedia is concerned with I. Franko's literary and scholarly milieu. It contains 255 personalia entries about writers, scholars in literature, folklore and linguistics. Comprehensive summarizing and novel essays elucidate his ties with those figures, his reviews of and opinions about his predecessors and contemporaries, as well as reminiscences and judgements about I. Franko of those who knew him in his lifetime.

A domestic technology of producing infrared detectors

The 'Arsenal' state enterprise of special instrumentation successfully tested a pilot production lot of infrared (IR) detectors. These devices rely on the technology developed by NAS V.Ye. Lashkaryov Institute of Semiconductor Physics and meet product performance specifications required by the customer.

The deployment of the technology permits the closed production cycle of IR-homing warheads for various types of missiles to be implemented in Ukraine. This both strengthens the nation's defense capability and extends its export potential as a manufacturer of high-tech products.

The devices developed (they are shown with pointers in the picture) are sensitive to the thermal radiation of objects in the 3-5 μm wave range and due to that they allow one to observe objects heated to temperatures of 300 K and above.

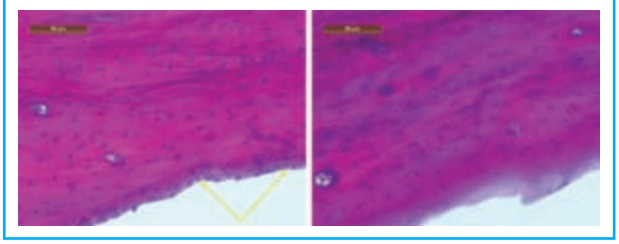
The main applications of such IR homing systems are in military equipment, in particular, weapon sights, missile warheads, systems of thermal direction finding, target detection and tracking.

Besides, similar systems are used in security alarm systems, equipment for technological process control, non-destructive tests of products, flight navigation in transport, resource monitoring (early detection of forest fires), in equipment for disease diagnostics (particularly, inflammation processes), in environment control systems, as well as scientific research instruments, especially in astronomy.

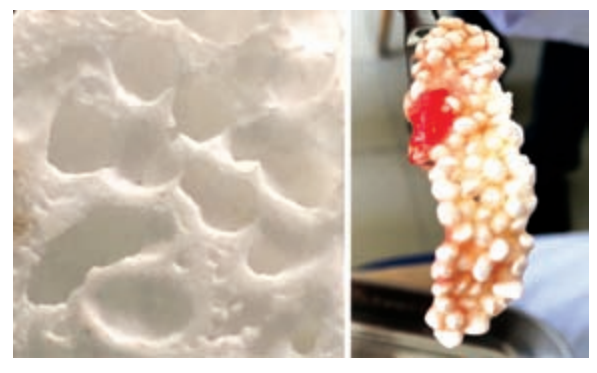
Novel biocompatible implant materials

A fundamentally new titanium-based (Ti-Si-Nb) biocompatible alloy, developed by NAS I.M. Frantsevich Institute for Problems of Materials Science and intended for implant manufacturing, demonstrates a greatly improved compatibility with bone material due to its lower elastic modulus. The alloy is strengthened with elements that are harmless and even, to some extent, useful for human body.

According to the results of comparative tests carried out by the Institute of Traumatology and Orthopedics of the NAMS of Ukraine, the new material in terms of



A histological section of rabbit bone with implanted titanium alloy of Ti-Si-Nb (left) and BT6 (right) system after 6 months. Osteoblasts – young bone tissue cells – are visible on the bone-implant interface (left)



Bioactive ceramic framework (left) and bioactive ceramics with autologous components (right)

Implants with bioactive ceramic coatings

its biomechanical compatibility is 5—20 % better than metal materials (stainless steels, titanium BT6 alloys) that are now widely used in medicine. The State Enterprise 'Academician L.I. Medved Research Center of Preventive Toxicology, Food and Chemical Safety', of Health Ministry of Ukraine gave a positive conclusion on the successful use of the implants made of the abovementioned alloy.

Besides, new technologies were developed to manufacture bioactive ceramic frameworks for cultivating patient's autocells, which enables medical specialists to use such materials instead of donor bones in regenerative medicine for the regeneration of large volumes of lost bone tissue.

The deposition of aseptic bioactive ceramic coatings on the surfaces of titanium implants, using the procedure developed, improves the reliability of bone implants, meets relevant strength requirements and, at the same time, ensures their quick integration with bone tissue in case of wound infection.

Wear- and corrosion-resistant nanostructured materials and energy-efficient methods of their deposition on the surfaces of parts and structures intended for machine-building industry

Specialists of the NAS G.V. Kurdyumov Institute for Metal Physics developed a series of high-strength corrosion-resistant technological alloys that have satisfactory casting properties, high wear resistance, heat resistance and thermal stability; they can relatively easily be produced as rapid-quenched tapes, rods and powders and are suitable for manufacturing a wide range of parts and structures at machine-building plants.

Some of the alloys obtained (HB-4 and NHRP-6) are promising for restoring work surfaces of agricultural tools and geological prospecting equipment. The restoration is carried out with newly developed methods of energy-efficient thermal sputtering and fusion that ensure long operation life of the parts.

To establish the series production of nanostructured powders of new multiple-additive weak magnetic alloys, Institute's researchers developed and coordinated relevant technological regulations that provide for the application of induction melting under protective atmosphere and inert-gas sputtering. To produce nanostructured coatings with high strength and tribological properties, the use of the standard process of "cold" sputtering with the application of torch was recommended as the most energy-efficient method of depositing nano-crystalline or amorphous powders.

A pilot batch of industrial parts was manufactured using new materials and technologies; they were tested at "FORT ENGINEERING" Ltd, "Kyivskyi Remontno-Mekhanichnyi Zavod" public company, "Atskon" private enterprise, "MELTA TERM" Ltd.

After obtaining pertinent patents, the abovementioned R&D products will be deployed at "MELTA TERM" plant under the licensing agreement with NAS G.V. Kurdyumov Institute for Metal Physics on using intellectual property rights. A relevant agreement was drawn up and approved by the two parties.

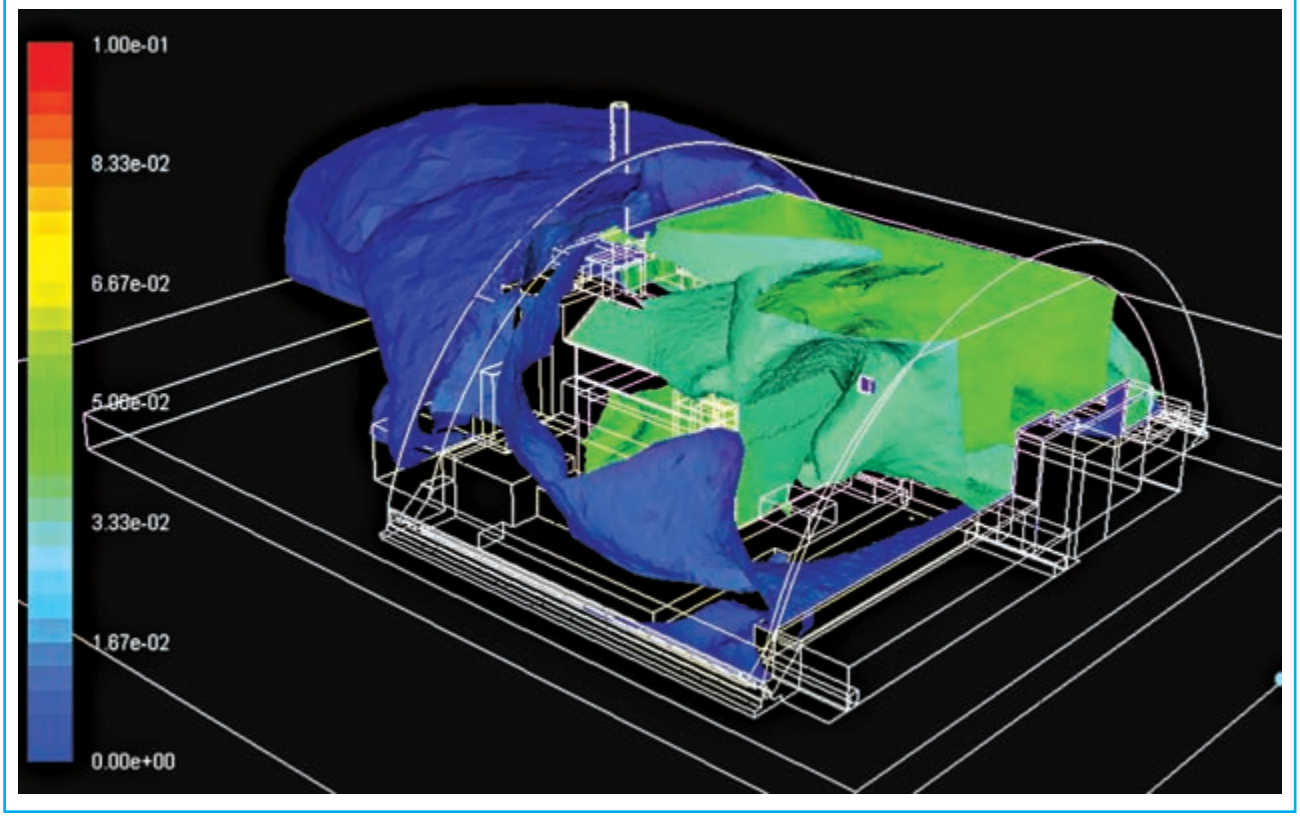
S&T support of turning the 'Ukryttia' ('Shelter') facility into an environment-friendly system

In November 2016, the primary operations of assembling and moving the main structure of the New Safe Confinement to the site specified by the design were completed. Such a large-scale project, which had been named *Shelter Implementation Plan* (*SIP*), was implemented in Ukraine for the first time ever.

