SUMMING UP THE YEAR

Looking back at the previous year, one can state with confidence that the National Academy of Sciences continued to worthily fulfill its statutory tasks. Its scholars, despite a rather difficult situation, worked hard and obtained quite a lot of important results in the cutting-edge research areas.

E.g., among the achievements in the field of mathematics are new solutions of the Mathisson–Papapetrou equations, which revealed earlier unknown peculiarities of the motion of particles with intrinsic angular momentum around a Schwarzschild black hole in the de Sitter cosmological model. Specialists in cybernetics developed new highly effective unions of algorithms that enabled them to disjoin the process of solving complex discrete high-dimensional optimization problems. Academy physicists, in collaboration with their French colleagues, invented a breakthrough method of medical drugs transport in human blood; its essence is the binding of specially engineered drug molecules to lipoprotein particles of the blood plasma. Astronomers made two major and, without exaggeration, breakthrough discoveries in extragalactic astronomy and cosmology: that was the discovery of two galaxies, one of those was the galaxy with the lowest content of chemical elements heavier than helium, and the other was the galaxy whose radiation is so powerful that it could have ionized the neutral intergalactic medium in the epoch of universe re-ionization. Chemists created advanced functional nanomaterials by integrating important functional characteristics of graphene, graphene oxides, and inorganic semiconductors with the properties of conducting conjugated polymers, they obtained novel condensed pyrimidine derivatives able to suppress human papillomavirus, and also identified and investigated a number of compounds that are effective against multidrug-resistant tuberculosis pathogen. Biochemists proved that acetylcholine receptors play an important role in activating regulatory B-lymphocytes by suppressing antibody production and activating the processes of liver regeneration. Microbiologists and virologists isolated and studied molecular genetic properties of five *Enterobacter* viruses, which are considered as promising agents of the phage therapy of fruit tree sunscalds. Biologists grounded a new concept of managing multifunctional nature-conservation areas with variable flexible conservation regimes, which envisages the introduction of the ecosystem conservation principle rather than the territo-

rial one. Scholars in socio-humanities prepared the National Report "Ukraine's Civilizational Choice", where they investigated the prerequisites, current status and prospects of implementing the new stage of the civilizational development of Ukraine in the context of today's socio-political changes and identified risks and possible threats to the Ukrainian state and the national identity. Economics scientists constructed spatial and functional models of the basic administrative territory units – territorial communities and administrative districts, detected decentralization problems and proposed ways to resolve them. Sociologists carried out an empirical study that yielded new data on the state of the Ukrainian society and the level of social tension. I would also note that the work on major publishing projects was continued in 2017, and the first volume of the multi-volume document series "Archive of the Ukrainian People's Republic" was issued.

Among the applied results of the last year there were also a lot of developments worth mentioning. Relying on the SCIT supercomputers, cybernetics and geophysics scientists constructed a 3D computer model of the Moho (or Mohorovičić) surface; the model is intended for the precise prospecting and evaluating the resources of superdeep oil and gas fields, and ore deposits whose borehole exploring is very expensive. Under the targeted scientific research program "Aerospace monitoring for sustainable development and security", which the NAS of Ukraine had started in support of the *ERA-PLANET* international project as the national segment of the respective European project of the "Horizon 2020" program, its specialists developed an effective information technology for the earth cover classification. That enables them to assess territories over the entire country and is a key component of the integral estimate of the "intelligent city" development in the context of comfort and safety of its inhabitants. Mechanics scientists, in collaboration with specialists of the state-owned enterprise "M.K. Yangel 'Pivdenne' Design Office" developed a special platform for removing the third stage of launcher, which, among other things, was proposed to be used for removing from the orbit the third stage of the *Tsyklon-4M* launcher and space vehicles whose terms of active operation expired. Materials scientists produced an automated shearography unit that permits remote control of the quality of metal and composite structures in the real-time mode. Specialists in thermal physics developed a multistage technology and a facility for producing heat insulating super-thin basalt fiber, which is important for further production of novel environmentally friendly, durable and fire-resistant thermal insulation for civil engineering. Chemists proposed very effective technologies to process plant waste and sediments of Bortnichi sewage aeration station. Biochemists tested a new hemostatic agent designated for patients with congenital hemostasis pathologies, hemophilia in particular. Also developed was a technology for obtaining recombinant creatinine deaminase — an effective creatinine sensor, which serves as a biomarker of renal failure and a measure of hemodialysis efficiency. Another medical product of utmost importance was a highly effective innovative technology of speech recovery in post-stroke patients; its particular feature is the personalized activation of patient's organism reserves. Biologists created the first in Ukraine National Biodiversity Information Network (*UkrBIN*) — the Internet resource combining efforts of biologists, ecologists and numerous volunteer naturalists for the acquisition and analysis of the primary information about the distribution of various plant and animal species on the territory of this country. Economics scientists created an information analysis system to forecast the energy sector development.

It is worth emphasizing that a lot of Academy's research achievements either are already of benefit to the state and society or are planned to be implemented in the near future. Specifically, last year our specialists validated the lifetime and demonstrated the feasibility of extending the safe exploitation of the nuc-

lear reactor of power unit #2 at the Yuzhno-Ukrainska NPP for at least 20 years over the design service life, i.e. till 2048, and the lifetime of power unit #4 of the Rivnenska NPP – till 2026 at the very least. The *RODOS* system, intended for forecasting and supporting the decisions concerning radiation accidents at Ukrainian power plants, once again proved its effectiveness: it helped identify the sources of atmospheric emissions with great accuracy; later that was proved by respective research of foreign specialists. Completed was industrial deployment of the *Metovitan* preparation, which has energy-boosting, cardioprotective, hepatoprotective action, and prevents aging. Our scholars contributed to developing the procedure of integrated poverty assessment which is to take into account radically new approaches to fighting poverty; those are specified by the governmental 'Strategy of overcoming poverty'.

Over three recent years, the R&D aimed at strengthening security and defense of Ukraine has remained the top priority for the Academy. The results obtained include networks for joint operation of robotic ground and air combat systems, a package of measures to develop import-substituting products, among them being semiconductor circuitry, units for the servicing of precision armaments, technologies for extending the operation life of aircraft and armored vehicles, high-temperature heat-resistant composite materials for combustion chambers of gas-turbine engines, components of solid rocket propellants, technologies for laser and arc welding of thin-walled elements of the flight control surfaces and nozzles of guided missiles and for underwater welding of combat ship hulls under extreme conditions, technologies for hardening and machining the barrels of smooth-bore firearms and rifles of various calibers, development of transparent and laminated ceramic and light metal alloy composite structures for protection of light-armored vehicles, as well as coatings that minimize the vehicle detectability in microwave, high-frequency and infrared ranges.

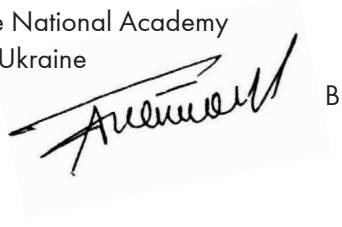
A highly informative reference series "Promising S&T Developments of the NAS of Ukraine" was published last year. Its 11 subject-oriented editions presented the major achievements of Academy scientists in various areas — from agribusiness and decorative horticulture to machine- and instrument-building. Everyone can have access to those books: their electronic versions are open to public on the website of the NAS of Ukraine.

2017 was remarkable for our Academy not only in terms of its research work but also due to the important events that already made history. The most important of them was, undoubtedly, the establishment of the National Board on the Development of Science and Technologies, on whose activities we pin great hopes. Of special importance for us is deeper cooperation with the Ministry for Economic Development and Trade of Ukraine — the Academy concluded a co-operation agreement with it. I also cannot omit an important jubilee date marked last year — 25 years since the foundation of the Ukrainian national member organization of the International Institute for Applied Systems Analysis (IIASA). This is an honorable international institution in collaboration with which our scientists have been implementing projects in the areas of balanced agriculture development, the integrated management of food, energy and water security, a stable energy future for Ukraine, the management of financial crisis and natural disaster risks.

2018 is the great jubilee year of our Academy: we will mark its 100th anniversary. I'll mention that this jubilee will be celebrated both in Ukraine and internationally, as that has already been included in the UNESCO Calendar of memorable events 2018. We have lots of plans — both scientific and educational and hope that we will manage to fulfill them. To that end, an extensive preparatory work was started last year both by the Academy as a whole and by its sections, departments, regional science centers, and leading scientific institutions. Another fact that is of im-

portance for the jubilee is the election of NAS active members and corresponding members, held in the early March of the current year. No doubt, due to them the Academy has added new worthy members to its ranks.

To be sure, the recent signs of positive changes in the financial provision of the NAS of Ukraine are very pleasing. The 2018 State Budget provides for 3,758.6 million for the Academy, which is significantly more than last year's figures. Besides, in the near future the National Research Foundation of Ukraine is to start its work. It will allocate competitive grant finance to the most efficient and promising Ukrainian research teams. We do hope that due to such urgently needed steps the crisis in the Ukrainian science will be over at last and the rise of the science sphere will begin, and this really vital for our country.

President of the National Academy
of Sciences of Ukraine
Academician  B.E. Paton

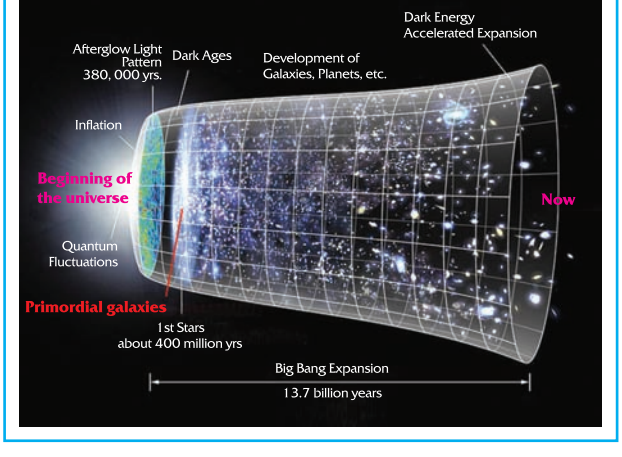
RESEARCH ACHIEVEMENTS. NATURAL AND ENGINEERING SCIENCES

Dwarf star-forming galaxies are natural laboratories for investigating the early universe

One of the important research areas of the Main Astronomical Observatory of the NAS of Ukraine is studying physical characteristics of primordial galaxies, which were the first objects in the universe and were formed in large numbers in the gas medium. Their birth signified the end of the Dark Ages, when the matter of the universe consisted of the neutral gas which did not radiate. Primordial galaxies played an important role in the evolution of the early universe, since they were the first objects in which the synthesis of chemical elements heavier than helium began. Cosmological models show that primordial galaxies were very small in size and had masses that were one-ten-thousandth of the mass of the spiral galaxy where the Sun is located. This fact, in conjunction with the enormous distances to the primordial galaxies, do not allow them to be studied with the necessary accuracy. So, there is a need for finding counterparts of such galaxies at closer distances.

For this purpose, at first the search for candidates to such proxies was carried out among more than four million galaxies by the world's largest Sloan Digital Sky Survey. Further observations of the J0811+4730 galaxy, which were made with the Large Binocular Telescope (Arizona, USA), revealed that this galaxy is very small, its mass being one ten-thousandth of that of the typical spiral galaxy, and it is 600 million light years away. Its content of chemical elements heavier than helium is 1/60-th of that of the Sun and the Solar System and is the lowest among all known star-forming galaxies. So, galaxy J0811+4730 is the best counterpart of primordial galaxies in terms of its properties, and its further comprehensive studies will give scientists a better insight into the processes that occurred in the early universe.

Besides, the observations of 11 galaxies, carried out in 2017 in cooperation with astronomers of Switzerland, the FRG, the USA, and the Czech Republic with the Hubble Space Telescope, proved that due to their small



The diagram of the universe evolution from its initiation (left) till now (right). The first galaxies began to emerge when the universe was about 400 million years old

Assembled image of the discovered J0811+4730 galaxy and a typical spiral galaxy. These galaxies are situated in different regions of the sky but shown side by side only for comparing their linear dimensions

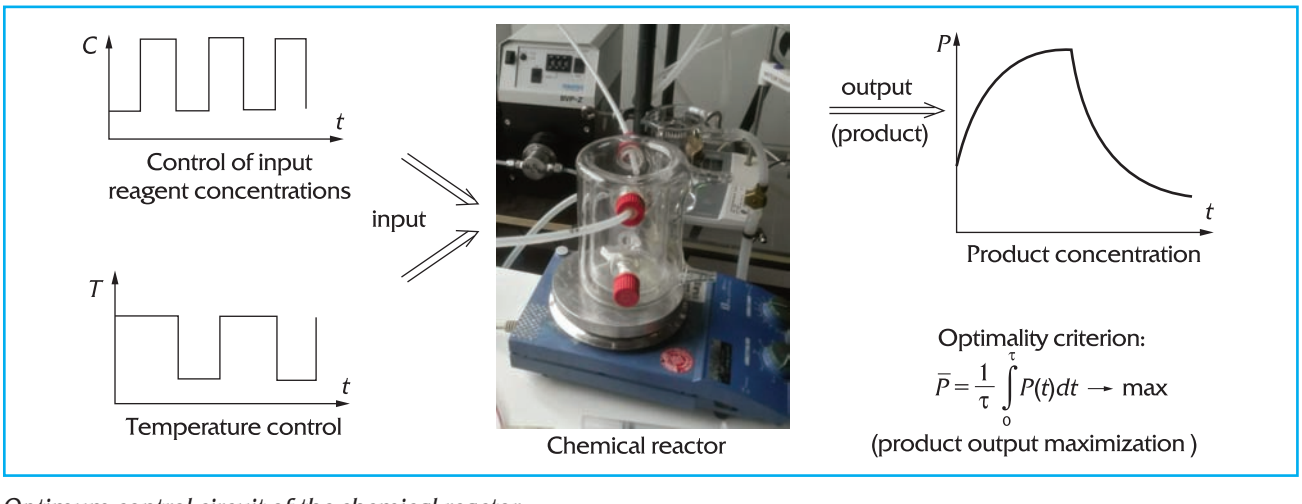
sizes all those galaxies lose a significant amount of the ionizing radiation produced in them. Specifically, three of the galaxies observed lost about a half of the generated ionizing radiation. If that proportion was typical of the primordial galaxies, then those galaxies were capable of ionizing the neutral intergalactic medium, which it was during the "Dark Ages" of complete opacity for the early universe radiation. This discovery was a breakthrough in the observational cosmology, as it experimentally proved the hypothesis that dwarf galaxies with their high rate of star formation could have been responsible for universe reionization.

Y.I. Izotov, N.G. Guseva

Improving the efficiency of non-linear chemical reactors with methods of optimal control theory

Under the collaboration agreement between the NAS Institute of Applied Mathematics and Mechanics and Max Plank Institute for Dynamics of Complex Technical Systems (Magdeburg, FRG), scientists of these institutions investigated optimal control of non-linear mathematical models of chemical reactors. Those studies aimed at solving modern engineering problems to optimize the production of new substances in chemical and pharmacological industries. Conventional approaches to optimizing the stationary operation mode of chemical reactors do not permit the maximum mass of the end product to be obtained within the chosen period under specified limitations on resources, so they do not meet quality criteria.

In solving this problem, known research results were taken into account; that research had found the possibility of improving the capacity of the non-isothermal chemical reactors in the process of employing control time-variant signals. At first, relying on the methods of non-linear analysis, the maximum reaction efficiency was evaluated and the average product concentration at the reactor exit under fixed consumption of input reactants was determined for non-linear non-isothermal models. Then a computation scheme was developed to determine the quality criterion at the reactor exit during the employment of periodic control functions and compare this criterion with the stationary parameters of model chemical reactors. A comprehensive quantitative and qualitative description of the family of optimal control problems, depending on the reactor's physical parameters and resource limitations, was proposed and a detailed analysis of the solutions of the systems of non-linear equations determining the moments of control function switching was carried out. It was found that the proposed algorithms of control with switching ensured a more efficient transformation of input substances into the end



Optimum control circuit of the chemical reactor

product of the non-isothermal reaction as compared to harmonic modulations of control that had been used in previous works of German and Serbian researchers.

The proposed control strategies were successfully tested at the special equipment in the laboratories of Max Plank Institute for Dynamics of Complex Technical Systems and Otto von Guericke University (Magdeburg). The employment of the analytical and numerical methods developed opens up new prospects of optimizing the processes of crystallization and chromatographic separation in the production of high-purity substances in today's chemical and pharmacological industries.

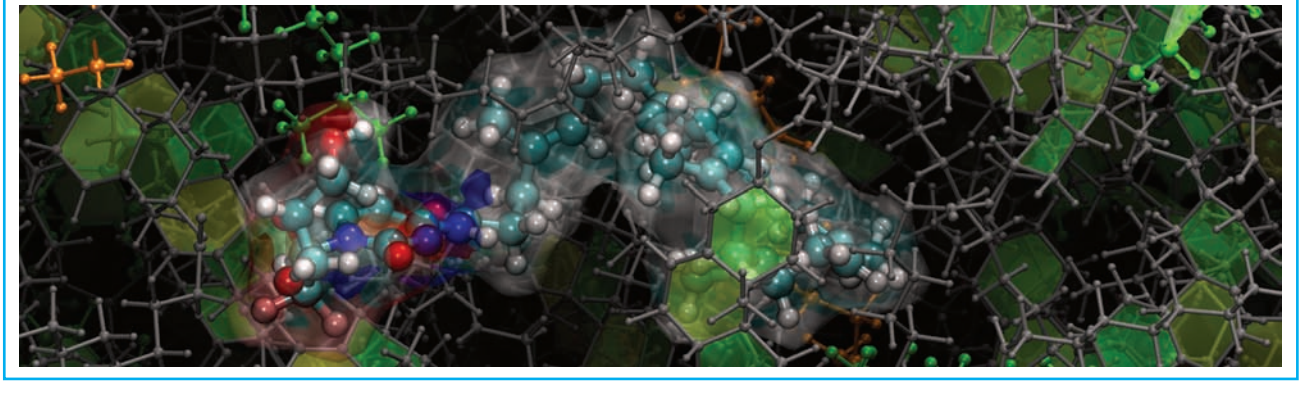
Alexander L. Zuyev

A new method of transporting medical preparations in human blood

Relying on computer modelling, as well as data of biological experiments, scientists of the NAS Institute of Physics in collaboration with French researchers from the University of South Paris and the Academy of Besançon, in the framework of a joint project under the EU programme "Horizon 2020", discovered a method of transporting medical preparations by human blood. It consists in binding specially modified molecules of such preparations with low-density lipoproteins. The latter are natural nanoparticles of around 20 nm size, which are responsible for the transport of fats and cholesterol in human blood, and because of their involvement in plaque formation in blood vessels of atherosclerosis patients they are often called "bad cholesterol". The molecular structure of these nanoparticles is only known in general outline despite their practical importance for biomedical research.

A computer model of lipoprotein particles enabled researchers to investigate in detail their interaction with gemcitabine squalene, which is a new medical substance believed to be promising in cancer therapy though it was not clinically tested yet. In this substance the well-known water-soluble anticancer drug — *gemcitabine* — is chemically cross-linked with the molecule of squalene, which is a natural fat-soluble substance that is a precursor in steroid synthesis in cells. The modelling showed that this preparation effectively accumulates in protein particles. That is due to the fact that the fat-soluble squalene "tail" acts as an anchor and reliably "draws" the water-soluble gemcitabine molecule into the lipoprotein particle in which it then travels in human blood.

Since cancer cells capture from blood much more lipoprotein particles than normal ones they obtain a high dose of the preparation, which, after all, kills them and does not do much harm to the healthy cells. Such transportation by lipoprotein particles can be employed for a large number of medical drugs — an-



Gemcitabine molecule inside a lipoprotein particle. A snapshot of system's part during computer modelling. Atoms of the gemcitabine molecule are shown as large balls surrounded by the semitransparent molecular surface. Lipid molecules of the lipoprotein particle are shown in grey color. Cyclic chemical groups of cholesterol are shown as semitransparent polygons

titumor preparations, neuroprotectors, antibiotics, antiviral agents etc.

The results obtained are published in the prestigious scientific journal *Nature Communications* (https://www.nature.com/articles/ncomms15678). According to numerous specialists, they have a great potential for further practical use in biomedical research.

Dunja Sobot, Simona Mura, Semen O. Yesylevskyy, Laura Dalbin, Fanny Cayre, Guillaume Bort, Julie Mougin, D. Desmaële, Sinda Lepetre-Mouelhi, Grégory Pieters, Bohdan Andreiuk, Andrey S. Klymchenko, Jean-Louis Paul, Christophe Ramseyer, Patrick Couvreur

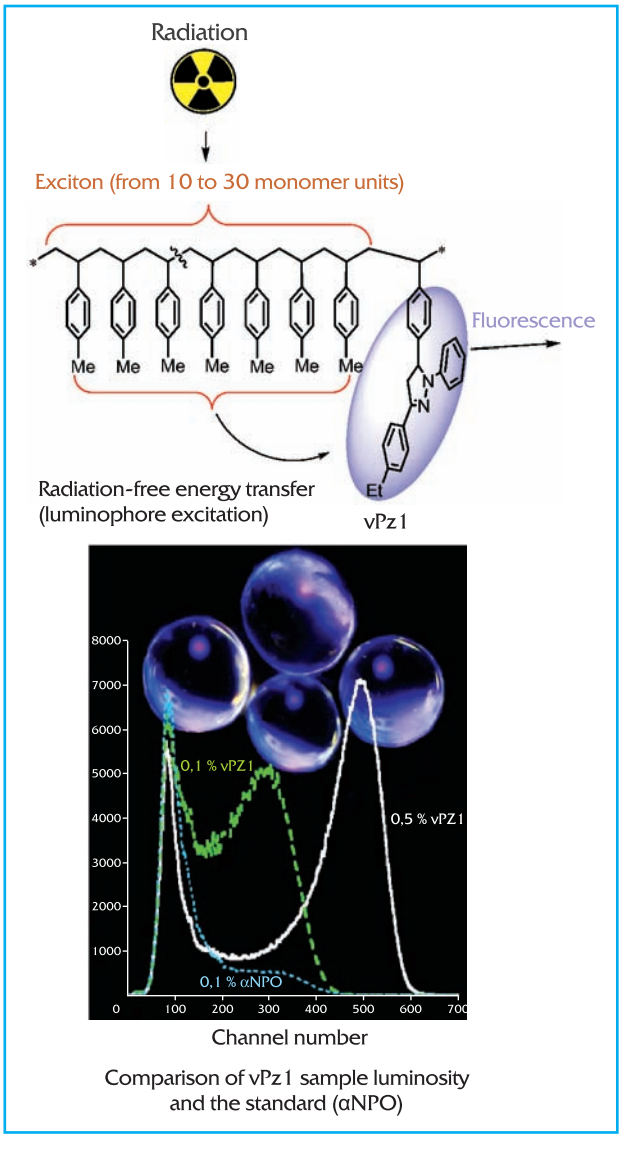
Fluorescent organic scintillator for α-, β- and γ-radiation

The NAS Institute of Organic Chemistry, relying on the theoretical analysis with non-empirical quantum-chemistry methods of the electron structure of organic molecules and characteristics of light energy in them, predicted new promising luminophores based on pyrazoline derivatives. Preparative methods of their synthesis were developed.

It was shown that such luminophores, as the theory predicted, have both significant Stoke's shift (80—100 nm) and the high quantum yield of fluorescence (75—98%). Besides, of great importance is the fact that the luminophores synthesized have a high fluorescence brightness in the range of radiation detectors under α-, β-, and γ-irradiation. In terms of fluorescence intensity they are five times better than their best known counterparts.

In collaboration with scientists of the Clemson University (USA), on the basis of new radio luminophores, new polymer scintillators were developed; those can respond to both the dose and type of radiation. The additional effectiveness of the scintillators was achieved due to the covalent luminophore binding with the polymer, as that increased the exciton transport in it. Using them, film- and disk-shaped polymer dosimeters were produced; their sizes could be adjusted according to the task.

A.A. Ishchenko



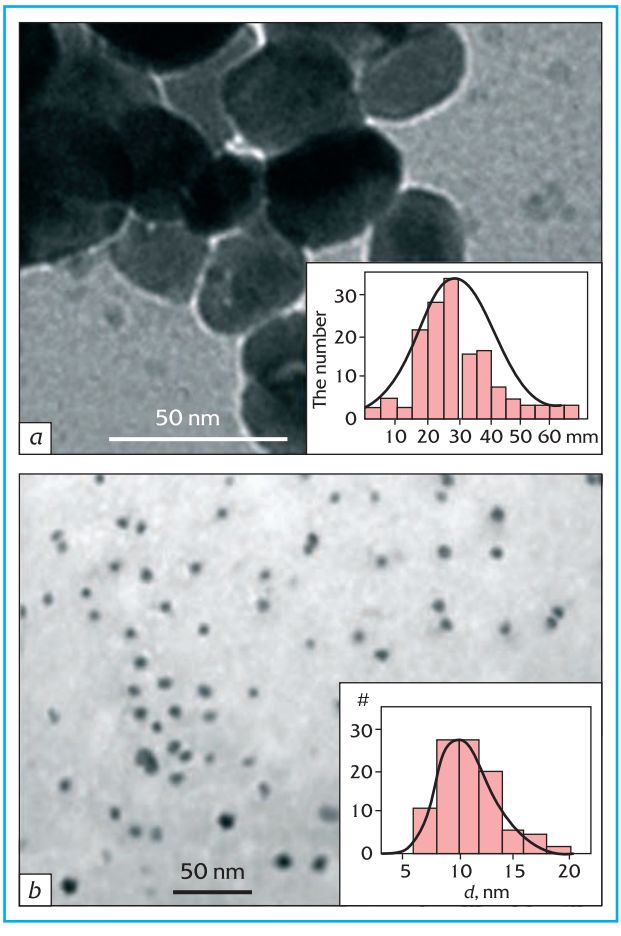
Fluorescent organic scintillator

Magnetic liquids as inducers of malignant tumor hyperthermia

The NAS V.I. Vernadsky Institute of General and Inorganic Chemistry developed methods of synthesizing weakly agglomerated ferromagnetic nanoparticles (deposition from aqueous solutions, deposition from diethylene glycol and microemulsion solution (sol gel method) with the spinel and perovskite structure, which are intended for practical use in medicine as inducers of the hyperthermia of deeply located malignant tumors. The methods proposed and the synthesis conditions enable specia-

lists to change particle size and agglomeration as well as their electrophysical properties.

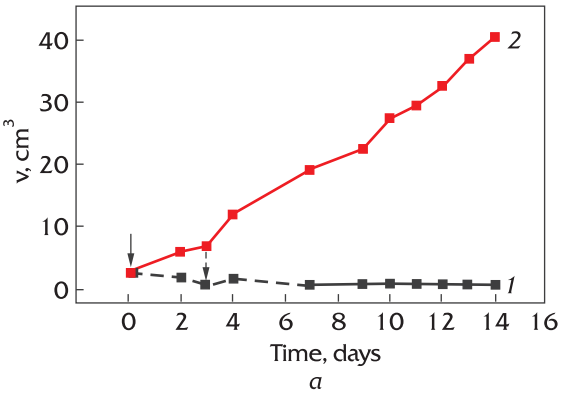
In collaboration with the NAS Institute of Magnetism and the NAS Institute of Physics, its scientists determined the mechanisms of energy losses in the synthesized spinel- and perovskite-structured superparamagnetic nanoparticles under the action of an alternating magnetic field, which is important for their practical use as hypothermia inducers. Using perovskite-structured particles as an example, it was shown that the main contribution to the heating of (La,Sr)MnO_3 particles during the action of external magnetic field is made by the Stoner–Wohlfarth (SW) mechanism. It was determined that this mechanism in superparamagnetic particles can be effected by producing nano particles whose blocking temperature is close to the room temperature.



(La,Sr)MnO_3 particles synthesized with sol gel method (a), Fe_3O_4 nanoparticles synthesized by deposition from the nonaqueous solution (b)

These magnetic liquids based on the synthesized Fe_3O_4 spinel- and (La, Sr)MnO_3 perovskite-structured nanoparticles of ferromagnetic materials were studied at the NAS R.Ye. Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology. The biological assessment of the possibility of employing (La,Sr)MnO_3 magnetic liquid as the inducer of tumor hyperthermia was made; it showed that the magnetic liquid did not cause substantial manifestations of the general toxicity and changes in the histological structure of normal rat and mouse organs and was capable of raising significantly the temperature of subinoculated tumors *in vivo* under the action of alternating magnetic field, specifically by 13.6° C within 30 minutes.

The experimental pre-clinical pharmacological studies of lanthanum-strontium manganite nanocomposite allowed it to be recommended as a hyperthermia inducer, in particular in



a

Heren carcinoma (n = 15)	The number of rats with the complete tumor regression (%)	The number of cured rats (%)
MF + ACF + cisplatin (1,5 mg/kgb. w.)	70.0	70.0
Cisplatin (3,0 mg/kgb. w.)	65.0	65.0

b

Heren carcinoma volume under the action of nano-hyperthermia (Curve 1, the effects are shown with arrows) and that without hyperthermia (an intact tumor, Curve 2) (a), nano-hyperthermia combined with chemotherapy (b)

thermal ablation and hyperthermic chemotherapy schedules, with the purpose of improving the procedure of malignant tumor nano-hyperthermia. This nano-hyperthermia method could be useful in the treatment of peritoneal carcinomatosis and malignant ascites patients.

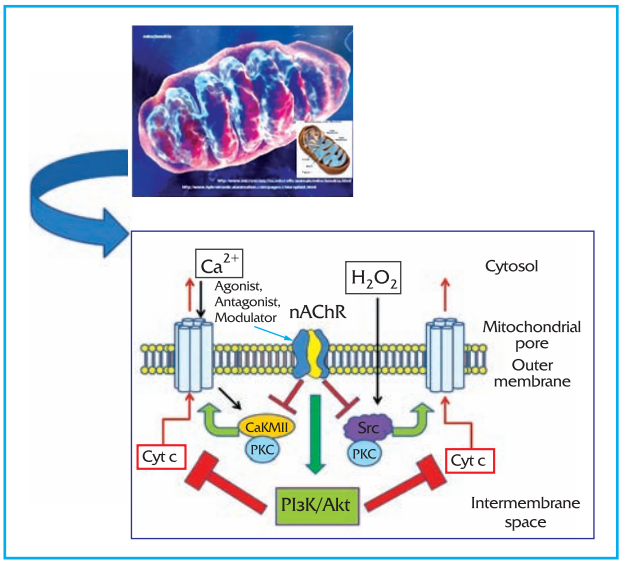
Anatolii G. Belous, Sergiy O. Solopan, Yulia.Ya. Shlapa

The mechanism of mitochondrial nAChRs functioning, pathways of their transport to mitochondria and the role in tissue regeneration

Palladin Institute of Biochemistry of the NAS of Ukraine developed a new concept concerning the mechanism of nicotinic acetylcholine receptors (nAChRs) functioning on intracellular organelles — mitochondria, the pathways of their transport to mitochondria and their role in the processes of tissue regeneration.

It is known that nicotine is an intracellular chaperone that facilitates folding, assembly and maturation of nAChR molecules during biosynthesis. It was found that nicotine intake by mice increased the relative number of mitochondrial nAChRs in liver, raised their glycosylation level but prevented binding of nAChR-specific ligands and, respectively, attenuated their effect on the release of pro-apoptotic factors. The results obtained provide evidence that it is the glycosylation process which determines the post-translational targeting of nAChRs to mitochondria; besides they demonstrate the negative effect of using nicotine on the functions of mitochondrial nAChRs.

To specify the mechanism of nAChRs functioning in mitochondria, selective allosteric modulators of different subtypes of this receptor were used. It was found that three types of different nAChRs are selectively coupled to three different kinases. The binding of nicotinic AChRs to mitochondrial signaling pathways occurs through the ion-independent mechanism and requires conformational changes in ligand binding at certain specified sites.



Nicotinic acetylcholine receptors (nAChRs) localized in the mitochondria outer membranes and their signaling due to the conformational change

In collaboration with the NAS Institute of Molecular Biology and Genetics, the role of mitochondrial nicotinic AChRs in the process of rat liver regeneration after partial hepatectomy was studied. The investigation showed that the early regeneration stage (3–6 hours after hepatectomy) was accompanied by a higher content of α3β2, α7β2 and, especially, α9β10 nAChRs in mitochondria, which increased mitochondrial stability against the action of pro-apoptotic agents. The study emphasized the important role of α9-containing nAChRs, which, depending on the requirements, can be involved in homomeric or heteromeric configuration.

The data obtained deepen our insight into the mechanisms of mitochondrial nAChR signaling and form the basis for identifying the structural transformations of nAChR molecules that are necessary for triggering mitochondrial signaling pathways. Besides, researchers for the first time ever determined their physiological role in the process of tissue regeneration as well as the function of α9-containing nAChRs as the universal "reserve" subtype that is expressed under stress.

M.V. Skok, O.Yu. Lykhmus, K.R. Uspenska

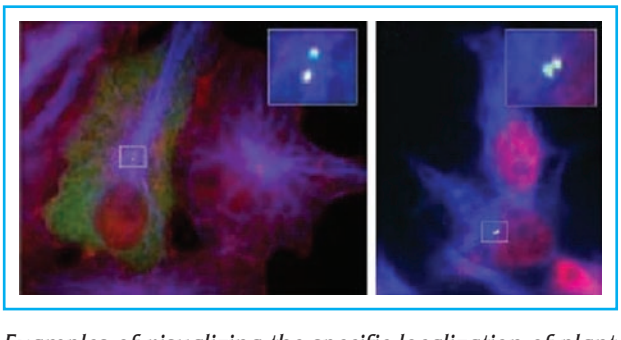
Evolutionary conservatism of the key elements of the mitotic apparatus of cell division

Mitotic division (mitosis) in animals and in plants proceeds by means of the so-called mitotic spindle consisting of microtubules which, in turn, are formed by subunits (α and β) of the tubulin protein. The centers of mitotic spindle organization are essentially different in animal (centrosomes consisting of two centrioles) and plant cells (their structure has not been described as yet), though their nuclei consist of γ-tubulin.