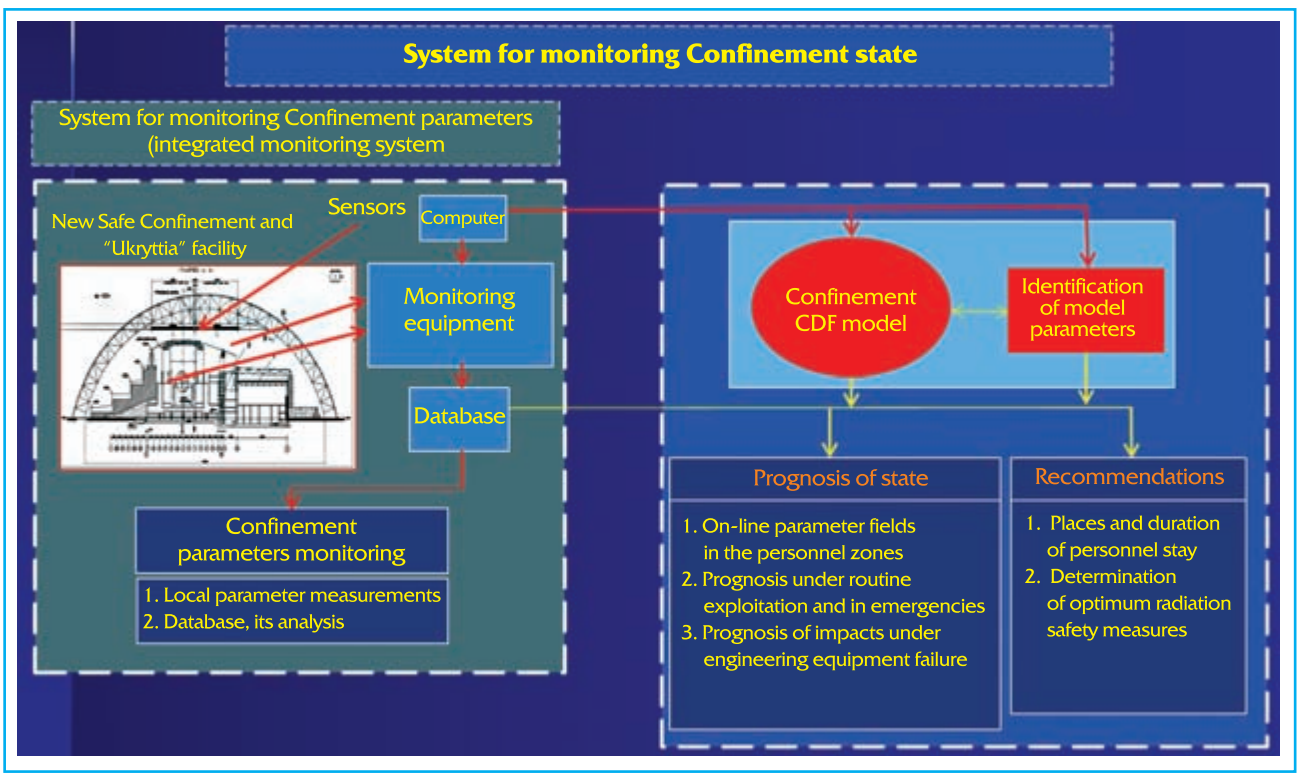
A significant contribution to the implementation of this project was made by specialists of the NAS Institute for Safety Problems of Nuclear Power Plants and NAS Institute of Engineering Thermophysics, who provided close R&D support for all stages of creating this unique facility, starting with drawing up the basic document 'Action Plan for the "Ukryttia" facility' in 1997.

Since the erection of the "Ukryttia" facility, NAS scientists carried out research and practical work for the

Samples of products with deposited coatings of Fe-based multiple-additive weak magnetic amorphous and nanocrystalline alloys



Isosurfaces and isolines of radioactive dust concentrations inside and outside the new safe confinement, Bq/m^3



System for monitoring Confinement state

radiation survey of the ruined NPP unit premises to locate the remaining nuclear fuel, develop diagnostic systems, design a ventilation system, analyze the distribution of fuel-containing materials, determine the amount of nuclear fuel and the composition of radioactive release, they also studied the impact of power unit debris on the environment and participated in developing the strategy of turning the "Ukryttia" facility into an environment-friendly system.

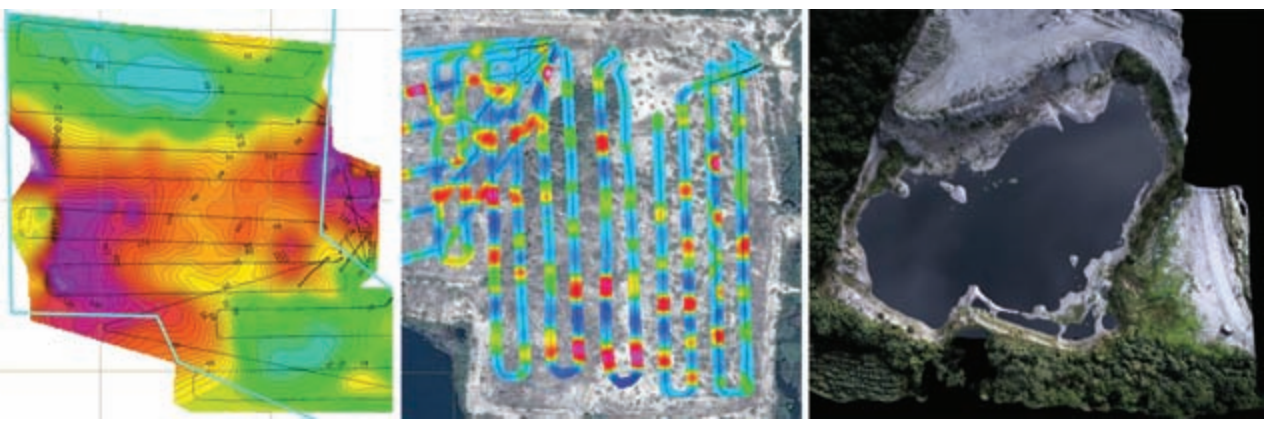
A drone-based system for remote radiation, IR and visual monitoring of nuclear fuel cycle

Specialists of the NAS Institute of Environmental Geochemistry developed a radically new integrated multi-purpose drone-based system designed for on-line remote radiation, IR and visual monitoring of nuclear fuel cycle objects (NFC).

The system developed implemented cutting-edge engineering solutions, the latest achievements of radiation physics and advanced information technologies.

The use of modern equipment in the background and crisis monitoring of NFC objects will permit a significant improvement in the nuclear and radiation safety of Ukraine. In particular, the system provides periodic control of radiation situation under routine exploitation of NFC facilities for the objective evidence of the environment safety for the population, as well as the on-line monitoring of the radiation situation development in emergencies, to evaluate the scale of radioactive material release and predict its impacts on the adjacent territories. Today the system is used by the State Corporation 'Ukrainian State Association "Radon"' to detect the sites of illegal radioactive waste burial in the Chornobyl NPP Exclusion Zone.

The complete set of the "GIV-smart" system for on-line monitoring of specific NFC objects



The map of radioactive contamination in the Chornobyl NPP zone – object 1, taken from a drone; The map of radioactive contamination in the Chornobyl NPP zone - object 2, taken from a drone; 2d – video panorama, taken from a drone

Organizing the industrial production of substances and therapeutic forms of original medicines

On 17 May 2016, a ceremonial opening of the new research and production facility of the "INTERKHIM" company, organized by the Ukrainian pharmaceutic enterprise "INTERKHIM" jointly with NAS O.V. Bogatsky Physico-Chemical Institute, was held. V.B. Groysman, the Prime Minister of Ukraine, attended the event.

The implementation of such an advanced innovative industrial project was a logical development of the fruitful collaboration of scientists and manufacturers, a joint practical implementation of research results. That was made possible due to a close co-operation of the "INTERKHIM" company with NAS Physico-Chemical Institute aiming at the development of innovative medicines and continuous search for new technologies of their production and industrial deployment.

The project allows a four-fold increase in the amount of medicines produced, which will provide Ukrainian people with high-quality affordable medicines and help open foreign markets for domestic pharmaceutic products.

A significant step in promoting such co-operation was the establishment of the "Medpharmkhim" — the association of participants in the scientific and innovative activities in medical and pharmaceutical chemistry, whose work is focused on advancing scientific research in chemistry and pharmacology — with the purpose of providing consumers with state-of-the-art high-quality pharmaceutical products.

It is important to emphasize that NAS O.V. Bogatsky Physico-Chemical Institute, in collaboration with the "INTERKHIM" company, for the first time implemented the "full cycle" of finished medicine production in the pill form, in compliance with the requirements of the 'good manufacturing practice' adopted in the European Union. The "INTERKHIM" company produces substances and pharmaceutical forms of original medicines (*phenazepam, amixin, gidazepam, levan* etc.), which were formulated by the Academy institution.

Joint efforts of NAS scientists and pharmacologists in developing efficient technologies made an important contribution to the production of medical agents.

Of special importance is the fact that a state-of-the-art innovative industrial facility was founded despite the current tight economic situation. The beginning of its operation will permit an objective assessment of pharmacological research and use their results in practice; it will also facilitate the integration of Ukrainian pharmaceutical industry to the European area. It should also be noted that the "INTERKHIM" company is the only domestic enterprise producing substances for original medicines that could compete with their foreign analogs and be exported.

High-yield varieties of winter wheat

Relying on the latest achievements of introgression breeding, molecular genetics and biotechnologies,

'Smuhlianka', 'Zolotokosa' and 'Favorytka' varieties produced an all-time high yield of 124 – 131.8 centners per hectare

Academy scientists developed theoretical fundamentals and methodologies for creating high-yield varieties of winter wheat that demonstrate high grain quality and resistance to stress factors.

For the first time in Ukraine, they developed a breeding biotechnology that is based on combining the potentials of classical genetics and involves an active use of new mutant genes, molecular markers, chromosome translocations and man-made structures; that ensures a radical wheat improvement in terms of quantitative and qualitative protein characteristics, starch physical properties, the content of trace elements and the nutritional value of the grain.

Through targeted crossing created was the genetic basis for breeding high-yield wheat varieties that possess extra strong characteristics of bread-making quality. Promising wheat breeding material with maximum grain yield and high and extra high characteristics of flour bread-making quality was obtained.

The innovative winter wheat varieties produced by NAS scientists were recognized as a new breeding achievement of the national scope. They are protected by patents in Ukraine and abroad, particularly, in Russia and Moldova.

In 2016, 6 new varieties of winter wheat were created; author's certificates have already been received for 3 of them. Nearly 75 soft (winter) wheat varieties bred by the NAS Institute of Plant Physiology and Genetics have been entered in the state register of plant varieties that are suitable for distribution in Ukraine.

The area taken by these wheat varieties has reached 2.0 million hectares, which amounts to 30 % of the areas under this crop. The annual economic gain due to introducing Institute's research outcomes (plant varieties and technologies) to agrarian production is in excess of UAH 6.5 billion.

New diet supplements with multifunctional biological effect

New glycine-based diet supplements — "Corectin" and "Glycivit C" — were proposed, their prototype being the multifunctional "Corectin" medicine that had been developed at NAS Palladin Institute of Biochemistry and patented in Ukraine.

Data of earlier preclinical tests and two stages of clinical tests have shown that the "Corectin" medicine is an effective and safe agent that can be used both alone and in combination with other drugs to treat disorders of the skeletal system and liver lesions, as well as a supplementary pharmaceutical preparation for integrated chemotherapy of onco-hematological diseases.

Diet supplement "Corectin" and its "Glycivit C" modification with vitamin C added could be recommended as an additional glycine source for normalizing the functional state of the nervous and immune systems, bone tissue strengthening, blood detoxification, improving the general condition of human body, as well as for facilitating its adaptation to negative environmental factors, reducing psycho-emotional tension and fatigue, and accelerating alcohol detoxification.

NAS scientists, in collaboration with "Nutrimed" Ltd formulated these diet supplements, developed a technology for producing their encapsulated form and produced their pilot batches. They also worked out specifications and technological standards for producing diet supplements of the "Corectin" and "Glycivit C" series, as well as respective labelling texts.

The diet supplements of the "Corectin" and "Glycivit C" series were approved by the State R&D Center for Nutrition Hygiene of the Health Ministry of Ukraine and won a favorable conclusion of the O.M. Marzeyev Institute of Public Health for the State Sanitary-Epidemiological Expertise.

The new draft technological standards for diet supplements production were checked and approved by the Ministry of Economic Develop-ment and Trade of Ukraine in accordance with applicable regulations and included in the state register of technological standards.

The joint work of NAS scientists and pharmaceutists resulted in the production of the commercial prototypes of encapsulated forms of the "Corectin" and "Glycivit C" diet supplements in compliance with the technological standards approved and the current legislation, with the respective labeling and user's instructions added.

Silicon-containing minerals for optimizing and balancing soils

Scientists of the NAS of Ukraine take leading positions in the world in studying the role of mono- and polysilicic acids in the structural and functional biocenosis organization. For the first time ever, specialists of M.M. Gryshko National Botanical Garden proved that the combined application of secondary organic raw materials (of both animal and plant origin) and silicon-containing minerals optimizes and balances soil processes through artificial simulation of the proportion between mono- and polysilicic acids, saves soil

Testing of silicon-containing mixture on sugar beet fields. Left – control plot, right – silicon-containing mixture 400 kg/ha

moisture due to the formation of the silicon matrix with information-resource properties, and stimulates the growth and development of plants as a result of their adaptation to stress factors.

The application of silicon-containing minerals ensures improved phosphate regime in soils due to phosphorus release from its relatively inaccessible forms; the mixture serves as nitrification inhibitor, it reduces soil toxicity and fatigue, stimulates the development of agronomically beneficial microorganisms, protects plants from pathogens. Field tests of silicon-containing mixtures on various crops in Kyiv, Kherson, Odesa and Ivano-Frankivsk oblasts showed an average yield increase of 29.3—51.2 %. Pilot technological lines for such mixtures were set up in Ukraine and their production was started by the "Sinta" company (Mykolayiv oblast). The product is competitive, inexpensive, environment-friendly and promising for launching similar lines abroad.

Adoption of a new version of the NAS Statutes

In April 2016 a session of the NAS General Meeting was held. It approved a new version of the Statutes of the National Academy of Sciences of Ukraine. The Statutes became effective on 27 July 2016 — the date of its registration by the Ministry of Justice of Ukraine.

The adoption of a new version of the Statutes was necessitated by noticeable changes in the eventful life of the country and the life of the Academy which occurred in the 14 years since the approval of their previous version.

In particular, quite a number of new legislative and regulative documents that directly or indirectly concerned the Academy appeared in that period. First of all, that was the new version of the basic law of Ukraine 'On Scientific and S&T Activities' adopted late in 2015. Changes in the functions and lines of activities of the Academy itself also took place. Certain issues of improving the management system of the Academy and its institutions, ensuring regular rotation and rejuvenation of science-management personnel also became timely.

The preparation of the new Statutes started back in 2013 and since then the Commission chaired by Academician B.E. Paton, the President of the National Academy of Sciences of Ukraine, carried out an immense amount of painstaking, important and effective work.

This is proved by the fact that the new version of the Statutes was approved by the absolute majority of 125 NAS academicians and 237 NAS corresponding members attending the session, as well as 204 research associates delegated by Academy institutions.

The Statutes specified the legal status of the Academy, significantly enlarged its tasks, and introduced a number of provisions aimed at the democratization of its life. They, in compliance with the Law of Ukraine 'On Scientific and S&T Activities', strengthened Academy's role in **conducting independent scientific assessments of draft strategic, prognostic and program documents**, preparing proposals concerning the principles of the state S&T policy, providing the **scientific expertise of draft laws**, government decisions and programs.

The Interagency Council is to be set up jointly by the Academy and the Ministry of Education and Science; its task would be not mere coordination of fundamental research, as it was before, but fostering the efficient use of its results in applied studies and developments as well.

The new version of the Statutes clearly defines norms concerning the self-governance of the Academy and its freedom of research. Its self-governance consists in its governing bodies being electable and collegiate, the General Meeting performing the functions of its top authority. Besides, the NAS of Ukraine independently determines the topics and forms of the scientific research conducted, it forms its own structure, addresses research-management, economic and human resource issues.

The Statutes provide for the right of the NAS of Ukraine and its institutions to found higher education establishments for training masters and PhDs. This norm is already being implemented. On the initiative of the NAS of Ukraine and the MES of Ukraine, the Cabinet of Ministers with its order of 14 December 2016 № 962 adopted the decision to set up Kyiv Academic University of dual subordination to the NAS of Ukraine and the MES of Ukraine. Now relevant steps towards establishing this education institution are already being taken.

The procedure of forming NAS leadership has also been changed, namely, the election of Academy Presidium, as well as the appointment of academician secretaries and directors of research institutions. Now, not only NAS active members (academicians) can be Presidium members, as it was earlier, but also NAS corresponding members and doctors of science who are permanently employed by Academy research institutions. For the members of NAS Presidium their term of office is limited to two 5-year periods. In future, candidates and doctors of science delegated by research teams of the relevant department's institutions will take part in voting to elect academician-secretaries of the departments.

The new NAS Statutes more clearly define the duties of NAS active members (academicians), which include, first and foremost: contributing to the deployment of their research results and other scientific achievements, training and upgrading of scientific personnel, as well as counteracting the dissemination of pseudoscience, fighting fraud and plagiarism.

It is important that, in compliance with the Law of Ukraine 'On Scientific and S&T activities', it is the sole right of the General Meeting to deprive NAS members of their membership in the Academy, and the new Statutes specify reasons and propose a transparent procedure for it. It is stated that NAS academicians, corresponding members and foreign members can be deprived of their status either due to a resignation declared by their own statement or in the event of repeated gross violation of NAS Statutes' requirements or actions which caused significant damage to the reputation of the National Academy of Sciences of Ukraine.

The new version of the Academy Statutes also establishes a new procedure for electing heads of NAS research institutions and limits their term in office. From now on they are elected at worker's meetings by secret ballot and cannot stay in their posts for more than two terms.

As of today, 47 heads of Academy research institutions were appointed through this new procedure according to the results of contests announced by NAS Presidium.

In 2016, new regulations for NAS sections and departments and the main principles of the organization and activities of NAS research institution were harmonized with the Statutes and approved by NAS Presidium. Similar work on the statutes of NAS research institutions was started and is now being completed.

The jubilee session of the General Meetings of the NAS of Ukraine and national sectoral academies to celebrate the 25th anniversary of Ukraine's independence

This jubilee session, held on 23 August in Kyiv in the Grand Conference Hall of the NAS of Ukraine, presented the achievements of Ukrainian academy science and the significant contribution of scholars to the establishment and progress of the independent Ukrainian state.

In their speeches, NAS Academician V.P. Gorbulin, First Vice-President of NAS, NAAS Academician Ya.M. Gadzalo, the President of the National Academy of Agrarian Sciences (NAAS), NAMS Academician V.I. Tsymbaliuk, the President of the National Academy of Medical Sciences (NAMS), NAPS Academician V.H. Kremen, the President of the National Academy of Pedagogical Sciences (NAPS), NALS Academician O.V. Petryshyn, the President of the National Academy of Legal Sciences (NALS), and NAA Academician V.D. Sydorenko, Vice-President of the National Academy of Arts, told the session about the achievements of Ukrainian academy science.

An excerpt from the speech of NAS Academician V.P. Gorbulin:

"... Ukrainian science sphere, as the whole country, is now in an extremely grave situation. But in spite of all problems, we have not yet lost chances of the innovative development and future prosperity of out independent state. And the National Academy of Sciences will remain a reliable support to the Ukrainian people in achieving this goal. There is one self-evident truth proven by history: full sovereignty of the state, its international prestige and effective national security are not possible without science. So, the duty of all academic community is not only to preserve invaluable science assets created by prominent intellectuals of the past epochs and of today but to multiply them and leave that legacy to the future generations".

On behalf of three ex-presidents of the independent Ukraine who attended the meeting (L.M. Kravchuk (1991—1994), L.D. Kuchma (1994—2005) and V.A. Yushchenko (2005—2010)), L.M. Kravchuk — the President of Ukraine in 1991—1994 — addressed the participants of the session, as did Vice-Premier V.A. Kyrylenko — on behalf of the Ukrainian Government and O.V. Spivakovskyi, First Deputy Chair of the Verkhovna Rada Committee for Science and Education, — on behalf of the Parliament.

NAS Academician, Hero of Ukraine I.R. Yukhnovskyi, Honorary Director of NAS Institute for Condensed Matter Physics, NAS Academician Ya.S. Yatskiv, member of NAS Presidium, Director of NAS Main Astronomical Observatory, and NAS Academician M.G. Zhulynskyi, member of NAS Presidium, Academician-Secretary of the NAS Department of Language, Literature and Art Studies, Director of NAS T.H. Shevchenko Institute of Literature, spoke about socio-political life at the turn of 1980s—1990s and their involvement in those processes of state formation.

In the presidium of the General Meeting's Jubilee Session

NAS Academician, Hero of Ukraine I.R. Yukhnovskyi

INTERNATIONAL COLLABORATION

The integration of NAS scientists into the European research area, their involvement in multilateral projects of EU international science programs, as well as NAS ties with EU scientific centers were further promoted.

In particular, as of late 2016, Academy scientists implemented over 20 projects of **Horizon 2020 — the EU Framework Program for Research and Innovation**. Among them was the "AERO-UA" project, aimed at stimulating scientific collaboration between Ukraine and the EU in aviation industry through strategic and targeted support of the institutes concerned. This project is Ukraine-oriented, as it has giant aerospace potential but a rather low level of S&T collaboration with the EU in that area.

Concluding the Agreement on Scientific and S&T Collaboration with the **European Atomic Energy Community** and Ukraine's associate participation in the **EURATOM** research and training programme, which is complementary to Horizon 2020, was instrumental in promoting our scientists' collaboration with their European colleagues in nuclear research and controlled thermonuclear fusion.

The signing of the Framework Agreement between Directorate-General JRC of the European Commission and the NAS of Ukraine on supporting research was an important step towards integration into the European research area. That agreement gave NAS scientists the opportunity to use JRC's powerful S&T infrastructure, including 6 scientific centers and 42 research laboratories, to conduct their own or joint research. The agreement signed also became the basis for co-operation between JRC and the NAS of Ukraine, in particular, within the EU Strategy for the Danube Region, specialization, nuclear safety and food security. Two of the projects proposed by the NAS of Ukraine were chosen for implementation.

At the National Academy of Sciences during the JRC information day in Ukraine

Close collaboration with international science centers, including **CERN**, continued. Among the major results of studying ultra-relativistic heavy ion collisions, which were obtained with the contribution of Academy scientists, one should mention theoretical predictions of the transport properties of quark-gluon fluid assumed to be formed in such collisions. Those will permit an answer to the key question about the structure and properties of the tiniest drops of matter. An important outcome of NAS collaboration with CERN is also its participation in developing elements of novel sensor systems for the **Large Hadron Collider**.