Scientists of the state institution "The Institute of Food Biotechnology and Genomics of the NAS of Ukraine" were able to obtain molecular genetics proofs of the evolutionary conservatism of some centriole elements in animals and microtubule organization centers in plants. During bio-information analysis researchers found plant homologues of the so-called *MAST* protein kinases of animal origin which are involved in regulating the mitotic spindle structure.

That enabled them to identify and isolate the respective genes from the model plant and, using genetic transformation, to transfer them into animal cells. In transformation structures researchers used the gene of the green fluorescent protein (GFP), whose expression allowed them to visualize the products of the expression of the transferred foreign genes.

The research conducted revealed the specific localization of plant protein kinase in animal cell centrioles, which showed the extraordinary evolutionary conservatism of the structural elements of mitotic division apparatus, though those structures in animals and plants strongly diverged at the supramolecular level.



Examples of visualizing the specific localization of plant protein kinase in cell centrosomes of various animal species

The discovery of this phenomenon will promote new developments in cell engineering, e.g., in solving theoretical problems in biology, industrial microbiology, biotechnologies employed in medicine, agriculture and other areas of science and industry.

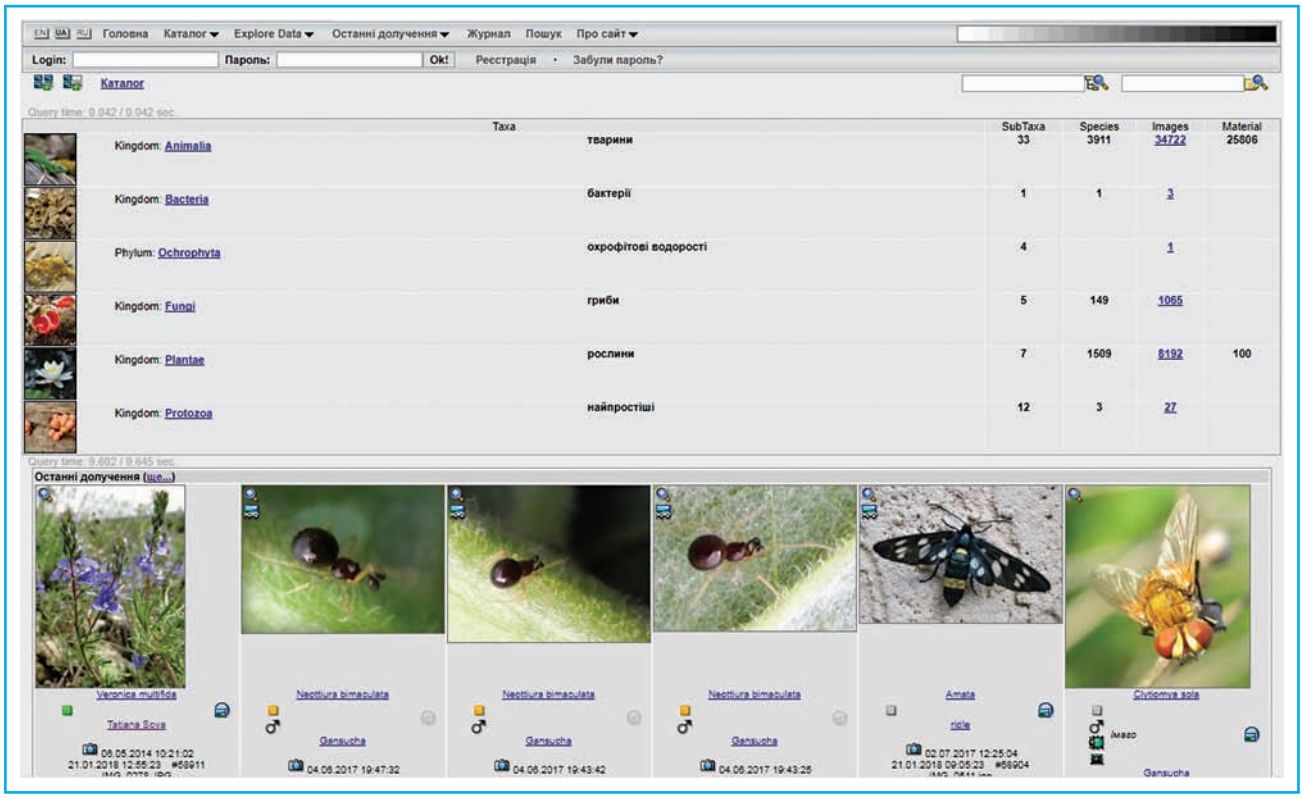
Ya.B. Blume, A.I. Yemets, P.A. Karpov, D.I. Lytvyn

Biological diversity conservation

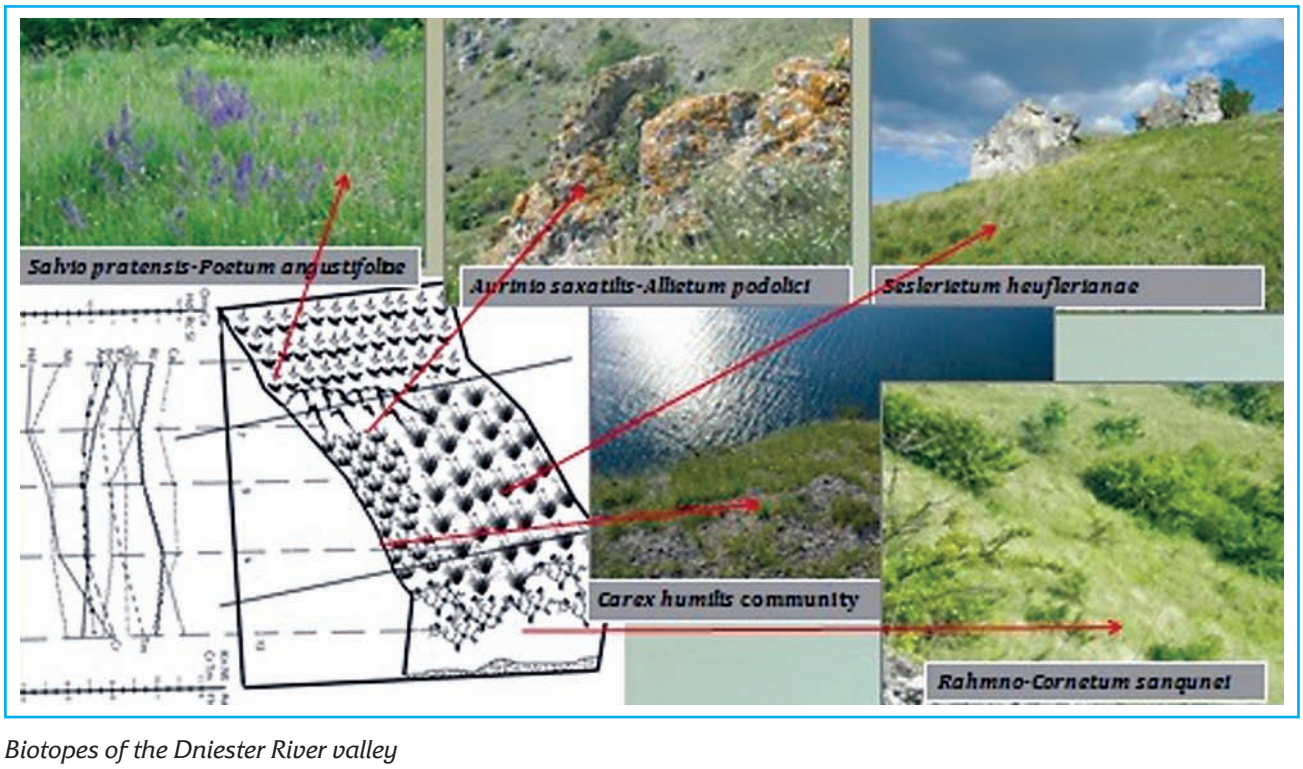
To generalize information on the species composition and the distribution of plant and animal species over the territory of Ukraine, I.I. Schmalhausen Institute of Zoology of the NAS of Ukraine developed the first *Ukrainian Biodiversity Information Network* (*UkrBIN*) — an interactive program of recording and compiling lists of species for various parts of Ukraine. This Internet resource provides a rich source of data on the distribution and numbers of flora and fauna species, in particular, those listed in the Red Book. Owing to *UkrBIN*, a user can get involved in the process of studying the plant and animal world of Ukraine.

An important task of *UkrBIN* is to integrate Ukraine into global information space for biodiversity, as well as resume the functioning of the Survey of Ukrainian Fauna at a new IT level. The aim of *UkrBIN* is to maximize the accessibility of the vast number of biodiversity observations conducted annually by both professional biologists and amateurs. The observations of each participant are added to others, which are carried out in the international network of *UkrBIN* platform users. Those data are the basis for a better understanding of biota distribution in Ukraine and outside it.

Extensive cooperation of botanists, mycologists, zoologists, microbiologists and virologists enlarges our knowledge of biological



The national network of biodiversity information (UkrBIN) – the interactive program of recording and listing species for different parts of Ukraine

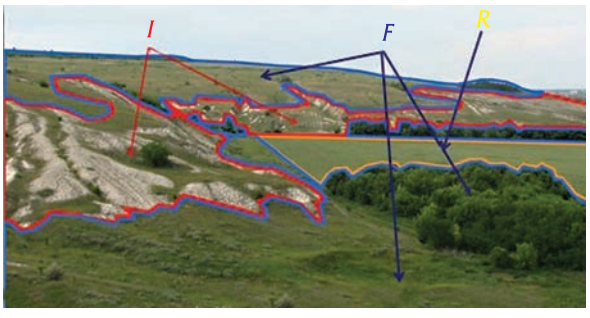


Biotopes of the Dniester River valley

diversity, of plant, fungus, animal species and bacteria and virus strains that are useful, safe and dangerous for people. Now nearly 1,235 thousand species are known in different kingdoms of eukaryotic organisms. According to specialists' estimates, 8,500 thousand species remain unknown to biological science. So, every year, thousands of new organisms, both existing now and extinct, are found and described in the process of studying the living matter.

In the year under review, NAS scientists in botany, zoology, mycology and paleontology described 151 new taxa, among them being 106 new species of fungi, diatoms, vascular plants, insects, and fossil vertebrates and invertebrates.

However, on the background of discovering new species, due to human activities and climate change, we witness ever-increasing extinction rates of numerous living beings. For this reason, the work of biology scientists is also aimed at minimizing these processes, particularly, through establishing new nature reserves and forming a branched ecology network.



Biotopes of the Krasna River valley I – sozological, F – regulating, R – resource

They proposed new principles and a concept of forming a system of protected areas as multifunctional categories with varied protection regimes. As of today, 186 biotopes representing all types of Ukraine's natural ecosystems have been identified, their sozological indices, viability and loss risks calculated, and a number of new environment change indices proposed.

Ya.P. Didukh, V.G. Radchenko, V.A. Korneyev, P.M. Tsarenko, A.V. Gumovsky, A.V. Martynov, O.M. Kovalchuk

RESEARCH ACHIEVEMENTS. SOCIAL SCIENCES AND HUMANITIES

The NAS Section of Socio-Humanities obtained important results in studying highly relevant issues of the state establishment and social progress of Ukraine.

A team of scholars of Academy institutes — I.F. Kuras Institute of Ethno-National Studies, H.S. Skovoroda Institute of Philosophy, M.V. Ptukha Institute for Demography and Social Studies, the Institute of Economics and Forecasting, the Institute of Problems of Nature Management and Ecology, the Institute of Sociology, G.M. Dobrov Institute for S&T Potential and Science History Studies — under the guidance of NAS Academician S.I. Pyrozhkov, Vice-President of the NAS of Ukraine, prepared the *National Report "Ukraine's Civilizational Choice: the Paradigm of Understanding and the Strategy of Action"*.

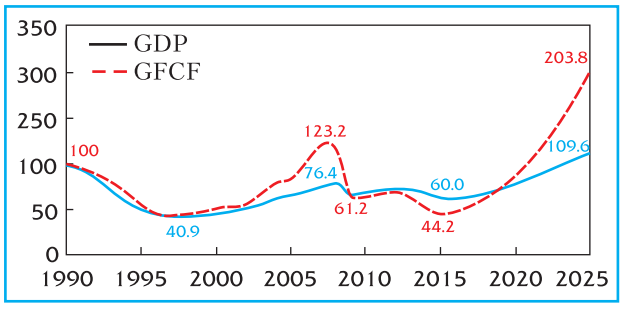
For Ukraine as a young independent state in search for the models of adaptation to modern global challenges and striving for establishment as an equitable subject of international relations, of great importance is the problem of civilizational choice, as the identification of the main line of country's development depends on it. The experience of living in the space of "soviet civilization" and that of state-formation processes of the modern epoch convinced that that the ideology and politics which are not supported with the resource base and the real dialogue of authorities with people sooner or later lose their system-forming function, leaving behind them social entropy.

Relying on modern theoretical concepts and analysis of political practices, the report **investigates the prerequisites, current status and prospects of implementing the new stage of Ukraine's civilizational development** in the context of today's socio-political change, identifies risks and possible dangers for the Ukrainian State and national identity. It specifies strategic areas of implementing the project of Ukraine's civilizational development, the legislative, political and administrative support for it, reforming the socio-cultural, educational and scientific spheres.

The pivotal idea of the National Report is that the true civilizational choice of the nation rather than its imitation can be made by people through the nationwide discussion and profound understanding of the civilizational development vector by all citizens. The discussion of today's crisis situation in Ukraine, Russia's aggression against our state, which is caused, among other things, by the civilizational choice, are to become the key issues of the discussion. The nation is to discuss, comprehensively assess and realize possible consequences of the decisive civilizational turn.

Scholars of the NAS Institute of Economics and Forecasting systemically revealed the **specific features of the interaction of basic factors affecting the acceleration of Ukraine's economy rise** in terms of major macro-sectors (real, budget, money-and-credit, and foreign economic ones) in the present development of the global and national economy. Relying on that

NAS Academician S.I. Pyrozhkov, Vice-President of the Academy, presented the National Report "Ukraine's Civilizational Choice: the Paradigm of Understanding and the Strategy of Action" at the NAS Presidium meeting on 29 March 2017



Projections of the gross domestic product (GDP) and gross fixed capital formation (GFCF) indices of Ukraine till 2025 if the dynamic model of economy development is realized (1990 = 100). The source: calculations relying on the data of the State Statistics Service of Ukraine, prognostic calculations of the State Institution "Institute of Economics and Forecasting of the NAS of Ukraine"

and employing integrated models of economic development in conditions of unstable economic conjuncture and the model instruments of swift testing of situational macro-environment changes (risk factors), scientists assessed growth trends and elaborated a target scenario of the dynamics of Ukraine's main macroeconomic indices till 2025.

NAS Acad. Valeriy M. Heyets, NAS Corr. Memb. Mariya I. Skrypnychenko, Serhiy O. Korablin, Iryna V. Kryuchkova, Yaroslav A. Zhalilo, Irina V. Zapatrina, Svitlana S. Shumska, Tetiana B. Lebeda, Lidiya I. Kuznetsova, Serhii M. Shvets, Hanna Yu. Yatsenko

Researchers of this institution also justified the **methodological approach to evaluating the potential budget revenues generated by value-added tax**; its employment allows an increase in the efficiency of VAT administration and, respectively, a reduction in the level of shadow economy in Ukraine. Assessments of the deficiency of VAT revenues to the budget of Ukraine (from 33 to 45 % of potential incomes or 5—8 % of the GDP in 2012—2016) were made, which are the highest figures as compared to the countries of the European Union. That results from both significant budget losses through tax allowances, gaps in income administration and VAT evasion by businesses.

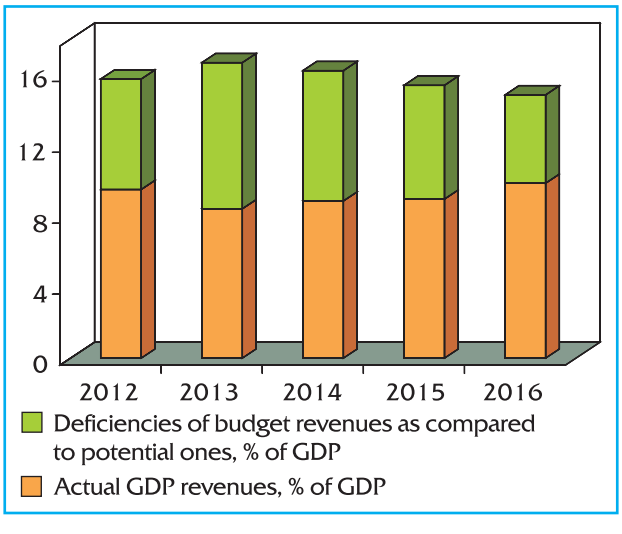
I.O. Lunina, O.S. Bilousova

Scholars of the M.V. Ptoukha Institute for Demography and Social Studies of the NAS of Ukraine, using various information sources, **assessed the effect of socio-economic and socio-demographic factors on people's living conditions**. They substantiated the major patterns and key transformations of people's living conditions development. In particular, they determined the degree of subjective factors' effect on the development of living conditions and formation of housing standards, revealed the relation of demographic processes and living conditions across certain groups of countries and those in major cities of Ukraine. It was proved that of a large variety of social interactions only those that lead to transformations in person's outlook and modify their needs are determining in terms of housing development. Scholars calculated the coefficient of housing accessibility in large cities of Ukraine with a view to substantiating the prospects of housing policies.

Ludmila M. Cherenko, Svitlana V. Poliakova, Vladyslav S. Shyshkin, Viacheslav S. Zaiats, Yurii L. Kohatko, Anna G. Reut, Yulia A. Klymenko, Maryna V. Ponomarenko

Historians completed the **multi-volume popular-science presentation of the history of Ukraine — "History Uncensored"** (Kharkiv: "Family Leisure Club" Publishers, 2016—2017).

The project was implemented through the initiative of: the Institute of History of the NAS of Ukraine, the Ukrainian Institute of National



Estimates of GDP budget revenue deficiencies in 2012 – 2016

Remembrance, Taras Shevchenko National University of Kyiv, the "LIKBEZ. Historical Front" educational resource and the Kharkiv publishers mentioned. The core of the team of authors were scholars of the NAS Institute of History. The aim of the publication was to present **current ideas of the past of Ukrainian people and the territory where they live**.

All in all, 10 books of the series were published: "Birth of the Country. From a Region to the State. The Name, Symbols, Territory and Borders of Ukraine", "The Shadows of Ancestors Recalled. From Sklavins to Rusyns: Primordial Ukraine, Rus and Origins of Ukrainians", "Knights of the Wild Fields. With Plough and Musket: Ukrainian Way to the Black Sea", "Rus "after Rus". Between the Crown and the Mace. Ukrainian Lands from the Rus Kingdom to the Zaporizhia Forces", "Princes and Hetmans of the Whole Rus. "Sabre is Our Right". "Ups and Downs of the Cossack State 1648–1783", "In the Claws of Two-Headed Eagles. Formation of the Modern Nation. Ukraine under Scepters of the Romanovs and the Habsburgs", "Battle for Freedom. The Victory through Defeats. Ukraine in the Wars and Revolutions of 1917—1921", "Soviet Ukraine. Illusions and Catastrophes of the "Communist Paradise", "From Reichstag to Ivodsima. In the Flames of War. Ukraine and Ukrainians in World War II", "The Battlefield is Ukraine. From "Lords of the Steppe" to "Cyborgs". War History of Ukraine from Old Times till Now".

The edition is distributed in the regions of the South and East of Ukraine, in the zone of the Antiterrorist Operation, in military units, and through bookshops and the library network. The 10-volume series "History Uncensored" has become the bestseller on the Ukrainian market of history literature.

Art scholars published **the first volume of "The History of Ukrainian Theatre in Three Volumes"** (Editor-in-Chief — NAS Academician Hanna A. Skrypnyk, Leading Editor — NAS Corresponding Member Igor M. Yudkin).

This work addresses the origin, establishment and development of Ukraine's theatre art as a special field of its national culture. It depicts the history of the theatre in the context of national culture as a dynamic integrity, in particular, the relations of the theatre art with the history of literary genres, primarily, drama.

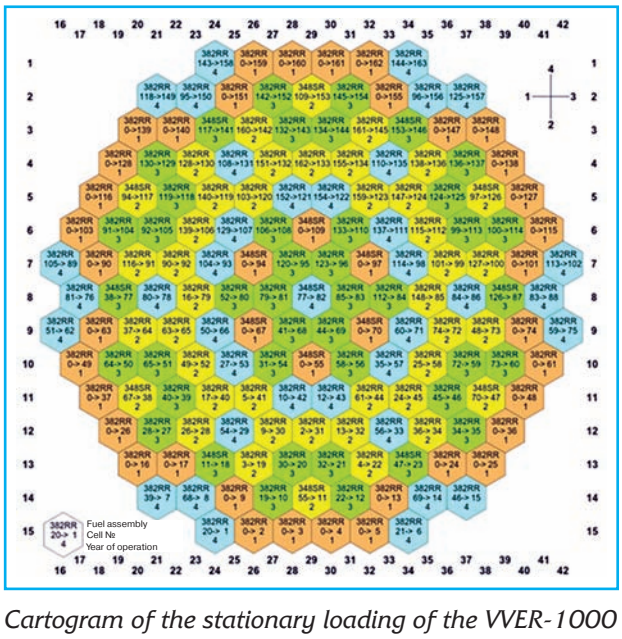
The volume elucidates a very wide range of events in the history of Ukrainian theatre from its initial manifestations in the prototheatrical forms of folklore before 1914, when it was not only definitely established as a full-fledged, mature national institution but achieved vanguard positions of the world theatre art as it entered the peer dialogue with other national theatre cultures.

For the first time ever, such unique achievement of the Ukrainian baroque culture as school drama was analyzed in detail, the significance of its artistic system was revealed, as well as its influence on other national theatrical traditions, special features of the national theatre establishment in the first half of the 19th century were demonstrated. The book follows in great detail the dramatic collisions of the rapid winning of the worldwide fame by the Ukrainian "coryphaeus theatre" in the late 19th century and re-create its chronicle in detail; it was proved for the first time that in the European "new drama" on the turn of the 19—20th centuries the Ukrainian theatre was on equal terms with the most advanced artistic achievements and paved the ways for the art of the future.

S&T support for using the *Westinghouse* nuclear fuel at Ukrainian NPPs

To ensure the independence of electric power generation by Ukrainian NPPs from a single nuclear fuel producer, specialists of the *Nuclear fuel cycle* R&D facility operating under the Kharkov Institute of Physics and Technology in 2017 provided R&D support to the activities of the State Enterprise "Energoatom" NAEC for a more extensive use of *Westinghouse Sweden Electric* fuel.

In particular, taking into account the performance capability of the fuel assemblies of the abovementioned alternative provider, a stationary fuel cycle for Ukrainian NPP power units with *VVER-1000* reactors was developed. The safety of switching reactors' cores to that cycle was validated. A strategy of switching to the *Westinghouse* fuel was elaborated and transition reactor cores were designed, which allowed a transition fuel cycle to be implemented; it involved a simultaneous use of fuel assemblies from different providers in nuclear reactors.



Cartogram of the stationary loading of the VVER-1000 reactor core with TB3-WR fuel

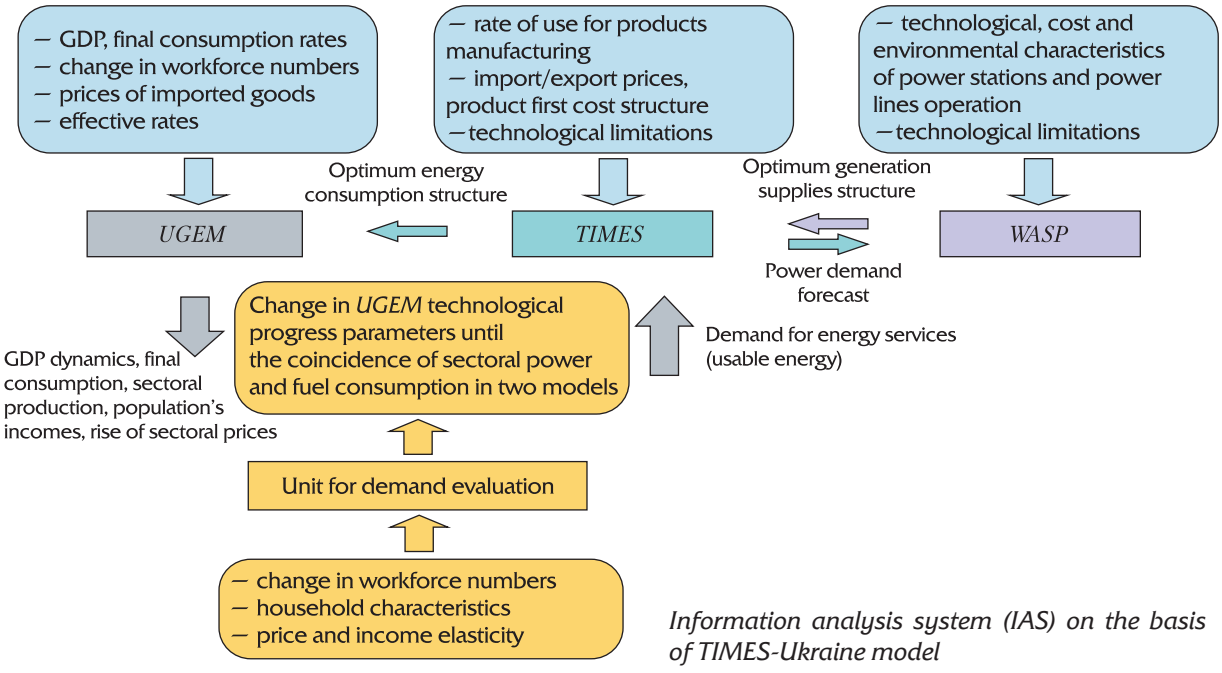
The transition and stationary fuel cycles were checked for compliance with national and international safety requirements for NPP reactor cores. State-of-the-art technologies of conformity with safety criteria were employed to substantiate the possibility of using an alternative nuclear fuel, and every aspect of reactors' core functioning was analyzed, namely, their mechanical, thermohydraulic and neutron physics components. In particular, the conformity to the criteria of the mechanical compatibility of heat-generating assemblies in reactor's core with the transport and technological equipment was analyzed and demonstrated, alongside their conformity to the national nuclear safety criteria during assembly transportation and technological operations, as well as their storage in cooling ponds.

The data on the safety of using the *Westinghouse* fuel underwent the state expert examination and were approved by the State Nuclear Regulatory Inspectorate of Ukraine. As a result, today six power units of Ukrainian NPPs successfully use mixed reactor cores with fuel from two providers.

Akif Abdullayev, Volodymyr Baydulin, Oleksandr Zhukov, Andriy Kostromin, Volodymyr Krasnorutskyy, Grigory Kulish, Oleksiy Sleptsov, Sergiy Sleptsov, Sergiy Soldatov, Sergyi Maryokhin, Sergyi Ryabchykov, Vitaliy Chernukha

Information analysis system for forecasting the energy sector development

The NAS Institute of Economics and Forecasting developed an applied information analysis system (IAS) for forecasting the energy sector development; it is used both for scientific research and for preparing state program



Information analysis system (IAS) on the basis of TIMES-Ukraine model

documents. The available modelling instruments of the system enable specialists to integrate particular forecasts of aggregate macroeconomic indicators; relying on those, make projections of the demand for energy services; optimize the energy balance structure, with a view to meeting long-term demand; and assess socio-economic and environmental impacts of implementing a wide range of energy scenarios.

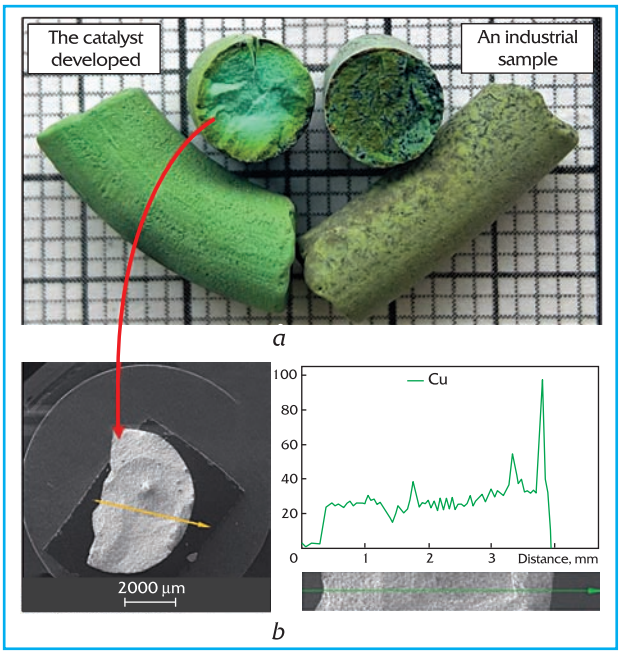
The IAS advantages are the possibility to present detailed performance characteristics of the technologies of energy resources production and consumption; analyze measures of energy and environment policies; forecast the emissions of greenhouse gases and pollutants produced by fuel utilization. Besides the *TIMES*-Ukraine basic linear quasidynamic optimization model, the IAS also includes a dynamic computational general equilibrium model with the *UGEM* extended power unit and an optimizing power sector model of the *WASP* type for verifying the structure of generation supplies under the scenario-imposed performance limitations.

R.Z. Podolets, O.A. Diachuk, M.S. Chepeliev, B.S. Serebrennikov

Nanostructured catalyst for neutralizing nitrogenous toxic waste in gaseous release of nitric acid production

Nitric acid production is accompanied by a large amount of gaseous release containing toxic nitrogen oxides (NO_x). The most effective and environment-friendly method of their neutralization is the process of selective catalytic reduction (SCR) of NO_x with ammonia (NH_3), which is widely used in the chemical industry of Ukraine. The *ABK-10* granulated catalyst is also used for neutralization but its disadvantages are the content of expensive and highly toxic vanadium compounds and the impossibility of the total conversion of ammonia, whose residual level does not meet today's environmental standards.

The NAS L.V. Pisarzhevsky Institute of Physical Chemistry (IPC) developed a nanostructured aluminum-copper-zinc (ACZ) oxide catalyst with the regulated active layer thickness, which ensures total conversion of both NO_x and residual NH_3. The pilot batch of the ACZ catalyst was produced by the state enterprise "Catalysis and Ecology" operating under the



The developed (10 % CuO – ZnO – Al_2O_3) and industrial (14 % CuO – ZnO-Al_2O_3) samples of aluminum-copper-zinc catalysts for selective catalytic reduction of nitrogen oxides with ammonia in nitric acid production: a – grain's general view; b – copper distribution with grain depth in the new skin-type catalyst shown by the energy dispersive analysis

IPC of the NAS of Ukraine. The trials carried out with the industrial nitric acid production unit of the Ostchem Holding showed that this new catalyst, in terms of its activity and selectivity, is much superior to all known counterparts, the *ABK-10* included. The high activity of the ACZ catalyst is due to active components localization in the subsurface layer of its grain, forming the skin-like structure, which is the most accessible one for decontamination.

The technological process of producing the developed ACZ catalyst with adjustable active layer thickness was deployed at the *Katalizator* state plant (Kamianske town) and catalyst production was launched.

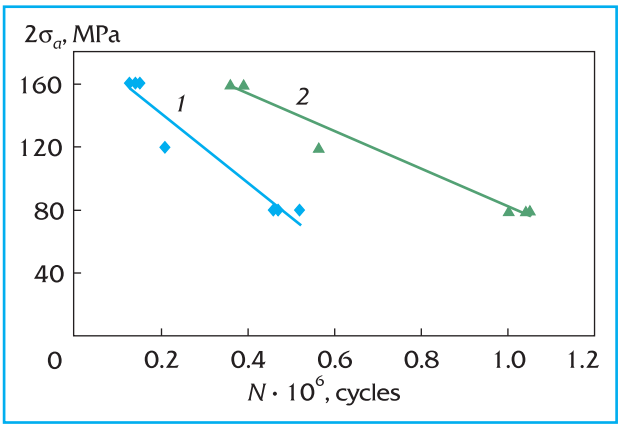
S.O. Soloviev, P.I. Kiriienko, N.O. Popovych, O.V. Larina

New technological process for treatment of welded joints

In the manufacturing of welded structures, one of the most energy-intensive operations is the postweld heat treatment, which is carried out to reduce residual stresses in welded joints, improve the mechanical properties and other performances of the products. With a view to that, recently, the search for new technologies of postweld treatment of metal structures which can be an alternative to thermal tempering has been continued.

The specialists of the E.O. Paton Electric Welding Institute developed a new process of treatment with high-density electric current and created the respective equipment. A series of experimental studies carried out using the proposed technology for AMg6 aluminum alloy specimens showed that this electrodynamic treatment produced a significant effect on the structure of treated metal and enabled specialists to lower residual stresses in welded joints 2–3-fold, increase their resistance to fatigue and brittle fracture, and to reduce the deformation of buckling in thin-walled structural elements.