The 4-year **joint project of the NAS of Ukraine and IIASA** was completed successfully. During its implementation, specialists of 6 Academy institutions developed a methodological basis for strategic planning and optimum decision-making in sustainable management of food, water and energy security of Ukraine in the global context. Change, impact and hazard scenarios were developed in collaboration with the IIASA partners, and optimum strategies for economic development under predicted global climate and environment change at the regional level were proposed.

The **4th World Congress of Biosphere Reserves 'A New Vision for the Decade 2016—2025: UNESCO Biosphere Reserves for Sustainable Development'**, held in Lima (the Republic of Peru), was an important activity in Academy's international collaboration. The Congress approved the Lima Declaration and Plan of Action, which contained guidelines of UNESCO biosphere reserves functioning for 2016—2025, including working papers and proposals prepared by the NAS of Ukraine.

The fulfilment of the tasks of the **NATO Program 'Science for Peace and Security'** was continued. Today, Academy scientists are implementing 25 many-year projects. Their results include the development of superselective sorbents for neutralizing chemical, biological, radiological and nuclear materials; development of advanced electro-chemical nanosensors for detecting toxic ions etc. Of great importance for further promotion of collaboration with the Alliance was the visit of Ambassador S. Dukaru, NATO Deputy Secretary General for New Security Challenges, and his negotiations with Academy leadership.

On 28 September 2016, a regular session of the **Council of the International Association of Academies of Sciences (IAAS)** was held in Minsk (the Republic of Belarus) with Academy's active participation. NAS Academician A.G. Naumovets, First Vice-President of the NAS of Ukraine, read Academician B.E. Paton's summary report 'Main results of IAAS activities in

S. Dukaru, NATO Deputy Secretary General, (second right) is watching the remediation of the military base territory contaminated with hydrocarbons

NAS delegation at the meeting with the People's Government of Tszilin province, PRC

2011—2016'. The session started the procedure of electing a new IAAS President.

6 international agreements and memorandums were signed during the year.

Particularly, a new form of collaboration between the NAS of Ukraine and the Polish Academy of Sciences was started — 1-month traineeships of young Ukrainian researchers in PAS scientific institutions. 17 young scientists pursued such traineeships in 2016.

The collaboration agreement between the People's Government of Tszilin province, Tszilin University and the National Academy of Sciences of Ukraine provides for the establishment of an international scientific center to advance fundamental and applied research and novel technologies at this university. The center is to be financed by the Chinese side. The institution will be provided with the state-of-the-art scientific equipment for research in materials science, solid state physics, radio electronics, low-temperature physics, electromagnetism etc. The center will be managed by the scientific council set up on the parity principles.

TIES OF RESEARCH AND EDUCATION. YOUNG SCIENTISTS

The new Law of Ukraine 'On Scientific and S&T Activities' (part 6 of article 7 and part 5 of article 17) grants **the NAS of Ukraine and its research institutions the right to found higher education institutions for training** specialists of different qualification levels, including those of master and doctor of philosophy.

A joint session of the Board of the MES of Ukraine and Presidium of the NAS of Ukraine made an important decision on founding **Kyiv Academy University** (KAU) as a public scientific institution of dual subordination — to NAS and MES.

By the Cabinet of Ministers order of 14 December 2016 № 962-p, the NAS Research and Training Center for Physics and Technology (RTCPT) was reorganized into Kyiv Academy University.

KAU is of utmost importance for ensuring the breakthrough development of Ukraine in the field of fundamental and applied research, as it is to be based on combining education, science and innovations. The education process at this university will be organized relying on the so-called "Phystech System", successfully implemented at California Institute of Technology, Massa-chusetts Institute of Technology and later — at Moscow Institute of Physics and Technology as well.

KAU will permit us to preserve and develop RTCPT's time-tested concepts of training highly qualified specialists for the NAS of Ukraine and high-tech industries of Ukraine and to involve, starting with the bachelor level, the potential of leading universities and research institutions for that purpose.

A joint session of NAS Presidium and Ministry of Education and Science Board on 25 March 2016

A team of researchers and academics, employed by NAS Ya.S. Pidstryhach Institute for Applied Problems of Mathematics and Mechanics, NAS M.M. Bogolyubov Institute for Theoretical Physics, NAS Main Astronomical Observatory, NAS Institute of Radio Astronomy, National Scientific Center "Kharkiv Institute of Physics and Technology", NAS Institute for Nuclear Research, Taras Shevchenko Kyiv National University, Ivan Franko Lviv National University, I.I. Mechnikov Odesa National University, co-authored the 3-volume edition "Dark Energy and Dark Matter in the Universe". The monograph was published in 2013—2015 in the 'Ukrainian books in foreign languages' series by the 'Akademperiodika' Publishing House. In 2016 this publication won the award of the International Academy of Astronautics in the category 'The best book in fundamental sciences'.

The collaborative work of Academy scientists and educators resulted in the publication of 70 textbooks and manuals for higher education institutions in 2016.

In 2016, **young scholars of NAS institutions won**: 14 prizes of the President of Ukraine for young scientists, 10 prizes of the Verkhovna Rada of Ukraine for the most talented young scientists in fundamental sciences and R&D, as well as one Verkhovna Rada scholarship for the most talented young scientists. Besides, young scholars of NAS institutions received 16 grants of the President of Ukraine for supporting young scientists' studies.

100 best research projects of young NAS scientists were financed. NAS Presidium meetings heard **research presentations of 8 young scientists**, who will have the opportunity to open additional 1-year projects addressing the subjects reported and to lead them. The funding of such projects was **increased from UAH 30,000 to UAH 50,000** for candidates of science and to **70,000** for doctors of science. 'Naukova Dumka' Publishers issued **11 scientific monographs prepared by young researchers** under the 'Scientific book (Young scientists)' project. 6 research works were chosen through regular reviewing to be published in 2017.

The work on **establishing the Council of Young NAS Scientists** was completed. Its regulations and membership were approved by a NAS Presidium resolution. Council members took part in analytical talk shows on national and regional TV channels (1+1, TVRC 'Kyiv'), where they discussed the current state and further advancement of science.

In 2016, 23 young professionals who had attended various study groups of the Junior Academy of Sciences (JAS) in their school years came to work to NAS research institutions. On 2 March 2016, a meeting of NAS Presidium discussed the issue of extending JAS co-operation with research institutions of the NAS of Ukraine, popularizing and spreading scientific

M.M. Shumylo, Doctor of Juridical Science, senior researcher of NAS V.M. Koretsky Institute of State and Law, is presenting his research project 'The current state and development prospects of the pension system in Ukraine'

knowledge among schoolchildren, involving gifted and talented children in scientific research.

As of 31 December 2016, **2338 young scholars** worked at research institutions of all 3 NAS sections, holding positions from junior research scientists to chief research scientists and having science management jobs. Among them were **41 doctors of science under 40**. 1209 young scholars had candidate-of-science degrees. 90 researchers under 40 were working towards their doctor-of-science degrees.

The number of young scholars at the Academy has been decreasing for three years running. The total number of young scientists taking the abovementioned positions fell by 12.8 % as compared to 2015. The number of young candidates of science shrank by 9.6 %. As compared to 2013, those numbers amounted to 21.6 % and 14.6 %, respectively. That could lead to a further decline of the science sphere, which endangers Ukraine's national security.

AWARDS

The UNESCO medal 'For the Development of Nanosciences and Nanotechnologies' was awarded to NAS Academician A.G. Naumovets for his work in surface physics, electron emission and nanoelectronics.

For the significant personal contribution to the state establishment, socio-economic, S&T, cultural and educational development of Ukraine, the Order of Freedom was awarded to NAS Academician I.R. Yukhnovsky, the Order of Prince Yaroslav the Wise II Class — to NAS Academician Yu.S. Shemshuchenko, the Order of Prince Yaroslav the Wise IV Class — to NAS Academicians S.V. Volkov, M.H. Zhulynskyi and K.A. Yushchenko, the Order of Prince Yaroslav the Wise V Class — to NAS Academician Ya.S. Yatskiv, the Order "For Services" II Class — to NAS Corresponding Member O.L. Kopylenko and N.M. Onishchenko, department head at NAS V.M. Koretsky Institute of State and Law, the Order of Princess Olga III Class — to L.P. Nahorna, chief research scientist of NAS I.F. Kuras Institute of Political and Ethno-National Studies, and the Order "For Services" — to V.A. Voinalovych, department head at NAS I.F. Kuras Institute of Political and Ethno-National Studies.

For their personal contribution to the advancement of Ukrainian science, strengthening Ukraine's S&T potential, the Order of Prince Yaroslav the Wise IV Class was awarded to NAS Academicians V.G. Koshechko and V.Yu. Storizhko, the Order of Prince Yaroslav the Wise V Class — to NAS Academician L.M. Lytvynenko, the Order "For Services" I Class — to NAS Academicians S.A. Andronati and V.M. Shestopalov, the Order "For Services" II Class — to NAS Academicians A.G. Zagorodny and B.S. Stognyi, the Order "For Services" III Class — to O.G. Dodonov, deputy director of the Institute for Information Registration Problems, Ye. V. Moiseyenko, leading research scientist of NAS Bogomoletz Institute of Physiology, M.O. Popov, deputy director of the State Institution 'Scientific Center for Aerospace Research of the Earth' of NAS Institute of Geological Sciences, and Medal "For Labor and Victory" — to V.M. Shadura, senior research scientist of NAS M.M. Bogolyubov Institute for Theoretical Physics.

The "Friendship Award" — the honorary distinction of the Government of the People's Republic of China for foreign specialists — went to NAS Academician V.M. Shulha and S.V. Maksymova, leading research scientist of NAS E.O. Paton Electric Welding Institute, — for their outstanding contribution to the process of China modernization.

State Prizes of Ukraine in Science and Technology were awarded to 8 NAS scientists for the series of studies 'Modern dynamics of materials and structural elements'; to 9 scientists for the work 'Functional properties of ordered bulk and surface structures, and the development of metal-containing materials and structures'; to 10 researchers for the work 'Cutting-edge technologies of synthesizing nanodispersed powders for structural, functional and biomedical materials and products'; 8 scientists for the series of studies 'The structure and dynamics of geophysical fields as the reflection of geosphere evolution and interaction in the Antarctic'; 2 researchers for the work 'Versatile energy-efficient electromechanical technological systems';

The medal presentation ceremony at the Headquarters of UNESCO on 11 October 2016. A.G. Naumovets, First Vice-President of the NAS of Ukraine, and I. Bokova, Director-General of UNESCO

Presentation of the award to NAS Academician G.V. Elska at the session of NAS General Meeting on 14 April 2016

7 researchers for the series of studies 'Scientific fundamentals for conservation and restoration of biota and landscape diversity in Ukraine under environment change'; 9 researchers for the series of studies 'Monoclonal and recombinant antibodies for experimental biology, human and veterinary medicine'.

5 NAS researchers won prizes of the Cabinet of Ministers of Ukraine for developing and deploying innovative technologies.

The title 'Honored Worker of Science and Technology' was conferred on 12 NAS researchers, the title 'Honored Worker of Culture' — on 4, 'Honored Jurist' — on 1, 'Honored Inventor' — on 1, and 'Honored Economist' — on 1scientist.

8 NAS workers were awarded with the VR Diploma of Merit and 3 NAS workers — with the KM Diploma.

20 NAS workers were awarded with the Medal '25 Years of Ukraine's Independence'.

45 Academy researchers won prizes commemorating prominent NAS scholars.

Last year, two prestigious science awards were established: 'Scopus Awards Ukraine' and 'Ukraine's Research Leader. Web of Science Award'. The first award was founded by 'Elsevier Science & Technology' — a well-known provider of scientific, technological and medical products and services. The Academy won four of the five nominations: "The best journal", "The best scientific team that achieved significant research results without western collaborations", "The best scientists (without age restrictions)" and "The best young scientists". The latter award was founded by ClarivateTM Analytics — the former department for scientific property and science of the 'Thomson Reuters' media company. NAS scientists were awarded in seven declared nominations, namely, "Scientist of Ukraine. For a major success", "Scientist of Ukraine. For extraordinary achievements", "Scientific journals of Ukraine", "Productivity, efficiency and integration to the world science", "Commercialization of science", "For grant funding of science" and "Science and innovations".

The 3-volume monograph "Dark Energy and Dark Matter in the Universe" won the award of the International Academy of Astronautics as the best book in basic sciences. Researchers of six NAS scientific institutions were among its authors.

POPULARIZATION OF SCIENCE

An important place in the activities of the National Academy of Sciences of Ukraine was taken by informing the society about the outcomes of scientific research and their practical application, promoting the positive image of science in public opinion, holding popularizing events for the general public.

The main conduits of information in 2016 were: NAS official Website on the Internet, the NAS Facebook page (over 6,000 subscribers as of the end of the year) and some leading mass media, TV channels and radio stations in particular.

The Academy held the 10th Jubilee All-Ukraine Science Festival on 19—21 May 2016 in partnership with the Embassy of the French Republic in Ukraine, the French Cultural Center, the Institute of France, etc.

During the opening of the Festival in Kyiv, a press-conference attended by NAS leadership and prominent scientists was held alongside with popular-science lectures by world-renowned scientists, in particular, the lecture of Christoph Shaeffer, advisor to the Director General of the European Organization for Nuclear Research (CERN). Besides, an exhibition presenting NAS scientific achievements was opened; it demonstrated new R&D products, both deployed and ready to be introduced to production. All in all, over 1,000 events were held under the umbrella of the 10th All-Ukraine Science Festival in Kyiv, as well as oblast and district centers of Ukraine; those included popular-science lectures, demonstrations of films and experiments, excursions to NAS institutions etc.

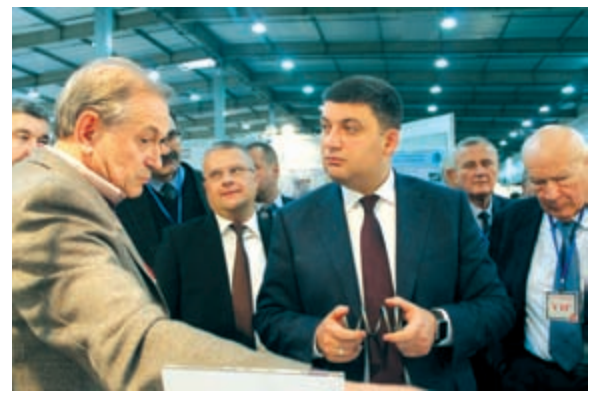
On 14—15 June 2016, research results of the NAS of Ukraine and national sectoral academies were demonstrated in the building of Ukrainian Parliament.

The press conference before the opening ceremony of the 10th All-Ukraine Science Festival

Nearly 150 R&D products responding to priorities of nation's economic development were displayed. The opening ceremony of the exhibition was attended by A.V. Parubiy, Speaker of the Verkhovna Rada of Ukraine, and O.V. Spivakovskyi, First Deputy Chairman of the VR Committee for Science and Education.

In the 'KyivExpoPlaza' Exhibition Center, in the framework of the 9th International Exhibition "LABComplEX. Analytics. Laboratory. Biotechnologies. HI-TECH" and the 7th International Exhibition of Equipment and Technologies for Pharmaceutic Industry "PHARMATechExpo", a special NAS exposition demonstrated about 350 R&D works in such areas as 'Information technologies', 'Energy engineering and energy efficiency', 'Machine building and instrument making', 'Medicine', 'Agribusiness and food security', 'Mineral and raw-material resources', 'Nuclear safety', 'Ecology and domestic waste processing'. Simultaneously, an exhibition presenting NAS R&D products

A.V. Parubiy, Speaker of the Verkhovna Rada of Ukraine, and O.V. Spivakovskyi, Deputy Chairman of the VR Committee for Science and Education, are visiting the exhibition of R&D products of the NAS of Ukraine and national sectoral academies in the Parliament



Prime Minister V.B. Groysman is examining the exhibition "Science – for Defense and Security of the Nation" at the 'KyivExpoPlaza' Exhibition Center

Scientific demonstrations during "Science Days – 2016"

"Science Picnics" in Taras Shevchenko Park in the capital of Ukraine

and technologies **"Science — for Defense and Security of the Nation"** was displayed. Prime Minister V.B. Groysman and O.V. Turchynov, Secretary of the Council of National Security and Defense, visited the Academy displays.

Young researchers of the NAS of Ukraine organized popularizing events in the framework of "Science days" — a scientific and educational project that enabled them to tell Ukrainians about scientists (in particular, those who work at research institutions of the NAS of Ukraine) and about the acknowledged results of their activities.

According to the tradition, "Science days" were organized twice in 2016: in May and in November. The spring events were held so as to coincide with Science Day — the official professional holiday of Ukrainian science workers and the autumn festivity was dedicated to the World Science Day under the auspices of UNESCO. Their activities included lectures, demonstrations of experiments, master classes and excursions.

Natalia Atamas, research associate of NAS I.I. Schmalhausen Institute of Zoology, member of NAS Council of Young Scientists, is a guest of "Science XXI" program of the "Rada" TV channel

Last year, the project involved seven Ukrainian cities: beside the capital, it was joined by Lviv, Odesa, Kharkiv, Zhytomyr, Ivano-Frankivsk and Kaniv.

Academy scientists took part in Polish-Ukrainian project **"Scientific Fun — Science Picnics in Kyiv"** — a series of interactive experiments for inhabitants of various Ukrainian cities. The project is coordinated by the Polish foundation 'Fundacja Wspólna Europa' and is supported by international and Ukrainian public organizations. The aim of "Science picnics" is to tell in a fascinating and understandable way about the mysteries of physics, chemistry, biology and other areas.

In 2016 the project was presented in many cities of Ukraine. Everyone interested could watch interactive scientific experiments and demonstrations, see photograph exhibitions, listen to popular-science lectures etc.

On the initiative of the Verkhovna Rada Committee for Science and Education, the parliamentary channel "Rada" started its popular-science series **"Science XXI"**. There a lot of leading Academy scholars discussed important issues of today's science, major achievements of research institutions, as well as problems that now exist in the S&T sphere of Ukraine.

In 2016, NAS scientists published a lot of papers and expressed their expert opinions as to important scholarly and socio-political issues in printed and Internet media, and took part in radio and TV programs. They were invited to live broadcasts of TV channels "UA: Pershyi", "1+1", "STB", "ICTV", "Inter", "5 Canal", "Ukraina TRC", "Novyny 24", "112 Ukraina", "Telekanal "Rada", "Kyiv" TRC", radio stations "Holos Kyeva", "Promin", "VESTI", Internet radio stations "Radio "Aristocraty", "Hromadske Radio" etc.

BACKGROUND INFORMATION. STATISTICS

Structure of the NAS of Ukraine

The structure of the NAS of Ukraine includes 3 sections and 14 departments, which incorporate 159 research institutions. Research-and-production organizations (R&D offices, pilot production facilities etc.) function within some research institutions. Science objects that have the status of National Asset (nuclear, physical and astronomical research facilities, test equipment complexes, archive scientific collections and museum displays, plant genetic funds, collections of microorganism strains and plant lines, landmarks of history and culture etc.), as well as centers for shared use of scientific equipment are parts of their structure.

Research organizations that have the National Institution status:

- V.I. Vernadsky National Library of Ukraine
- National Science Center 'Kharkiv Institute of Physics and Technology'
- 'Olbia' National Historical and Archeological Reserve
- M.M. Gryshko National Botanical Garden
- National Museum of Natural History
- V. Stefanyk Lviv National Scientific Library
- National Center 'Junior Academy of Sciences' of the MES of Ukraine and the NAS of Ukraine

Functioning within the Academy are 5 Regional Science Centers of dual subordination with the Ministry of Education and Science of Ukraine:

- Donetsk Science Center (Pokrovsk, Donetsk Region)
- Western Science Center (Lviv)
- Southern Science Center (Odesa)
- North-East Science Center (Kharkiv)
- Prydniprovskyi Science Center (Dnipro)
- Center for Problems of Scientific Support to Regional Development (Kyiv)

The statutory activities and funding of Crimean Science Center from the NAS budget were suspended in 2014.