Employing the technology and equipment developed, the electrodynamic treatment of welded joints of ship-building structures was carried out at Ukrainian shipbuilding enterprises and at the ship-building plant in the Guangdong Province (PRC). Besides, the electrodynamic treatment of repair welds of the intermediate body of the aircraft engine was



Fatigue test results for samples of AMg6 welded joints 2.5 mm thick ($2\sigma_a$ is cycle amplitude, N is the number of cycles before fracture): 1 – an intact sample, 2 – the sample after the electrodynamic treatment

carried out at the State-owned Enterprise "Plant 410 of Civil Aviation". This will provide an increase in their operational reliability and service life.

L.M. Lobanov, Mykola O. Paschyn

A technology to support workings in zones of high-amplitude geological disturbances

Distinctive features of Ukrainian coal mines are difficult mining and geological conditions as well as numerous tectonic disturbances surrounded by zones where rocks have damaged structure and low strength. During mining operations, these areas present serious danger due to possible roof rock falls, water inflows and gas outbursts. To avoid these dangerous phenomena, researchers of the N.S. Polyakov Institute of Geotechnical Mechanics of the NAS of Ukraine developed a unique technology for supporting mine workings in zones of high-amplitude geological disturbances and, in cooperation with specialists of the DTEK Company and the National Mining University, implemented this technology in extremely complicated mining and geological conditions of the *Samarska* and *Heroiv Cosmosu* mines during mining operations in the 'Bohdanivskyi Fault' geological disturbance zone.

The technology relies on a patented method of roof anchoring in mine workings, which consists in the use of intensified schemes for steel-polymer and injection anchors setting in areas with geological disturbance. A step-by-step intensification of the anchor setting while developing workings in zones of tectonic disturbance gradually increases the monolithic nature of rocks in this area, neutralizes the negative effect of the tectonically disturbed zone, and minimizes the filtration permeability of the rocks. That can prevent gas and water infiltration into the working space when there are gas-saturated and water-flooded rocks around the mining area, which significantly reduces the risk of rock roof fall and water and gas outbursts and helps improve workings stability in the zone of tectonic disturbance.

In order to validate parameters for the system of roof-supporting bolting, which will provide intensification of mining operations, with the account being taken of safety and resource-saving requirements, a numerical model of the block-structured rock massif with workings supported by steel-polymer anchors was developed. The advantage of this model is that it takes into consideration the effect of cracks in the rock mass around the tunnel on the deformation process and permits an investigation of displacements of the rock blocks formed by cracks and the effect of the anchor spatial location parameters on production stability in the block-structured massif. Besides, in order to check the state of the tunnels, a monitoring and observation system was developed, which makes it possible to regularly adjust the roof-supporting structure.

The improved tunnel stability and reduced water inflow and methane emissions into the workings due to employing this technology for roof supporting in the areas of high-amplitude geological disturbances will ensure timely preparation of mining sites, boost coal production, help improve safety and create proper working environments for miners.

A.F. Bulat, O.P. Krukovskiy

The stability of a mine working with the frame anchoring system during mining operations in the zone of high-amplitude geological disturbances

Forecasting local erosion of river beds and banks

The urgency of the problem of forecasting the local erosion of river beds and their banks behind river features produced naturally (such as ridges of river sediments or trees fallen into the rivers, etc.), results from numerous river-bank destruction cases behind these obstacles. Some of them caused catastrophic destroying of road infrastructure, recreational and other facilities.

Of special relevance is the problem of local erosion occuring in rivers of the Carpathian region; however, it is becoming increasingly important for the rivers of the plains part of Ukraine as well, due to significant anthropogenic river bed changes which were caused by hydro engineering construction and other activities within river basins.

Researchers of the Institute of Telecommunications and the Global Information Space developed a method for predicting the local erosion of river beds and banks that is based on computer imitation modelling.

Their research showed that of decisive importance for predicting local erosions on the basis of natural riverbed features is the knowledge of the types of riverbed processes in the relevant river sections, of current geospatial data concerning the river hydromorphology (in particular, riverbed width on the site of obstacle, river depth, hydraulic slope, average water current velocity, the weighted average diameter of sediment particles). Imitation modelling also requires the information on the geometry of river formations adjacent to the shores that deviate from the shores downstream at a certain angle. Besides, satellite images could serve, with a sufficient accuracy, as the source of computational geospatial data. Different types of fluvial-morphological process are also determined, relying on the Earth remote sensing data.

The imitation modelling of the kinematics of turbulent flow behind a bottom barrier and of the strength of bottom resistance, which characterizes the intensity of turbulent flow development, was performed for the most common types of fluvial-morphological processes (incomplete, limited, free meandering, focal type) occurring in rivers of the Ukrainian Carpathians. The boundary (minimum possible) angles of deviation of obstacles from river banks downstream were established. The intensification of the local river erosion is expected there.

The left bank of the Teresva river near Neresnytsya village destroyed during floods on March 4 – 8, 2001

The results of computer imitation modelling were verified as exemplified by the rivers of the Ukrainian Carpathians, whose hydromorphology is well-studied. Relying on the method developed one can promptly detect river sections where local erosions of river beds and banks could be very likely during floods. The necessary measures taken in proper time due to the forecasts made will prevent emergencies resulting from such processes.

O.M. Trofymchuk, D.V. Stefanyshyn

Manufacture of medical dressings for wounds and burns treatment

Scientists of the NAS Institute of Physics developed a technology for serial production of medical dressings for wounds and burns treatment based on irradiation crosslinked hydrogels and received a patent for the method of their irradiation cross-linking with powerful pulses of relativistic electrons. These dressings effectively anesthetize the wound, cooling it due to high thermal capacity of water and its gradual evaporation, protect against external in-

Examples of employing the irradiation crosslinked hydrogel as a medical dressing

fection and mechanical effects, they accelerate healing by keeping the wound moist, letting oxygen and drug solutions in and absorbing physiological discharge. Hydrogel dressings are removed painlessly, due to their transparency they permit wounds to be controlled and irritations and allergies to be avoided owing to their biological inertness.

A pilot line for small-batch dressing production was launched; it can manufacture up to 1000 products monthly. Their cost is approximately one half of the price of imported counterparts and their quality meets the best international standards.

Several hundred trial dressings were successfully tested in the Kyiv Burn Center, the Kharkiv Central Military Hospital, Bogomolets National Medical University, Kyiv Railways Clinical Hospital № 2, "Feofania" Clinical Hospital.

In collaboration with the *RADITEX* Ltd, a business plan was developed to launch mass production of medical dressings of irradiation crosslinked hydrogels, which is based on electron accelerator of the NAS Institute of Physics and the procedure of getting permission for employing these products in medical practice under the *HYDROBINT* trademark was started.

V.B. Neimash

Polysorb^{plus} enterosorbent for treatment of acute intestine infections, food poisonings and other diseases

O.O. Chuiko Institute of Surface Chemistry (ISC) of the NAS of Ukraine developed and implemented the *Polysorb* plus basic enterosorbent. It can be used for effective toxin removal from the body, improvement of its adaptogenic properties, treatment of acute intestine infections, food poisonings and other diseases accompanied with diarrheal syndrome, as well as virus hepatitis, alcohol intoxications etc. The production of this new sorbent was based on the procedure of silica hydro densification which developed at the ISC. That enabled its scientists to get rid of such disadvantages of highly dispersed silica as its low bulk density and dust formation during production and using without the deterioration of its therapeutic properties. The necessary licenses were obtained for this product, including the certificate of the Health Ministry of Ukraine, technological specifications were registered, advertising information and barcodes developed.

To produce the enterosorbent, the ISC created an experimental facility for silica structural modification and finished product packaging. The product is manufactured by the

The site for silica structural modification and finished product packaging

ISC Dzhankoy—Sivash and by the "MKM НАЙНЕХ" enterprise (under agreement). The monthly production capacity is 200 kilograms, which means 100,000 doses.

Now new forms of the *Polysorb*^{plus} enterosorbent are under development; they are intended for facilitating blood, lymph and liver detoxication and could be used as hemostatic and wound-healing drugs for treatment of infected wounds.

V.V. Turov, T.V. Krupska, M.T. Kartel, A.P. Golovan

Creation of new plant varieties

NAS institutions are involved in creating new varieties of cereal, fruit, industrial, spice crops, decorative, medicinal and energy plants. In particular, in 2017, plant breeder scientists of M.M. Hryshko National Botanical Garden of the NAS of Ukraine created and patented six varieties of peony, four varieties of garden chrysanthemum, four tarragon varieties, and one variety of rose. Six plant varieties promising for bioethanol and biodiesel production were brought into agro industrial production.

Significant scientific and practical results for Ukrainian economy and agribusiness were obtained by biology scientists of the NAS Institute of Plant Physiology and Genetics (IPPG), which is well known to agricultural producers for its high-yield cereal varieties and hybrids, in particular, soft winter wheat and maize. Nearly every year, scientists improve these varieties and create new ones. In 2017 alone, six winter wheat varieties were created; their novelty was proved by author certificates and patents, they were recognized as breeding achievements and included in the State Variety Register of Ukraine.

The high level of research and fundamental approach to creating new varieties of winter wheat at this institution is proved by the fact that even the heaviest summer drought in the last forty years did not harm the plants — under hard weather conditions the grain yields of 80—100 centners per hectare were harvested.

NAS Academicians B.E. Paton and V.V. Morgun sharing opinions about ensuring the food security of the nation

To provide extensive targeted information for large and small agricultural producers, scientists and representatives of relevant power bodies about IPPG's novel developments and varieties, the Institute annually organizes the international scientific and practical conference "Field Day", which is hosted by its agricultural trial production facility. Due to that the Institute is able to steadily increase the number of license agreements to grow agricultural plant varieties of IPPG breeding. As of today, the action of 3149 licenses is supported; those are provided with high-quality pedigree seed. As a result of that work, one third of all bread in Ukraine is produced from IPPG's grain varieties.

Now scientists have started fundamental research which could result in producing radically new varieties of winter wheat and its wild cousin — the spelt; they will have innovative properties for food production. The starting lines of extra soft black- and white-grained confectionery wheat have already been created, as well as lines with high amylose content in the grain, the increased content of protein and key chemical elements (Fe, Zn, Mn).

V.V. Morgun, O.I. Rybalka, D.B. Rakhmetov, V.F. Gorobets, Yu.V. Buidin

The international scientific and practical conference "Day of the Field". Crops survey

"Ryzobofit" gel preparation for improving soya growth and productivity

Today's biotechnology has gained significant experience in searching for microorganism strains with useful properties and in developing technological regulations to produce and use agricultural preparations based on them. Biopreparations of nitrogen-fixing microorganisms both improve plant productivity and increase the complete protein content in them. Now one of the most important tasks is to create user-friendly forms of biopreparations and develop technologies for their industrial production.

Researchers of the D.K. Zabolotny Institute of Microbiology and Virology of the NAS of Ukraine developed "Ryzobofit" — a novel gel preparation based on soya nodule bacteria *Bradyrhizobium japonicum* M8. They found that the use of the "Ryzobofit" gel preparation ensures the highest nitrogen-fixing activity of *Glycine hispida* Max. — *Bradyrhizobium japonicum* symbiotic systems. In collaboration with the "Cherkasybiozakhyst" research-and-production association they obtained a trial batch of the preparation and recommended it for serial production.

Using the "Ryzobofit" bacterial gel preparation in soya growing: top – after inoculation with Br. japonicum M8 (gel form), bottom – without inoculation

It was found that the conditions for plant growth and development were the best in those experiments where seeds were first treated with the "Rhyzobofit" gel preparation and "Harness" soil herbicide was applied immediately after sowing. Employing the technology of soya growing with the use of the "Ryzobofit" gel preparation resulted in a significant improvement of plant growth, development and yield. Three host businesses – "ZETO" private enterprise, "Skomoroshkivske" Ltd. and "Skomoroshkivske" farm – in the Vinnytsia oblast obtained the average rise in productivity of 2.46 tons per hectare, their profitability reached 109 % and the net cost of 1 ton of grain was ₴5025 per hectare.

The application of the "Ryzobofit" gel preparation ensures high soya yields, an increase in soil fertility, it also reduces the amount of nitrogen mineral fertilizers applied.

V.P. Patyka, L.A. Pasichnyk, H.B. Huliaieva, V.V. Krut, T.T. Hnatiuk, N.V. Zhytkevych

IMPORTANT EVENTS

The meeting of the President of Ukraine with the President of the National Academy of Sciences

On 7 April, a meeting of P.O. Poroshenko, the President of Ukraine, with Academician B.E. Paton, the President of the NAS of Ukraine, was held. A number of important issues were discussed, among them being the nation-wide celebration of the 100th anniversary of the National Academy of Sciences of Ukraine, the reformation of Academy's activities, its work towards providing scientific support to solving important country's problems, in particular R&D for strengthening Ukraine's defense potential and security, involving and retaining young researchers in the NAS of Ukraine, providing funding and proper logistics for it.

Academician B.E. Paton informed the head of state about the major achievements and problems of the National Academy of Sciences, stressed that **scientific support to solving important problems of the nation had always been and remained, alongside the advancement of basic research, one of the top priorities of NAS activities**, and put forward the proposal concerning organizing in 2018 official celebrations to mark the 100th anniversary of the Academy, in view of its significant contribution to the development of national and world science, as well as scientific support to the economic and cultural progress of Ukraine.

P.O. Poroshenko supported this proposal — on 18 May 2017 he **signed the Decree of the President of Ukraine "On celebrating the 100th anniversary of the National Academy of Sciences of Ukraine"**. It is important that the 39th session of UNESCO General Conference decided to include the 100th anniversary of the National Academy of Sciences of Ukraine to the calendar of memorable dates to be celebrated by UNESCO.

Ukraine's President P.O. Poroshenko and NAS President B.E. Paton during their meeting on 7 April 2017

Establishing the National Board of Ukraine on the Development of Science and Technology

The Cabinet of Ministers of Ukraine set up the National Board of Ukraine on the Development of Science and Technology in April 2017 and approved its membership in August. This board, which is a continuing advisory body under the Government, was established to ensure the effective interaction of the representatives of scientific community, executive power bodies, and the real sector of Ukraine's

The first session of the National Board of Ukraine on the Development of Science and Technology on 16 January 2018

economy in forming and implementing the state policy in the sphere of S&T activities.

The National Board consists of the Scientific Committee, involving 24 scholars, and the Administrative Committee, which also involves 24 persons, among them being the heads of all national sectoral academies of sciences, ministries and agencies concerned with the sphere of science and technology. The Chairman of the National Board is V.B. Groysman, the Prime Minister of Ukraine.

According to Academician B.E. Paton, the President of the National Academy of Sciences, **the most important mission of the National Board is to elaborate an integral and effective strategy of the S&T development of the country**, which would be coordinated with other governmental strategic documents. Its activities are to give a new impetus to the development of state S&T policies, make essential improvements to the situation in Ukrainian science.

The first session of the National Board of Ukraine on the Development of Science and Technology was held on 16 January 2018. It considered, among other issues, **launching the work of the National Research Foundation of Ukraine** — a major source of grant support for R&D.

Junior Academy of Sciences got the UNESCO Center Status

Junior Academy of Sciences (JAS) is a unique joint activity of the NAS of Ukraine and MES of Ukraine aimed at **discovering gifted schoolchildren and involving them in science**. Leading scientists of Academy institutions consistently take part in the most varied activities for JAS pupils in the areas of natural, social sciences and humanities.

In July 2017 the Cabinet of Ministers of Ukraine approved the draft Agreement between the Government of Ukraine and the United Nations Educational, Scientific and Cultural Organization (UNESCO) to set up on the basis of the Junior Academy of Sciences a category 2 National Center. The agreement was signed in December but somewhat earlier,

S.O. Dovhyi, NAS Corresponding Member, President of Junior Academy of Sciences, speaking at the session of UNESCO Executive Board on 13 October 2017

on 13 October 2017, **the Executive Board of UNESCO unanimously supported granting the Junior Academy of Sciences the status of Category 2 UNESCO Center**. UNESCO provides this status to organizations that proved their cultural and intellectual value for the world, can share their experience due to the system of their work, the high quality and depth of their research.

Now JAS, working under the auspices of UNESCO, will help other countries develop scientific work and involve talented young people in it. Irina Bokova, then UNESCO Director-General, noted: "The support of children's creative abilities starting from their school years is an extremely important element of today's education. We are interested in extending the experience Ukraine has in this area, first of all, to the regions where education has been thriving recently".

The visit of Nobel laureate Harald zur Hausen

On 8 September 2017, Harald zur Hausen, Nobel Prize winner in physiology and medicine (2008), professor emeritus of the German Center for Cancer Research (Heidelberg, FRG) visited the National Academy of Sciences of Ukraine. He had a meeting with Academician V.G. Koshechko, Vice-President of the NAS of Ukraine, Head of the NAS Section of Chemical and Biological Sciences, Academi-

Nobel laureate Harald zur Hausen (fourth from the left) during his visit to the National Academy of Sciences of Ukraine

cian S.V. Komisarenko, Academician-Secretary of the NAS Department of Biochemistry, Physiology and Molecular Biology, Director of Palladin Institute of Biochemistry of the NAS of Ukraine, NAS Corresponding Member S.O. Dovhyi, President of Science Center "Junior Academy of Sciences" of the NAS of Ukraine and MES of Ukraine.