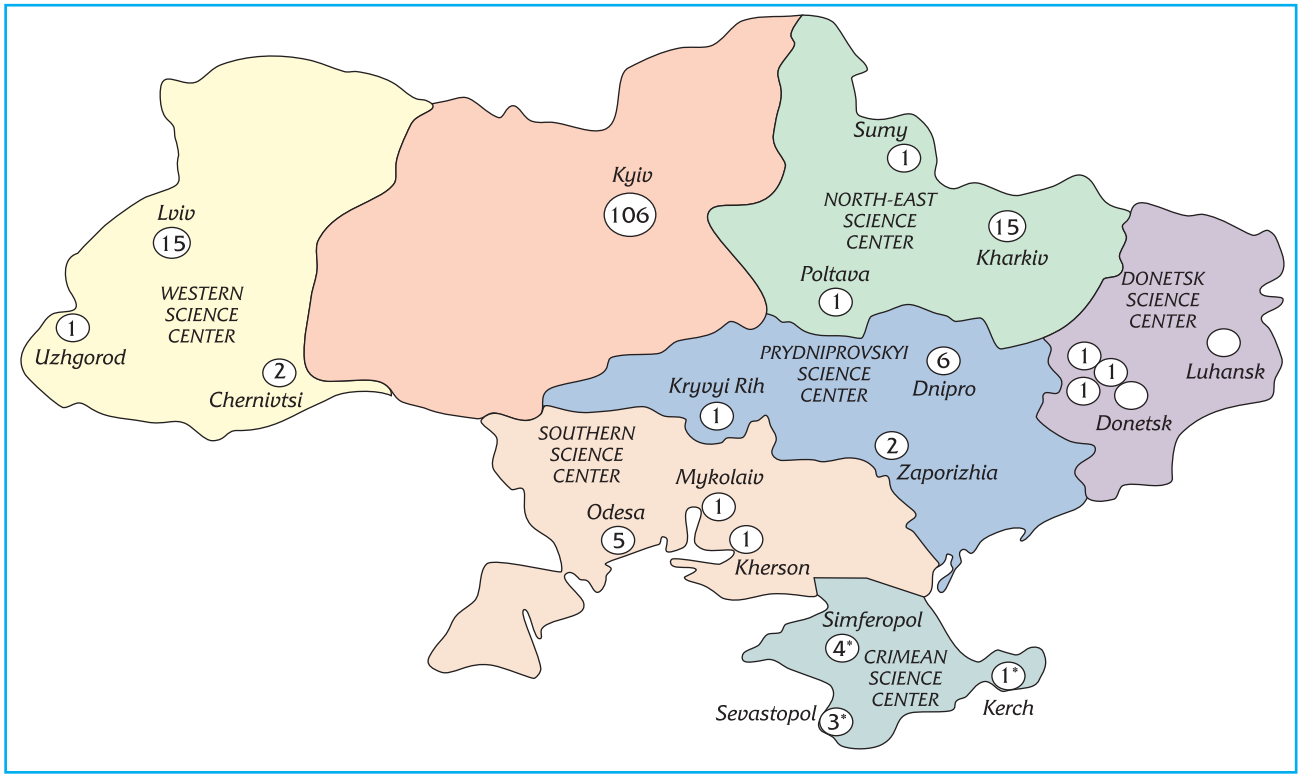
The results of the work to optimize the network of NAS institutions, their structure and reduce staff numbers (in pursuance of article 28 of the Law of Ukraine 'On the 2016 State Budget of Ukraine'):

- the decision on the advisability of dissolving over 20 research institutions and organizations was approved. Five research institution were dissolved
- 220 institution divisions were liquidated
- 5.15 thousand (13.7%) employees were laid off

DISTRIBUTION ACROSS SECTIONS AND DEPARTMENTS

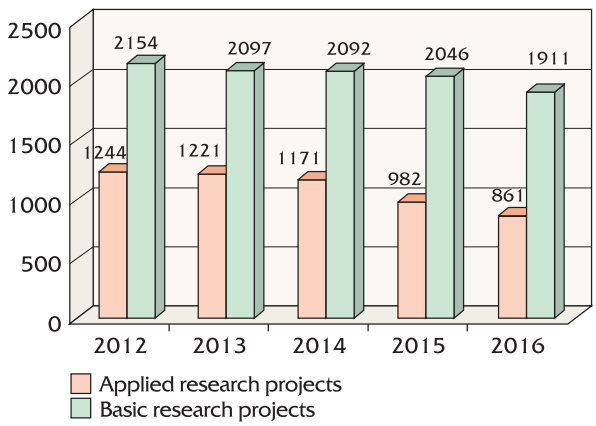
Department	The number of research institutions	The number of pilot production organizations	The number of objects that have the National Asset status	The number of centers for shared use of equipment
The Section of Physical, Engineering and Mathematical Sciences				
Dpt. of Mathematics	4	—	—	0
Dpt. of Information Science	7	—	—	0
Dpt. of Mechanics	6	3	3	6
Dpt. of Physics and Astronomy	16	3	8	16
Dpt. of Earth Sciences	15	1	—	5
Dpt. of Physical and Technological Problems of Materials Science	11	18	1	12
Dpt. of Physical and Technological Problems of Power Engineering	12	7	2	4
Dpt. of Nuclear Physics and Power Engineering	6	2	2	6
The Section of Chemical and Biological Sciences				
Dpt. of Chemistry	13	7	—	11
Dpt. of Biochemistry, Physiology and Molecular Biology	9	1	5	9
Dpt. of General Biology	25	1	14	12
The Section of Social Sciences and Humanities				
Dpt. of Economics	9	—	—	0
Dpt. of History, Philosophy and Law	17	3	5	0
Dpt. of Literature, Language and Art Studies	9	—	4	0

Regional structure of the NAS of Ukraine

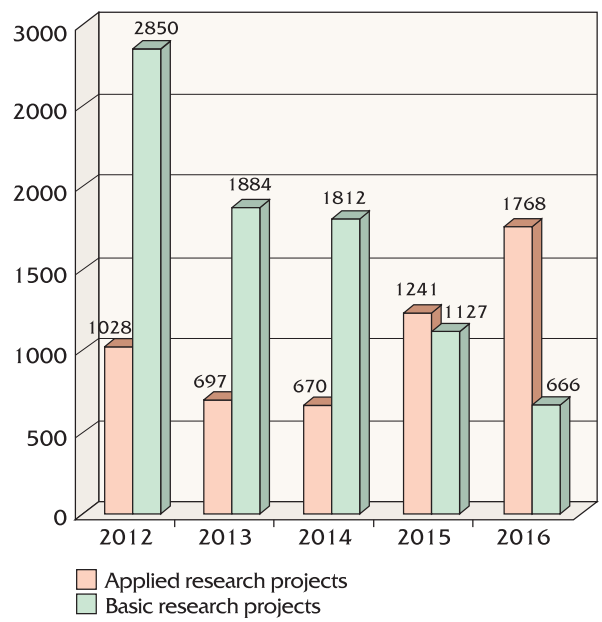


The number of research institutions.
** The status of NAS institutions located in the Crimea Autonomous Republic is defined by the Law of Ukraine 'On guaranteeing the rights and freedoms of citizens and the legal regime of the temporarily occupied territory of Ukraine'*

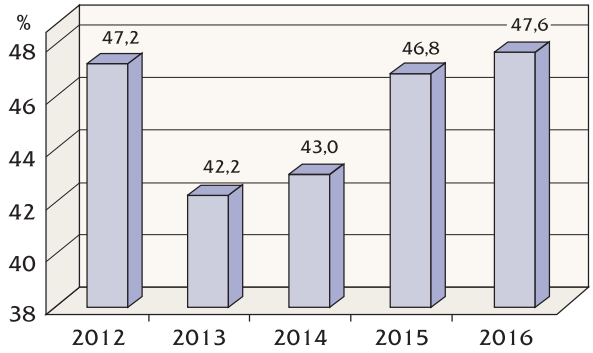
Conducting research



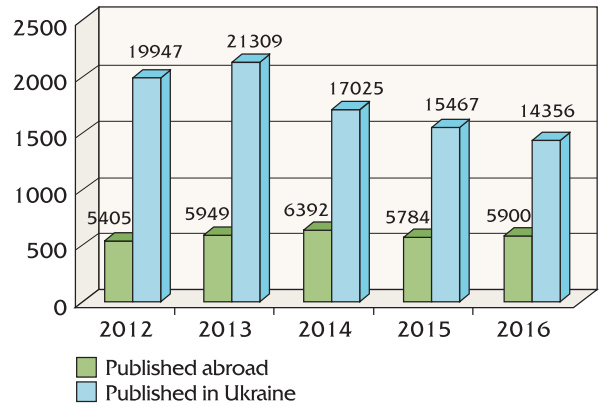
The number of research projects financed by the general fund of the state budget



The number of research projects financed by the special fund of the state budget



The proportion of targeted-program and competitive projects in the total number of projects



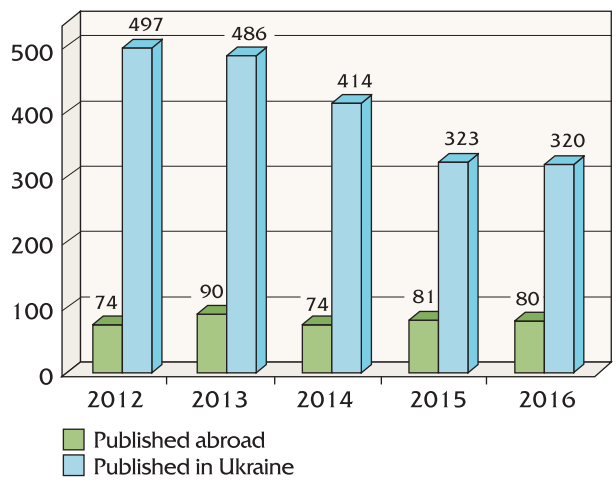
Papers of NAS scholars in periodicals

NAS targeted-program and competitive projects in 2016 involved research under:

- a targeted state R&D program;
- 6 targeted basic research programs of the NAS of Ukraine;
- 14 targeted applied research programs of the NAS of Ukraine;
- 4 separate targeted projects

as well as that based on the results of:

- joint contests with foreign and international organizations;
- a contest of S&T (innovation) projects;
- a contest of research projects in socio-humanities;
- a contest of research projects of young scientists performed under NAS grants.



Academic monographs

Publishing activity. Publishing

The total number of Academy journals: 84 scientific journals, 1 popular science journal — "World Vision", and Ukrainian Journal of Abstracts "Dzherelo" ("Sourse") in four series.

- **published in English in Ukraine:**

1. Science and Innovation
2. Semiconductor Physics, Quantum Electronics & Optoelectronics
3. Journal of Mathematical Physics, Analysis, Geometry
4. The Paton Welding Journal
5. Advances in Electrometallurgy
6. Journal of Thermoelectricity
7. Ukrainian Journal of Physics
8. Functional Materials
9. Biopolymers and Cell
10. Experimental Oncology
11. Problems of Cryobiology and Cryomedicine

- **published in English abroad:**

Springer

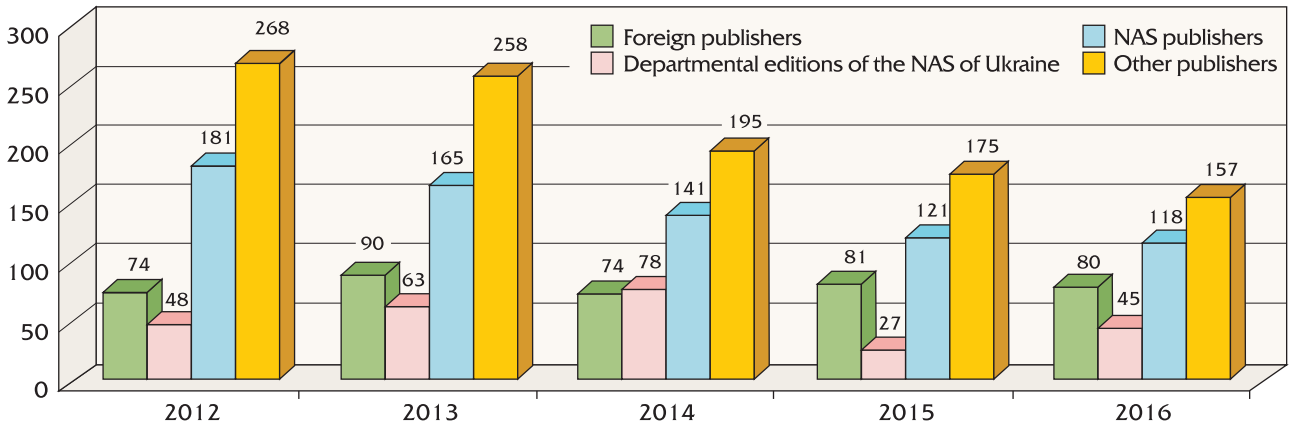
1. Ukrainian Mathematical Journal
2. Cybernetics and Systems Analysis
3. International Applied Mechanics
4. Strength of Materials
5. Materials Science
6. Theoretical and Experimental Chemistry
7. Neurophysiology

Pleiades Publishing, Inc.