During the meeting, Academician V.G. Koshechko informed the esteemed guest on the history, status, tasks and structure of the Academy. It was stressed that **Ukrainian—German collaboration is an important component of NAS international scientific and R&D activities**. Addressing Professor H. zur Hausen, Academician V.G. Koshechko stressed: "The National Academy of Sciences of Ukraine deeply appreciates your personal contribution to the advancement of the world science, first and foremost, in the field of physiology and medicine. It is due to your research that a number of novel vaccines were developed and their production launched. They can prolong the life of cancer patients whose disease is caused by certain types of human papillomavirus" and **handed to his foreign colleague the diploma of the Doctor *Honoris causa* of the National Academy of Sciences of Ukraine**.

Thanking for the high honor, Professor H. zur Hausen spoke about scientific research of cancer in which he was involved and expressed his hopes for meeting Ukrainian scientists on international research sites and a closer collaboration between Ukraine and the FRG in science.

Launching a new budget-financed NAS program "Support to the development of priority areas of scientific research"

During the preparation of the 2018 draft State Budget the Government supported the joint initiative of the NAS and the Finance Ministry as to starting in the NAS a new budget-financed program "Support to the advancement of priority lines of scientific research". The funding of this program — amounting to ₴500.0 million, was approved by the Law of Ukraine "On the 2018 National Budget of Ukraine".

The finance for the new budget-supported program is allocated to support scientific research in top-priority areas, the projects of the utmost importance for the state, as well as R&D products with a high degree of readiness, including those intended for the national security and defense, for procurement of new equipment and upgrading of the available one, for support to talented young researchers, maintenance of joint international projects and membership in international scientific organizations. The targeted and addressed support will be variable and provided exclusively on the basis of the results of evaluating the efficiency of research institutions' activities with the new procedure adopted by NAS Presidium in March 2017 and ratings determined in the process of optimizing the network and inner structure of the institutions, taking into account the activity of their research work, scientometric indicators and the efficiency of their individual subdivisions, as well as the results of competitive selection of scientific and R&D projects, including projects proposed by young scientists, and collaborative projects with international scientific organizations.The actual implementation of the new 2018 budget-supported program is to be started after the Cabinet of Ministers approves the procedure of spending the funds envisaged by the State Budget for the National Academy of Sciences of Ukraine to support the development of top-priority research areas and the approval of program's registration certificate by the Finance Ministry.

ACADEMY SCIENTISTS WORK FOR ENVIRONMENT CONSERVATION

Significant efforts of NAS scientists were aimed at scientific research into sustainable development, rational nature management and environment conservation.

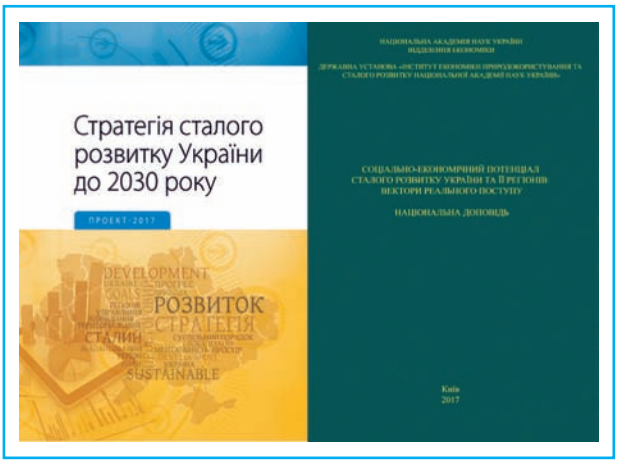
The elaboration of scientific fundamentals of Ukraine transition to the sustainable development principles was continued. A team of experts led by NAS Academician L.G. Rudenko, Director of the NAS Institute of Geography, with the support from the United Nations Development Programme in Ukraine and the Global Environment Fund prepared a draft Strategy of Ukraine's Sustainable Development until 2030 and the National Action Plan for 2017—2020 as to its implementation. The proposed draft Strategy is a framework document that will identify strategic lines of the long-term development of Ukraine. Besides, the NAS Institute of Nature Management and Sustainable Development Economics presented the National Report "Socio-economic potential of the sustainable development of Ukraine and its regions: vectors of actual progress".

NAS specialists were actively involved in developing the plan of measures to implement the concept of enacting the state policy in the sphere of climate change until 2030. The result of that work was the adoption of the plan by the Cabinet of Ministers of Ukraine in December 2017. The plan envisages a systemic approach to elaborating the scientific basis for the activities in the sphere of climate change, coordinating it with the legislation and legal acts in other socio-economic spheres, fulfilling new tasks for the implementation of the Paris Agreement provisions.

In October 2017, through the initiative of NAS Corresponding Member V.I. Osadchyi, national coordinator of the Intergovernmental Panel on Climate Change, the Day of Information and Education on Climate Change in Ukraine and the World was held. It included a press conference "Climate change: facts, consequences and necessary actions for prevention and adaptation"; a round-table discussion "Ways to increase community awareness of climate change: the world's best practices", which was attended by representatives of the stakeholders; a scientific workshop on IPCC activities and opportunities for collaboration with Ukrainian scholars in preventing climate change and minimizing its impacts in Ukraine.

In accordance with the results of the session of the NAS Scientific Board for Forest Research and Forestry, held on 25 September 2017, proposals on the urgent measures to deal with the drying out of coniferous forests in Ukraine were sent to Prime Minister V.B. Groysman. This problem has already assumed the signs of emergency and is a cause of a deep concern of scientists and public. To implement the respective order of the Cabinet of Ministers, the Ministry for Agriculture Policy of Ukraine is now working towards introducing amendments to the sanitary regulations in the forests of Ukraine.

Members of the National Committee of Ukraine of the UNESCO "Man and the Biosphere" (MAB) Programme, which operates under the NAS of Ukraine, coordinated the work on



Press conference "Climate change: facts, consequences and necessary actions for prevention and adaptation"

preparing answers to the remarks of the Advisory Committee for Biosphere Reserves concerning the periodic reviews of some UNESCO biosphere reserves in Ukraine. It should be noted that the periodic reports of biosphere reserves "Ascania Nova", the Carpatskyi and Shatskyi ones, and the "Danube Delta" Romania—Ukraine transborder reserve were approved by the International Coordination Council of the UNESCO MAB Programme. That way, the reserves mentioned were recognized as such that meet the criteria of the UNESCO World Network of Biosphere Reserves and proved their rights to be members of that network. Besides, the nomination form for the new "Roztocze" Ukraine—Poland Transborder Reserve of UNESCO was elaborated, harmonized and submitted to the MAB Programme Secretariate.

Reactor for synthesizing nanocomposite materials

Among the particular last year's S&T developments one should mention the one-stage technology for producing activated carbon from biomass waste, which was developed by the NAS Institute of Renewable Energy. It is recommended to add this activated charcoal to soil for increasing its fertility and depositing carbon. A prototype of farmer's batch-operation facility for producing bio carbon from plant waste and straw was developed. It has the capacity of 50 kilograms per 24 hours and is of the "oxygenating biomass pyrolysis, partial gasification generators" type. Similar consumer equipment with 12-litre reactor, as well as *Vohnyk 1B* and *Vohnyk 2B* gas-generator cooking stoves, were also produced. The upgrading of the equipment is planned so that it could use unprocessed raw materials.

Farmer's batch-operation facility for producing bio carbon, and Vohnyk 1B and Vohnyk 2B gas-generator cooking stoves

Scientists of the NAS Institute of Bioorganic Chemistry and Petrochemistry developed a procedure for producing granulated mixed fuels from biomass with the utilization of waste water sediments. The carbon residue of these fuels is a valuable primary product for a number of chemical processes as a high-calorific-value fuel, as well as a deoxidizer and intermediate raw material for the synthesis of silicon carbides and nitrides. The ash remaining after burning can be used in road construction. A composite based on the ash obtained after processing the sediments of the Bortnychi aeration station and plant waste was developed, and it was shown that using this substance as a part of organo-mineral fertilizers significantly improves the nitrogen and phosphorus nutrition of plants.

The NAS Institute of Environmental Geochemistry developed a procedure, manufacturing scheme and produced a laboratory facility for obtaining nanocomposites that could be used to remove organic and radioactive pollutants from industrially contaminated liquids.

The deployment of this equipment will allow an essential improvement in the efficiency of NPP wastewater treatment and in environmental safety.

Specialists of NAS M.G. Kholodny Institute of Botany developed a concept of organizing multifunctional nature conservation territories with various conservation regimes. To establish an ecological network and base biodiversity conservation on new principles, 180 major biotopes representing all types of Ukraine's natural ecosystems were selected. New principles were proposed for protected area analysis that should underlie the further eco network structure.

YOUNG SCIENTISTS

In 2017, **young scientists of NAS institutions won**: 16 Ukraine President's prizes for young scientists; 13 prizes of the Verkhovna Rada of Ukraine for the most talented young scientists working in basic and applied research and R&D, and four Verkhovna Rada scholarships for the most gifted young scientists. In April 2017 a meeting of President P.O. Poroshenko with young scholars was held; at it the head of state signed the decree "On Ukraine President's grants to support the research of young scientists in 2017". According to it, young scientists of NAS institutions received 23 grants.

100 best research projects of young scientists of the NAS of Ukraine were financed. The annual cost of one project is ₴45—135 thousand, and the total funding for the second half of 2017 amounted to ₴2,272 thousand.

NAS Presidium at its meetings in 2017 heard **scientific presentations of nine** young scientists, who in 2018 have started additional one-year research projects in line with their presentations and headed them. The funding of those projects is **₴50 thousand** for candidates of sciences and **₴70 thousand** for doctors of science.

"Naukova Dumka" Publishers **issued six scientific monographs by young scientists** under the project 'Academic book. Young scientists'. In accordance with the results of the regularly held contests, 10 research works were selected to be published in 2018.

To increase the role and responsibility of young researchers for the development of state's scientific potential, enhance their participation in scientific research and science management, extend the work with young researchers and retain them in NAS institutions, the Council of Young Scientists of the NAS of Ukraine was established. In 2017 the Council was actively involved in organizing numerous popular science events, Science Days in particular. In spring those events were held in the framework of the International Day of Plants and the International Day of Museums. Autumn Science Days were timed to the World Science Day for Peace and Development. Visitors of those activities, both children and adults, were provided with more than fifty demonstrations and master classes, several dozen fascinating lec-

Scientific publications under the project "Academic book. Young scientists" issued in 2017 by the "Naukova Dumka" Publishers of the NAS of Ukraine

Scientific presentation of O.O. Vaneyeva, Candidate of Sciences, doctoral fellow of the NAS Institute of Mathematics, at a meeting of NAS Presidium

Science is the process of learning about the world (during Science Days)

tures, as well as excursions to museums and the astronomical observatory. About twenty NAS institutions organized the events. "Science Picnics", popular-science lectures, summer schools for students of the Junior Academy of Sciences etc. were held with the active involvement of young scholars.

As of 31.12.2017, NAS institutions employed (without engineers and doctoral fellows) 2170 young scientists under 35, their positions ranging from junior research associate to chief research associate and 6 doctors of sciences being among them. They also took science management positions. If the term 'young scientist' is used as defined by the Law of Ukraine "On Scientific and S&T Activities", **2854 young scientists worked at research institutions of the NAS of Ukraine**, among them 33 doctors of science under 40. 1199 young scientists have the candidate-of-science degree.

For the fourth year running the number of young scientists in the Academy is falling. The total number of young scientists taking the abovementioned positions, as compared to 2016, fell by 7 %. The number of young candidates of sciences also decreased by 1 %. In comparison with 2013, these figures are 27 % and 15 %, respectively. That has created a critical situation with involving young people in science and could have irreversible effects.

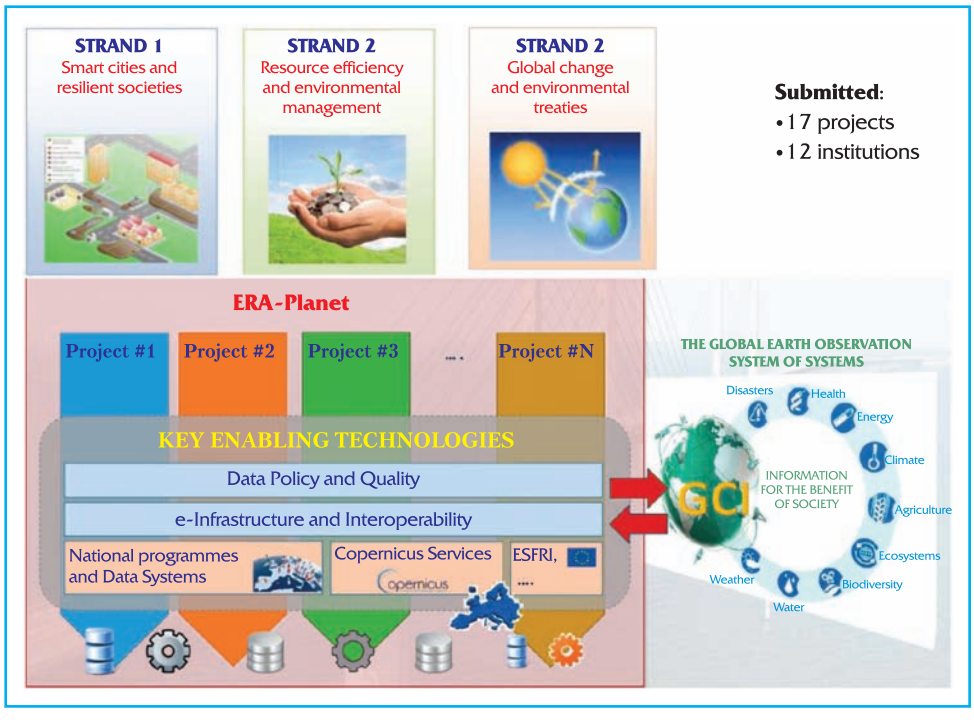
INTERNATIONAL COLLABORATION

In 2017, as before, one of the key areas of the international collaboration of the NAS of Ukraine was the **integration of its scientists and institutions into the European Research Area**. During the meeting of Academician B.E. Paton, NAS President, with Professor Peter Strohschneider, President of the German Research Foundation (DFG), a memorandum of understanding was signed. Its implementation envisages a call for parity projects. Of great importance for further development of this collaboration was the visit of professor Rolf-Dieter Heuer, a world-famous scientist and outstanding science manager, President of German Physical Society, to the Academy; during that visit ways and forms of collaboration were discussed.

The **representation of Ukrainian scientists in the EU Framework Programme for Research and Innovation — Horizon 2020** was extended. 13 representatives and experts from NAS institutions were selected for the work in the committees of this program. The total number of multilateral projects implemented by Academy institutions rose to 25, four of them being started in 2017. Five NAS institutions, jointly with Ukrainian enterprises, are involved in the implementation of the ***AERO-UA*** project, which is one of the largest coordinating and supporting projects within Horizon 2020 program in terms of both their funding and the number of participants. Of great importance is the fact that the **project is directed exclusively towards Ukraine and forming its ties with the EU**, while consortium's work is supported by such world aircraft construction leaders as *Airbus* and *DLR*, as well as *EADS* (European Aeronautic Defense and Space concern). In 2017, **under the *ERA-PLANET* project**, which involves specialists of 35 institutions of 11 countries, the **targeted NAS program for aerospace environmental monitoring was launched as a national segment of this project within Horizon 2020 program**.

NAS scientists worked in close collaboration with their colleagues from the countries of the former Soviet Union under joint multilateral projects (including Pan-European ones) and under direct bilateral arrangements. According to the Protocol to the Scientific Collaboration Agreement between the Polish Academy of Sciences (PAN) and the National Academy of Sciences (NAS) of Ukraine concerning scientists' 1-month visits to Poland, which was signed by the presidents of both academies, in 2017 the PAN received 20 young Ukrainian scholars as interns at its scientific institutions. With a view to disseminating the findings of joint research, 5 Polish cities hosted the exhibition **"Salvaged treasures of underground Lviv"**, which displayed several hundred artifacts found during excavations in Lviv's downtown that were conducted by specialists of the research center "Archeological rescue service" of the NAS Institute of Archeology.

B.E. Paton, the President of the NAS of Ukraine, and V.G. Gusakov, the Chairman of the Presidium of the NAS of Belarus, are signing the Scientific Collaboration Agreement between the NAS of Ukraine and the NAS of Belarus



The structure of the NAS targeted scientific research program "Aerospace environmental monitoring for sustainable development and security as a national segment of the Horizon 2020 ERA-PLANET project"

During the visit of NAS official delegation to Belarus, discussed was the transfer of current and archival documents of the International Association of Academies of Sciences (IAAS) to Belarus; organizing the IAAS work in the Academy of Sciences of Belarus, which is to become its host institution; the prospects of IAAS development, as well as bilateral collaboration of the NAS of Ukraine and NAS of Belarus. An **updated collaboration agreement of the NAS of Ukraine** and NAS of Belarus was signed at the summit meeting during the visit of O.H. Lukashenko, President of the Republic of Belarus, to Ukraine. An Agreement on Collaboration between the NAS of Ukraine and the NAS of Azerbaijan was also signed in 2017.

The S&T collaboration with institutions and organizations of the People's Republic of China was advanced, primarily, that aimed at commercialization of S&T developments and technologies produced by Academy's scientists. Over the last year, the NAS of Ukraine was visited by the official delegations of two PRC provinces, as well as those of several cities and R&D associations. The understanding on establishing the Ukrainian–Chinese Institute for Advanced Technologies was achieved with the Shandong province Academy of Sciences. The Institute is to perform coordination functions and harmonize cooperation forms, the mechanisms of funding joint projects and protecting intellectual property rights. A similar center is also to be founded in the Guangdong province, where representatives of seven institutions of the NAS of Ukraine attended the International S&T Innovation Forum and an innovation exhibition of R&D achievements. Relying on the results of one of those visits, the National Academy of Sciences of Ukraine and the Department of Science and Technology of the Zhejiang province signed the memorandum of understanding on collaboration in science and innovation, which is aimed at intensification and extension of the existing ties.

AWARDS

The V.I. Vernadsky Gold Medals were awarded to V.V. Skorokhod, Academician of the NAS of Ukraine, and to G.F. Tavadze, Academician of the NAS of Georgia — for their outstanding achievements in the scientific fundamentals of powder metallurgy.

For significant results in promoting international scientific collaboration, the honorary title of "Doctor Honoris causa of the National Academy of Sciences of Ukraine" was given to: American scientist Roald Hoffmann, Professor of Cornell University, Nobel Laureate in chemistry (1981); Harald zur Hausen, German medical scientist, Doctor of Medicine, Nobel Prize winner in physiology and medicine (2008), professor emeritus of the German Cancer Research Center; Li Yuanyuan, a leading materials scientist, Professor, Doctor of Engineering, Academician of the Chinese Academy of Engineering, President of Jilin University; Professor Rolf-Dieter Heuer, German scientist and science manager, President of German Physical Society, Director-General (2009—2015) of the European Centre for Nuclear Research (CERN, Switzerland).

For a major personal contribution to the advancement of Ukrainian science, strengthening Ukraine's S&T potential, Order of Prince Yaroslav the Wise II Degree was awarded to NAS Academician V.P. Gorbulin, Order of Prince Yaroslav the Wise IV Degree — to NAS Academician V.H. Kremen, Order of Prince Yaroslav the Wise V Degree — to NAS Academician B.V. Grinyov and NAS Corresponding Member M.V. Polyakov, Order "For Services" I Degree — to NAS Academician S.P. Pavlyuk, Order "For Services" II Degree — to NAS Academician V.I. Lalko, Order "For Services" III Degree — to I.B. Usenko, Head of Department of NAS V.M. Koretsky Institute of State and Law.

For their significant personal contribution to state establishment, socio-economic, S&T, cultural and educational progress of Ukraine, Order of Prince Yaroslav the Wise III Degree was given to NAS Academician V.O. Marchenko; Order of Prince Yaroslav the Wise IV Degree — to NAS Academician L.I. Anatychuk; Order "For Servces" I Degree — to NAS Corresponding Member I.M. Trakhtenberg; Order "For Services" II Degree — to NAS Academician V.F. Chekhun and V.M. Palii, Head of the Scientific & Management Personnel Department of NAS Presidium; Order "For Services" III Degree — to NAS Corresponding Member G.Yu. Ivakin; V.O. Kotyhorenko, Chief Research Associate of I.F. Kuras Institute of Political and Ethno-National Studies; A.I. Kudriachenko, Director of State Institution "NAS Institute of World History"; S.A. Halchenko, Deputy Director of T.H. Shevchenko Institute of Literature of the NAS of Ukraine; V.I. Horyn, Senior Research Associate of I. Krypiakevych Institute of Ukrainian Studies of the NAS of Ukraine; Order of Princess Olga III Degree — to O.V. Chervonenko, Deputy Director of the National Scientific Natural History Museum of the NAS of Ukraine; Medal "For Labor and Victory" — to L.S. Shevchenko, engineer of the National Scientific Natural History Museum of the NAS of Ukraine.

NAS Academician B.E. Paton, President of the NAS of Ukraine, received the top award of the NAS of Belarus — Gold Medal of the NAS of Belarus "For Great Contribution to the Development of Science".

The Galileo Galilei Award of the International Commission for Optics (ICO) "for basic mathematical physics research concerning the modelling of actual photonics and optoelectronics devices under comparatively difficult conditions" went to O.I. Nosich, the Chief Research Associate of O.Ya. Usikov Institute for Radio Physics and Electronics.

The Prize of P.H. Kostiuk Foundation was received by S. Kucherenko, Acting Research Associate of the NAS Institute of Molecular Biology and Genetics. The prize was established

At the awarding ceremony in the NAS Presidium building on 18 September 2017: Academician V.G. Koshechko, Vice-President of the NAS of Ukraine, and Nobel laureate Harald zur Hausen

in 2010 by disciples of Academician Platon H. Kostiuk, world-known Ukrainian biophysicist and neurobiologist (1924—2010); according to tradition, it is awarded to young scientists who carry out research in biomedical sciences in Ukraine.

The Big Silver Medal of the Construction Academy of Ukraine in the nomination "The best innovation project implemented in civil engineering" went to NAS Corresponding Member A.V. Nosovskyi for his work "Construction of new safe confinement for the 'Ukryttia' facility of the Chornobyl NPP".

V.O. Kiktenko, Doctor of Philosophy, Senior Research Associate, Head of the Far East Department of A.Yu. Krymsky Institute of Oriental Studies, became the winner in the nomination "China's Special Book Prize for Young Scholars".

The State Prize of Ukraine in Science and Technology was awarded to seven NAS researchers for their work "Optimization methods and computer technologies for modelling and controlling information processes and systems"; to eight scientists — for the work "Properties of neutrino and the weak interaction, the search for effects beyond the standard model of elementary particles"; four — for the study "Fundamentals of the realization of organism's anti-tumor defense mechanisms'; seven scholars — for publishing "Encyclopedia of the History of Ukraine (in 10 volumes); one scientist — for the work "Development of radiating structures of multifunctional radio electronic systems"; five — for the work "Development of multifunctional plastic scintillators"; three researchers — for the work "Development and deployment of a new class of eutectic composite materials in innovative technologies at machine-building plants"; three — for the work "Energy-efficient LED illumination systems"; one scientist — for the work "Development of nanosilica-based agents and technologies for efferent therapy"; two — for the work "Improving the efficiency of exploiting hydrocarbon deposits, using new-generation compressor equipment".

Seven NAS researchers won State Prizes of Ukraine in Education in the nomination "Preschool and out-of-school education" for the study "Research-and-education Internet portal "Taras Hryhorovych Shevchenko" (www.kobzar.ua). Nine NAS researchers received the title "Honored Worker of Science and Technology", two — the title "Honored Culture Worker".

59 Academy researchers were honored with prizes named after prominent NAS scholars.

Last year, three NAS institutions received Scopus Awards Ukraine. In the nomination "Engineering and technologies", the award went to the Institute of Physics, that in the nomination "Medical sciences" — to Bogomoletz Institute of Physiology, the one in the "Natural Sciences" nomination — to the National Science Center 'Kharkov Institute for Physics and Technology'.

According to the results of the 18th all-Ukraine "Book of the Year 2016" rating, the six-volume academic edition "Shevchenko Encyclopedia" (namely, vols. 5 and 6), which was prepared and published by T. Shevchenko Institute of Literature of the NAS of Ukraine, took the first place in the "Reading-book" nomination (sub nomination "Literature Studies") and also won Grand Prix — the main prize of the rating.

POPULARIZATION OF SCIENCE

Popularization of scientific results and educational activities are important areas of Academy's work. Last year, leading NAS scientists persistently informed the community about their own professional achievements and those of the world science. For that purpose they closely co-operated both with media of the nationwide circulation and with regional ones (TV channels, radio stations, printed and electronic media), organized educational events for the general public. For several years running, **versatile popular-science projects** — both large-scale and narrowly specialized ones — **have existed** through the initiative and with active participation of scientists of numerous NAS research institutions.

On 18—20 May 2017, **the 11th All-Ukraine Science Festival** was held in collaboration with the Ministry of Education and Science of Ukraine, Ministry for Sports and Youth of Ukraine, Kyiv universities and national sectoral academies of sciences, with the support of the French Embassy in Ukraine and the Institute of France. About 50 Academy institutions presented over 460 innovative developments at the traditional exhibition on its opening day. A mini-series of lectures covering highly relevant science issues was delivered, with presentations being made by Abderrazzak El Albani, Professor of Poitiers University (France) and Academician Olexander Konovalenko, Deputy Director of the NAS Institute of Radio Astronomy (Kharkiv). Festival events were held both in large cities of Ukraine (its capital and oblast centers) and in small towns, townships and even villages.

Equally well known in Ukraine is **the popular-science project "Science Days"**, started in 2013 by young Academy scientists. In 2017 it was held, as usual, in May and in November. The festival and the spring "Science Days" were timed to the Science Day established by President's decree — the third Saturday of May — and also to the fourth International Plants Day, marked in Ukraine on 18 May under the auspices of the European Plant Science Organization. The autumn "Science Days" were devoted to the **World Day of Science for Peace and Development, established by UNESCO** and celebrated every year on 10 November. Extra "Science Days" were also held. Some of those — the so-called "nerve" ones — presented the Academy's part of the program of the International Brain Week in Ukraine — the popular-science campaign intended for drawing attention to research in neuroscien-

Kyiv schoolchildren during the 11th All-Ukraine Science Festival at the NAS Institute of Physics (18 May 2017)

"Science Days" at the Festival of Modern Art in Kyiv (3 September 2017)

ces and brain research all over the world. The events were prepared separately for specialists and for laymen. Another extra "Science Days" event was a part of Modern Art Festival in Kyiv.

Over the year, Academy scientists from various cities were involved in a number of events of another large-scale **all-Ukraine popular-science project — "Science Picnics in Ukraine"**. Popular-science events, which are generally free, are held in varied formats the year-round. Those are, for example, the spring and autumn Astronomy Days, which every year in March and September, respectively, due to the efforts of NAS astronomers, gather large numbers of amateurs of space research and stellar sky gazers. Once a month — from September till May — researchers of the NAS Institute of Archeology deliver popular-science lectures for the general public "What archeology tells us". The special feature of this initiative is that every new history season traditionally starts and ends with an excursion to excavation sites or landmarks of history and culture.

Notable events were the cycle of popular-science lectures given by oncology scientists to mark the World Cancer Day, "Science Night" in Kharkiv, a large-scale scientific and social forum "Innovation Picnic — 2017" in Chernivtsi, which is held in the framework of international scientific-and-practical conference "Nanotechnologies and Nanomaterials".

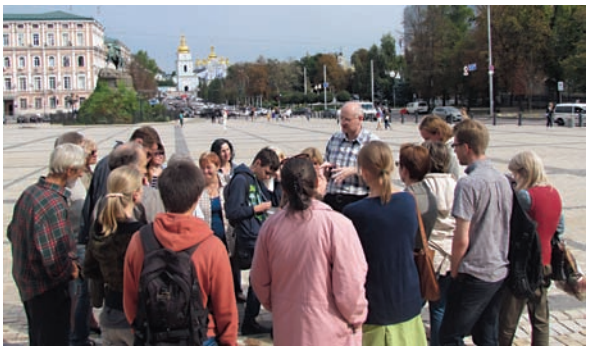
Also, worth mentioning is the first Popular-Science Conference *Brain&Ukraine*, which was intended for all kinds of people interested in science and cutting-edge achievements in its various areas. In 2017, NAS scientists were involved in the activities as invited speakers and participants of the exhibition of Ukrainian S&T and innovation developments that was held during the conference.

NAS institutions regularly demonstrate their research outcomes during specialized exhibitions as well. On 25 May 2017, a **"Made in Kyiv" presentation of industrial products of Kyiv's manufacturers was held**, where Academy scientists demonstrated their developments intended, among other things, for meeting various needs of the country capital. Prime-Minister Volodymyr Groysman and Kyiv's Mayor Vitali Klitschko visited and examined it. On 21—

Near the stall of the NAS Natural History Museum at the "Science Picnics" in Kyiv (23 September 2017)

Autumn Astronomy Day at the Main Astronomical Observatory of the NAS of Ukraine (30 September 2017)

Academician Serhiy Komisarenko, Director of Palladin Institute of Biochemistry of the NAS of Ukraine, speaking at "Nauka XXI" TV program on Rada Parliamentary Channel



An excursion to the Upper City of Kyiv organized by the Public Lectures Center "What archeology tells us"

24 November 2017, the **International Forum *Innovation Market*** was held; it was a site for meetings of inventors, innovators, authors of innovative technologies and start-up companies with businessmen interested in technological upgrading, economics experts, advisers in the intellectual property field, representatives of state authorities and respected Ukrainian and foreign investment and finance institutions. The Academy was a co-organizer of and active participant in the event.

NAS scholars continued their close co-operation with Ukrainian media, *1+1*, *Kultura, Kyiv*, *ICTV*, *5 Channel*, *STB*, *Rada*, *Hromadske TV channels*; *Promin*, *Kultura*, *Holos Kyieva*, *Holos Stolytsi*, *Radio Svoboda*, *Hromadske* radio stations in particular. E.g., in 2017, Hromadske Radio started the popular science show "Albert Einstein was the person". Going on was the co-operation with printed media: *Dzerkalo Tyzhnia*, *Holos Ukrainy*, *Uriadovyi Kurier*, *FOCUS*, *Novoye Vremia*, *Ukraina Moloda*, *Svit*, as well as Internet editions, Internet platforms and Internet portals *Science Ukraine*, *Dim Innovatsii*, *Ukrainska Pravda*, *RBK-Ukraina*, *The Ukrainians*. Scientists spoke about today's scientific achievements for theme TV spots filmed by Ukrainian popular-science resource *Sciences.in.ua*. Besides, Academy scholars are regular contributors to and main characters of publications of popular-science magazines *Svitohliad*, *Kunscht*, *Pulsar* and *Vselennaia*, *Prostranstvo*, *Vremia*.

Academician Oleg Kryshtal, Director of Bogomoletz Institute of Physiology of the NAS of Ukraine, with Olena Skyrta amd Miriam Drahina, presenters of the popular science radio show "Albert Einstein was the Person" on Hromadske Radio (21 June 2017)

2018 will be a special year for science popularization — at the end of this year **the 100th anniversary of the foundation of the National Academy of Sciences of Ukraine** will be marked. Jubilee events will be held: celebrations involving general public, representatives of culture and science workers both in the capital and country's regions, as well as jubilee session of the NAS General Meeting and a special exhibition of the S&T achievements of Academy institutions. A documentary about the history of the National Academy of Sciences, TV spots and video films covering the major developments of our researchers, the history of scientific institutions and prominent NAS scientists are being prepared. We are also planning several publications about that. Besides, the work on creating the virtual museum of Academy's history is under way. So, the year is going to be eventful and interesting.

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 infrastructure.