1. Kinematics and Physics of Celestial Bodies
2. Journal of Superhard Materials
3. Journal of Water Chemistry and Technology
4. Cytology and Genetics

Begell house inc. publishers

1. Journal of Automation and Information Sciences
2. Radio Physics and Radio Astronomy
3. Telecommunication and Radio Engineering
4. Inernational Journal on Algae



Distribution of academic monographs across groups of publishers

5. Hydrobiological Journal

Other publishers

1. Journal of Low Temperature Physics (American Institute of Physics)
2. Technical Diagnostics and Non-Destructive Testing (Cambridge International Science Publishing)
3. Vestnik Zoologii (De Gruyter)
4. The Ukrainian Biochemical Journal (Elsevier).

Scientific expertise

In 2016, NAS specialists contributed to the preparation of:

- The national strategy of promoting the social dialogue in Ukraine for 2017—2020;
- The strategy of developing high-tech industries till 2025;
- The concept of the state ethno-national policy;
- A comprehensive plan of actions for state regulation of population employment according to the tasks of Ukraine's socio-economic development till 2019;
- The national action plan for implementing the UN Convention on the Rights of the Child;
- The state report on the situation of children in Ukraine;
- The state report on the implementation of the state policy for counteracting human trafficking as of 2012 — the first half of 2016;
- The national report of Ukraine on the implementation of the Madrid international action plan on ageing in 2012—2016;
- The concept of the State Targeted Program of restoring and establishing peace in the Eastern regions of Ukraine.

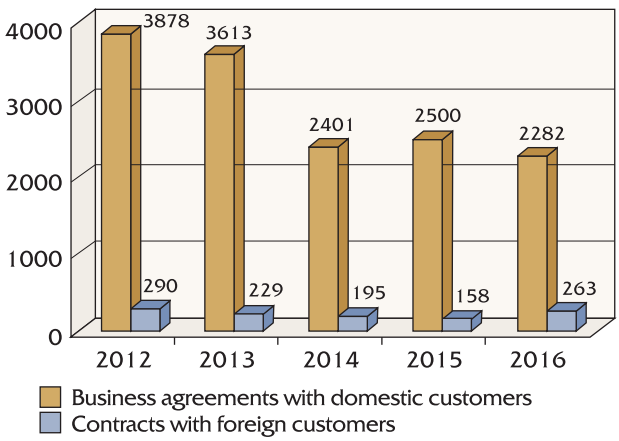
NAS scholars prepared expert conclusions, comments and proposals to the draft laws:

- 'On the support and development of innovation activities';
- 'On introducing amendments to the Budget Code of Ukraine';
- 'On introducing amendments to the Law of Ukraine "On the National Guard of Ukraine"';
- 'On introducing amendments to the Code of Ukraine on administrative offences';
- 'On introducing amendments to the Criminal Code of Ukraine concerning the extension of liability for the illegal turnover of arms, ammunition and explosives';

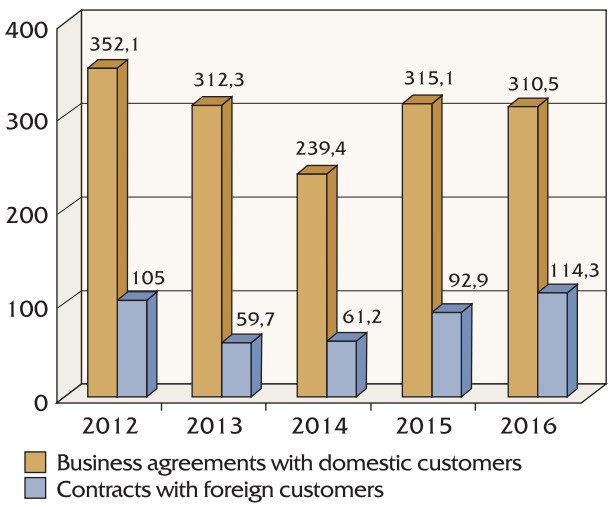
Expert conclusions	2012	2013	2014	2015	2016
Concerning normative legal documents, information and analytical documents on various issues of socio-economic development, sent to state authorities	1970	1560	1500	2017	2160
As to the advisability of conducting public research	661	457	492	1752	606

• 'On introducing amendments to some legislative acts of Ukraine (on proper provision of territorial communities with land resources';
• 'On introducing amendments to some legislative acts of Ukraine for ensuring publicity and preventing abuse in the sphere of registration and turnover of trademarks for goods and services, as well as protecting and enabling the implementation of their owners' rights';
• 'On introducing amendments to some legislative acts of Ukraine on recovering illegal assets';
• 'On introducing amendments to the Law of Ukraine "On national minorities in Ukraine"';
• 'On the protection and conservation of immovable cultural heritage'.

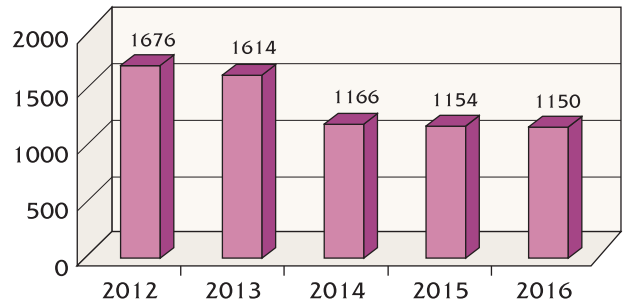
Innovation activities



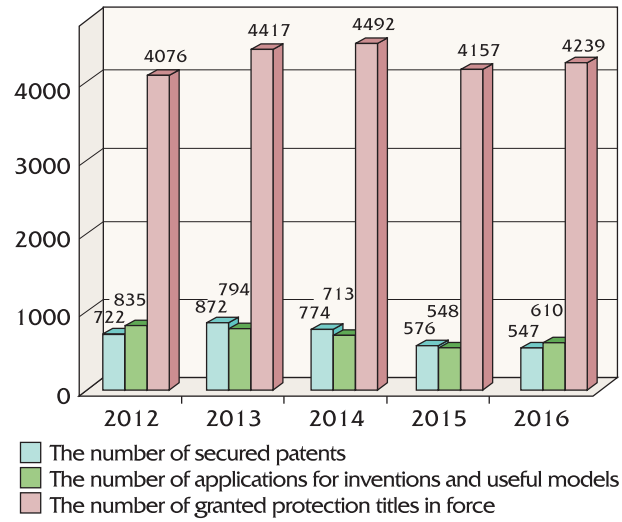
Implemented economic agreements and contracts



Revenues received by NAS institutions from implemented business agreements and contracts



The number of implemented research findings



Protection and use of intellectual property rights

Collaboration with higher education institutions and organizations of the MES of Ukraine

Collaboration agreements concluded by research institutions and higher education institutions	205
Research projects implemented jointly with academics	188
Published monographs co-authored with academics	83
Research scientists who worked in education	1239
including: NAS active members	41
NAS corresponding members	90
Published textbooks and manuals for higher education institutions	70
Scientists at the head of chairs in higher education institutions	74
Students of higher education institutions who pursued/are pursuing master's degree programs at joint research-and-training agencies hosted by scientific organizations:	
in academic year 2015/2016	437
in academic year 2016/2017	407

Students who wrote their graduate papers at research institutions	1009
Academics incorporated to specialized academic councils of research institutions	452
Scientists of research institutions incorporated to specialized academic councils of higher education institutions	541
Newly arrived graduate specialists who attended study groups of the Junior Academy of Sciences in their school days	23
Research scientists and teachers of higher education institutions and MES organizations who upgraded their professional skills at research institutions	380
Theses of academics defended at specialized academic councils of scientific research institutions	239
of those: thesis for the doctor-of-science degree	57
theses for the candidate-of-science (PhD) degree	82

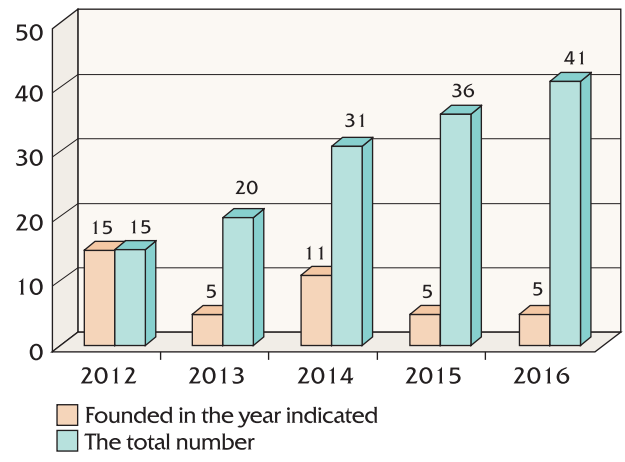
International ties

The contractual framework for the international collaboration of the NAS of Ukraine (effective agreements, contracts, memorandums etc.) —
a total of 122 documents,
of those:

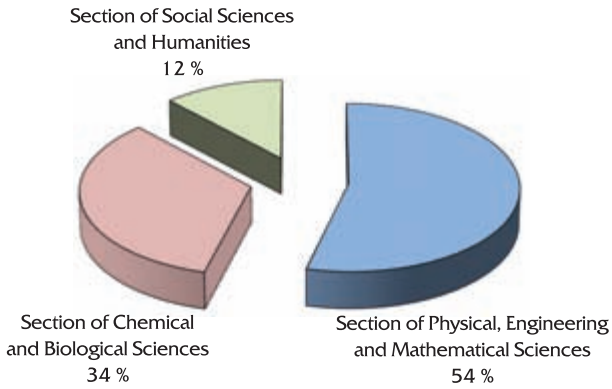
with international organizations	8
with academies of sciences of other countries	51
with foreign scientific research centers	20
with universities	18
with state authorities and municipal governments	20
with firms and companies	5

In 2016, the Academy signed 6 new collaboration agreements:

- The Framework Agreement on supporting research activities between the NAS of Ukraine and the Joint Research Centre of the European Commission
- The Memorandum of mutual understanding in the field of marine sciences and technologies between the National Academy of Sciences of Ukraine and the Lithuanian Academy of Sciences
- The Collaboration Agreement between the People's Government of Tszilin Province (China), Tszilin University and the National Academy of Sciences of Ukraine
- The Collaboration Agreement between the National Academy of Sciences of Ukraine and the Municipal Government of Ningbo (China)
- The Collaboration Agreement between the People's Government of Guangzhou (PRC) and the National Academy of Sciences of Ukraine
- The Memorandum of mutual understanding between the National Academy of Sciences of Ukraine and 'Thomson Reuters' Company.



Joint research-and-training organizations

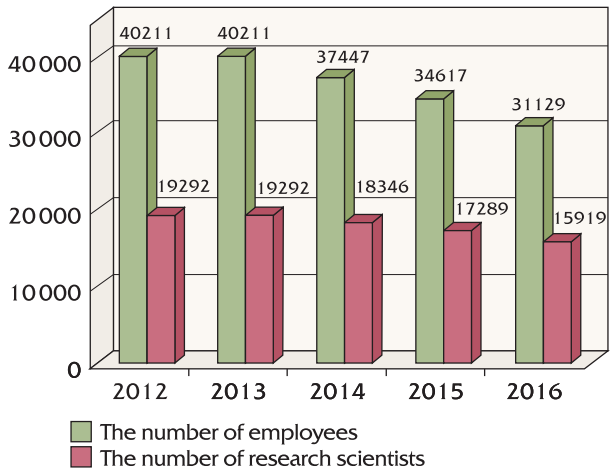


The distribution of direct agreements and contracts across institutions of NAS sections

There are about 500 direct agreements and contracts concluded by NAS institutions with foreign partners.

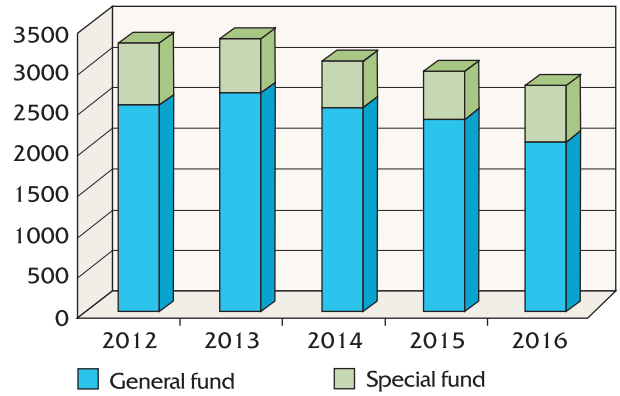
Personnel data sheet (as of 1 January 2017)

The total number of employees	31129
of them:	
in research institutions	28769
in research-and-production facilities	1425
in services organizations	935
The number of research scientists	15919
of them:	
doctors of sciences	2402
candidates of sciences (PhD)	6814
researchers without an advanced degree	6703
The number of young specialists recruited in 2016	361
The number of those who pursued post-graduate studies	1500
full-time studies included	1090
Defended candidate-of-science theses	322
Pursued doctorate courses	171
Defended doctor-of-science theses	82

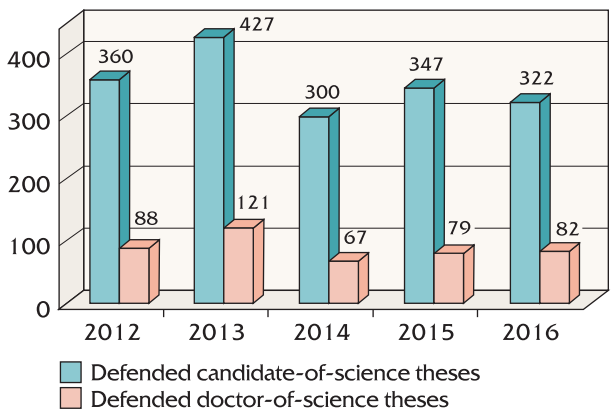


Dynamics of personnel numbers

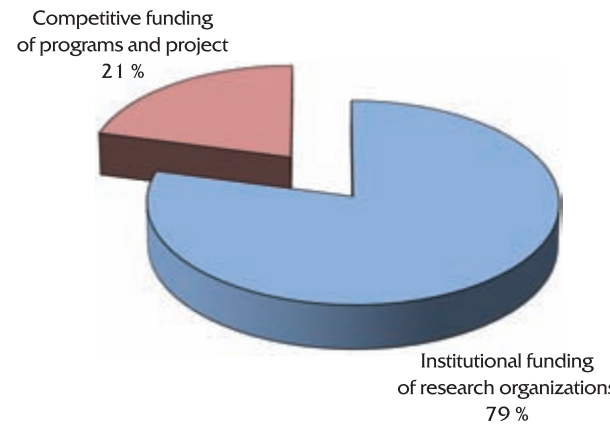
Financial provision for research



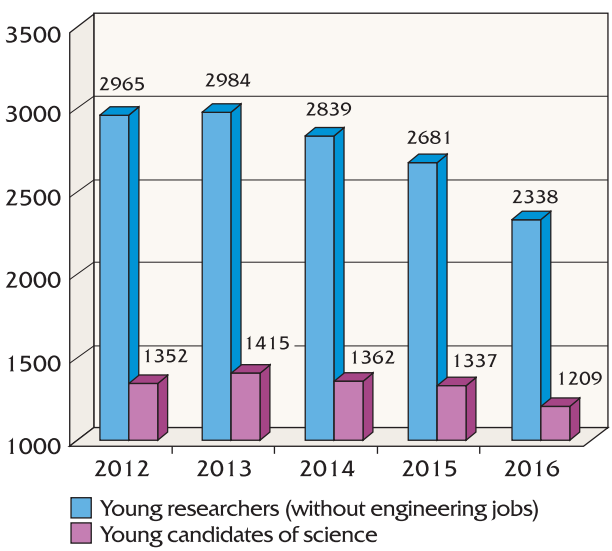
The total amount of NAS funding (UAH million)



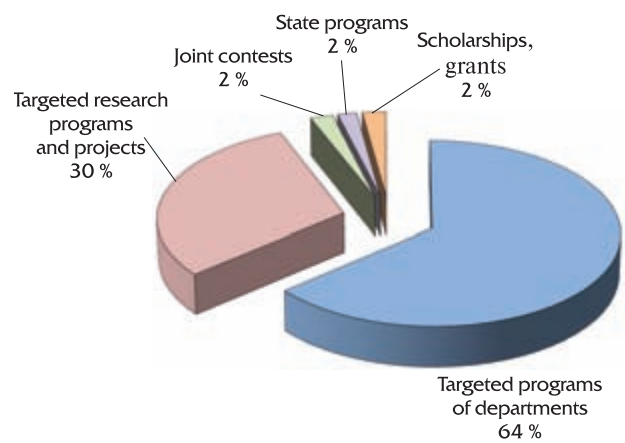
Dynamics of the training of research scientists



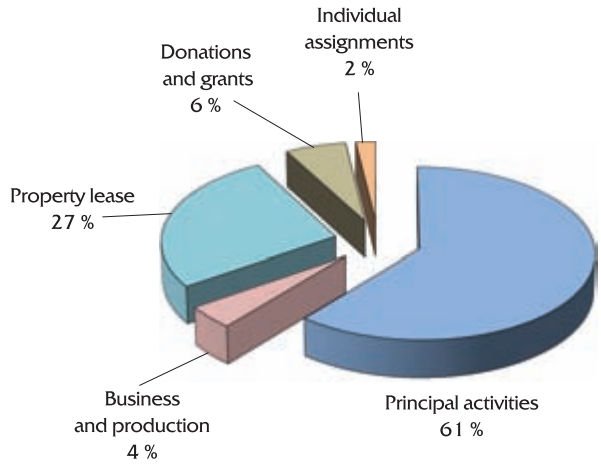
Distribution of the general fund finance



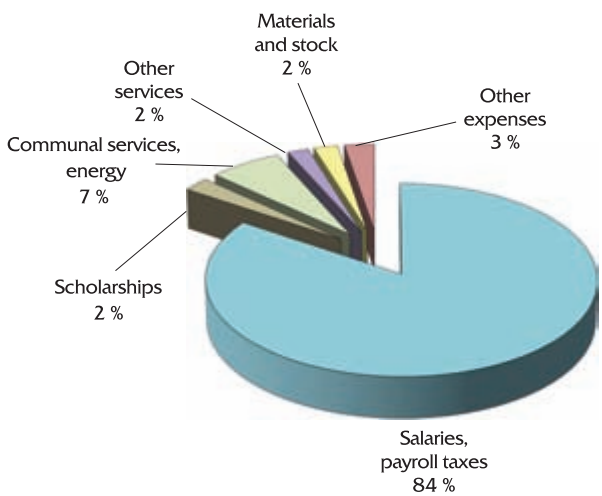
Dynamics of the numbers of young researchers



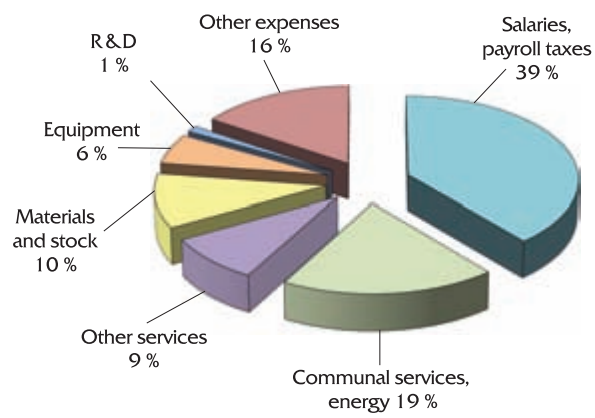
Targeted-program and competitive funding of the NAS of Ukraine



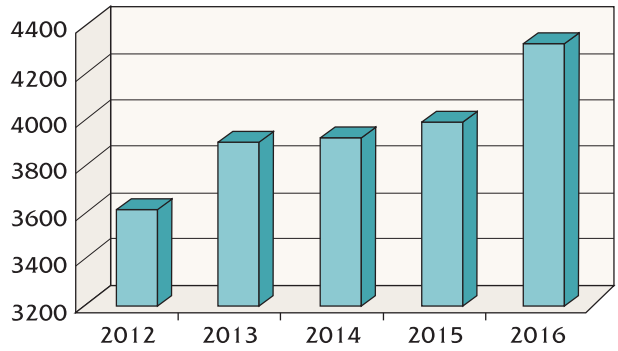
Structure of total NAS expenses



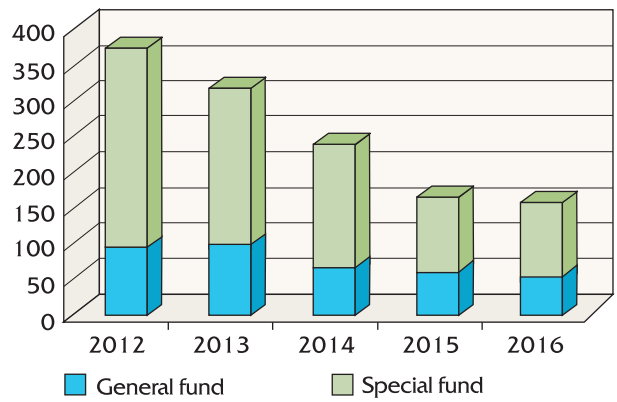
Structure of general fund expenses



Structure of special fund expenses



Average monthly salaries of employees (UAH)



Expenses for procurement of equipment and materials (UAH million)

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Переклад англійською мовою
І.І. Рахманової

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