Research organizations that have the National Institution status:

- V.I. Vernadsky National Library of Ukraine
- National Science Center "Kharkov Institute of Physics and Technology"
- "Olbia" National Historical and Archeological Reserve
- M.M. Gryshko National Botanical Garden
- "Sofiivka" National Dendrological Park
- 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 (Kramatorsk, Donetsk oblast)
- Western Science Center (Lviv)
- Southern Science Center (Odesa)
- North-East Science Center (Kharkiv)
- Prydniprovskyi Science Center (Dnipro),

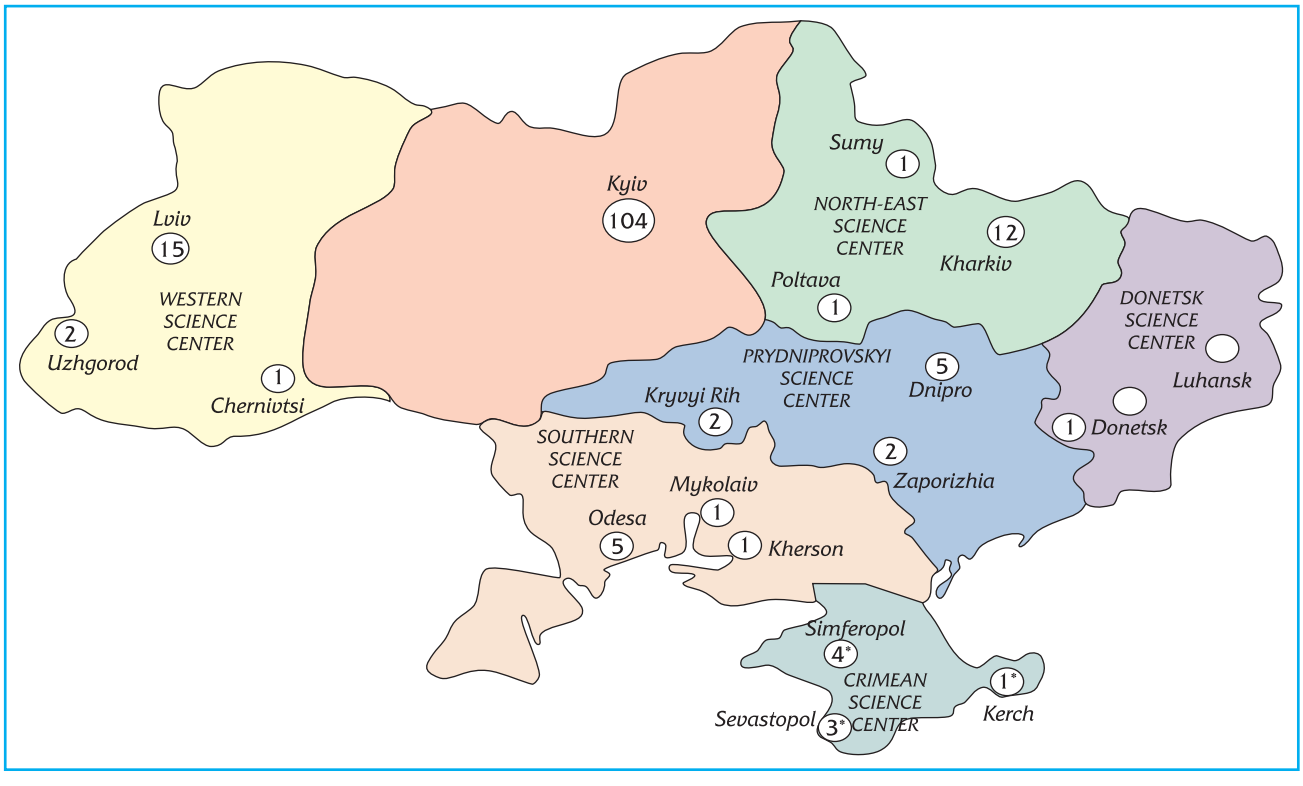
as well as the Center for Evaluating Research Institutions and Scientific Support to Regional Development (Kyiv)

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

DISTRIBUTION ACROSS SECTIONS AND DEPARTMENTS

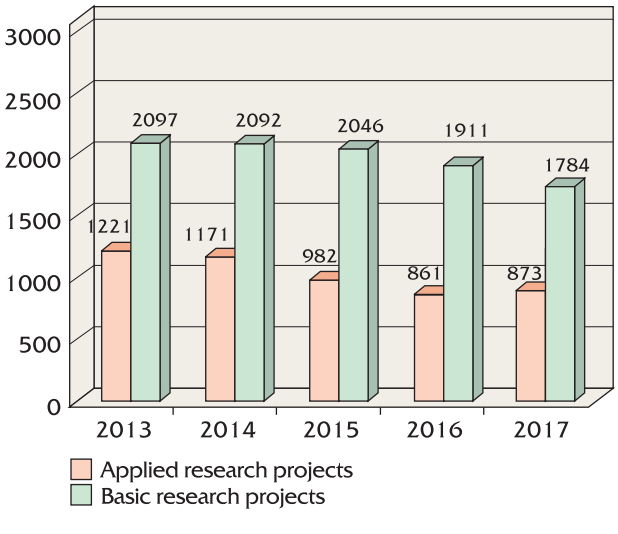
Department	The number of research institutions	The number of pilot production organizations	The number of objects that have the National Asset status	The number of centers for shared use of equipment
The Section of Physical, Engineering and Mathematical Sciences				
Dpt. of Mathematics	4	—	—	—
Dpt. of Information Science	7	—	—	—
Dpt. of Mechanics	6	3	3	6
Dpt. of Physics and Astronomy	16	3	9	16
Dpt. of Earth Sciences	14	1	—	5
Dpt. of Physical and Technological Problems of Materials Science	11	18	1	12
Dpt. of Physical and Technological Problems of Power Engineering	11	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	8	1	5	9
Dpt. of General Biology	22	1	19	12
The Section of Social Sciences and Humanities				
Dpt. of Economics	9	—	—	—
Dpt. of History, Philosophy and Law	17	3	5	—
Dpt. of Literature, Language and Art Studies	9	—	4	—

Regional structure of the NAS of Ukraine

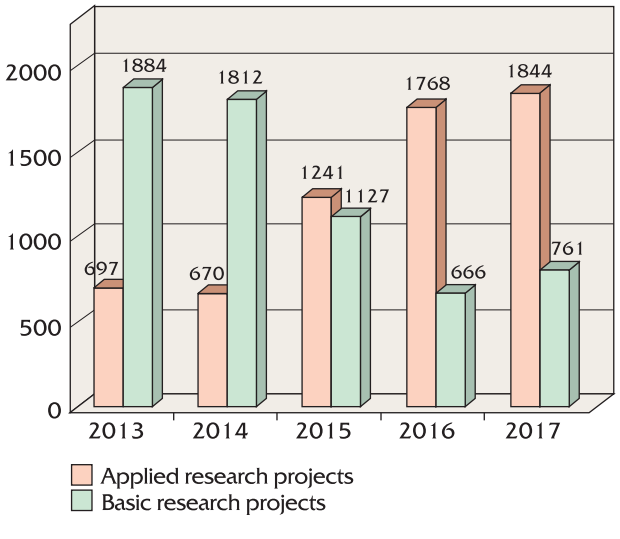


Numerals in the diagram show the number of research institutions
** The status of NAS institutions located in the Crimea Autonomous Republic is defined by the Law of Ukraine "On guaranteeing the rights and freedoms of citizens and the legal regime of the temporarily occupied territory of Ukraine"*

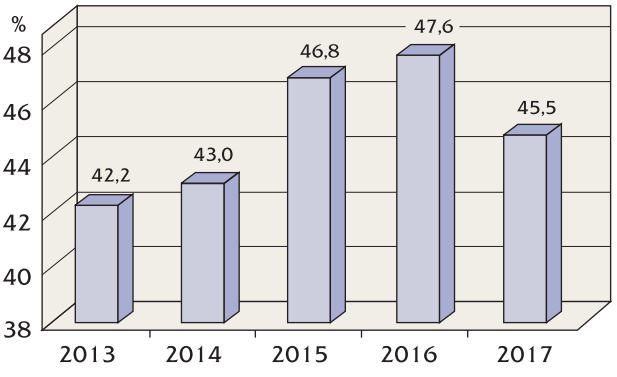
Conducting research



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

NAS targeted-program and competitive projects in 2017 involved research conducted under:

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

and were 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 carried out under NAS grants.

Publishing

The total number of Academy journals:

84 scientific journals, 1 popular-science journal — "Svitohliad", and "Dzherelo" abstract journal in four series.

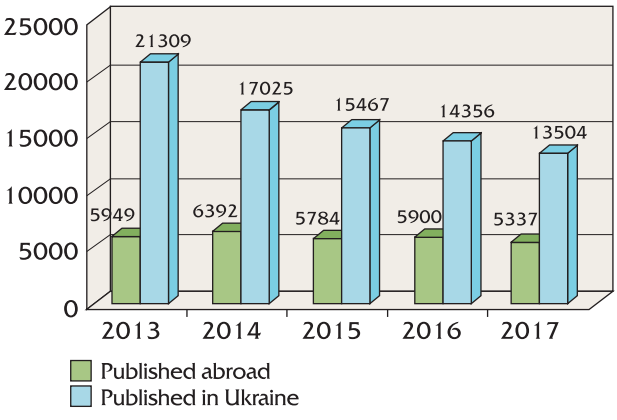
- **10 journals are published in English in Ukraine:**

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

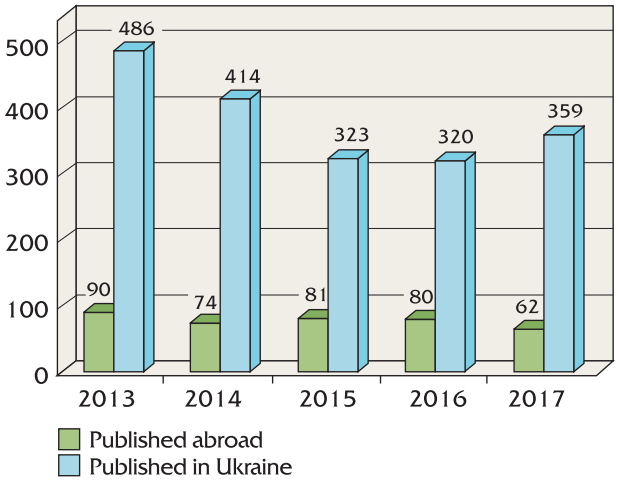
- **22 journals are published in English abroad:**

by Springer Publishers

1. Ukrainian Mathematical Journal
2. Cybernetics and Systems Analysis
3. International Applied Mechanics



Papers of NAS scholars in periodicals



Academic monographs

4. Strength of Materials
5. Materials Science
6. Theoretical and Experimental Chemistry
7. Neurophysiology

by Pleiades Publishing, Inc.

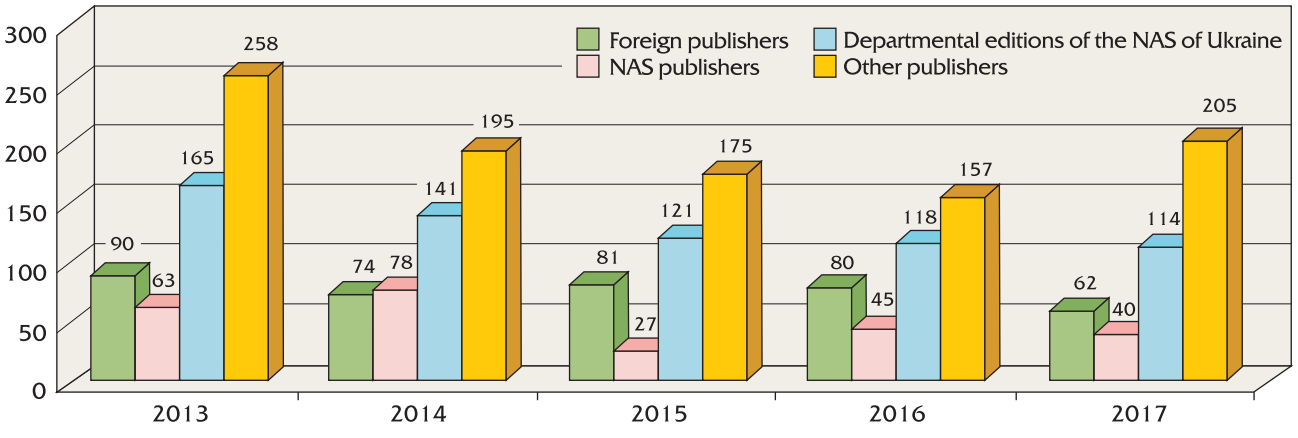
1. Kinematics and Physics of Celestial Bodies
2. Journal of Superhard Materials
3. Journal of Water Chemistry and Technology
4. Cytology and Genetics

by Begell house inc. Publishers

1. Journal of Automation and Information Sciences
2. Radio Physics and Radio Astronomy
3. Telecommunication and Radio Engineering
4. International Journal on Algae
5. Hydrobiological Journal
6. International Journal of Physiology and Pathophysiology

by other publishers

1. Low Temperature Physics
2. Technical Diagnostics and Non-Destructive Testing — *Cambridge International Science Publishing*



Distribution of academic monographs across groups of publishers

3. Advances in Electrometallurgy — *Cambridge International Science Publishing*

Electronic editions in English produced abroad

1. Vestnik Zoologii — *De Gruyter*
2. The Ukrainian Biochemical Journal — *Elsevier*

Scientific expertise

In 2017, NAS specialists contributed to the preparation of:

- Medium-term plan of Government's priority actions till 2020
- National Action Plan for 2017—2020 on implementing the Strategy of Ukraine Sustainable Development till 2030
- The Annual Address of the President of Ukraine to the Verkhovna Rada of Ukraine "On the Domestic and International Situation of Ukraine in 2017"
- The comprehensive plan of actions for implementing the state policy concerning population employment for the period till 2020
- National reports: "Sustainable Development Goals: Ukraine", "Civilizational Choice of Ukraine: the Paradigm of Understanding and Strategies of Action", "On the Status of Natural Environment in 2016", "Ukraine: from Confrontation to Consolidation"
- The National Transport Strategy of Ukraine till 2030
- The Energy Strategy of Ukraine till 2035: "Security, Energy Efficiency, Competitiveness"

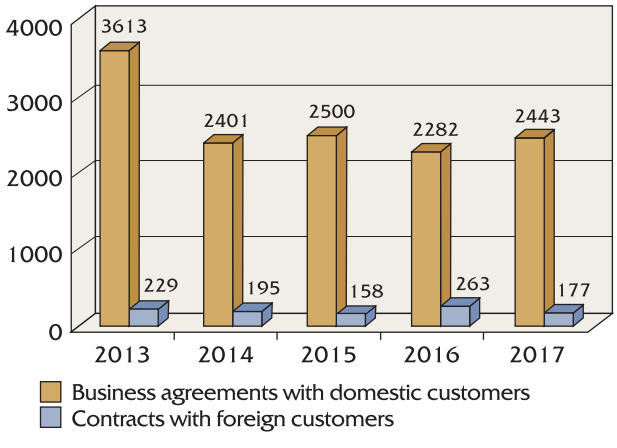
NAS scholars prepared expert conclusions, comments and proposals, in particular those to the draft laws:

- On introducing amendments to the Customs Code concerning the single-window service
- On introducing amendments to the Economic Code of Practice of Ukraine, the Civil Code of Practice of Ukraine, the Administrative Legal Procedure of Ukraine and other legislative acts
- On introducing amendments to the Tax Code of Ukraine and some legislative acts of Ukraine on stimulating the establishment and operation of small farm businesses and the deconcentration of powers in the sphere of land law
- On introducing amendments to the Law of Ukraine "On heat supply" concerning stimulating heat energy generation by alternative energy sources
- On cooperation in agriculture

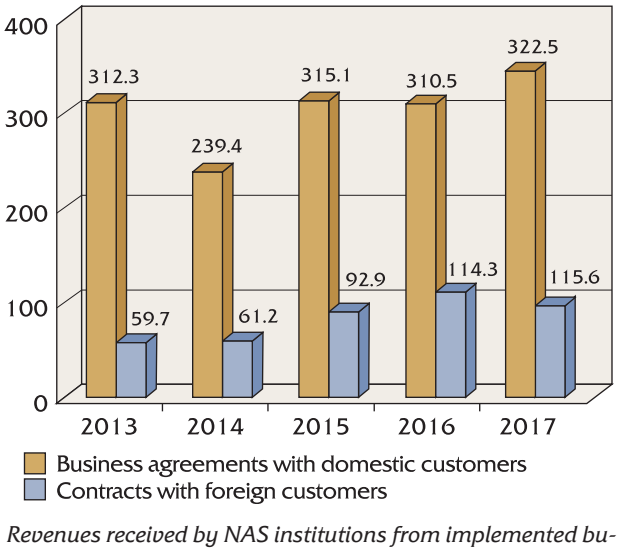
Expert conclusions	2013	2014	2015	2016	2017
Expert conclusions concerning normative legal documents, information and analytical documents on various issues of socio-economic development, sent to state authorities	1560	1500	2017	2160	2200
Expert conclusions as to the advisability of conducting public basic research	457	492	1752	606	393

- On introducing amendments to Article 46 of the Law of Ukraine "On preventing corruption"
- On introducing amendments to the Law of Ukraine "On the National Police" concerning the freedom of peaceful assembly
- On introducing amendments to the Law of Ukraine "On government service"
- On the state registration of businesses, individual entrepreneurs and NGOs
- On electronic declarations of civil society organizations

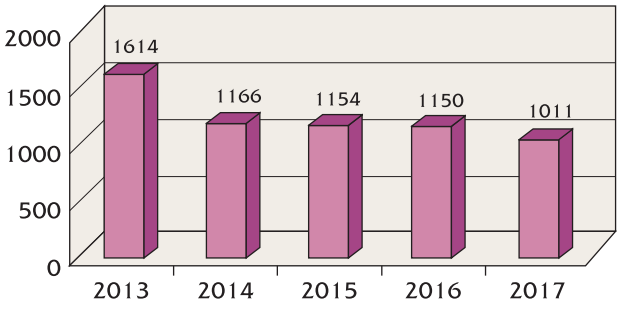
Innovation activities



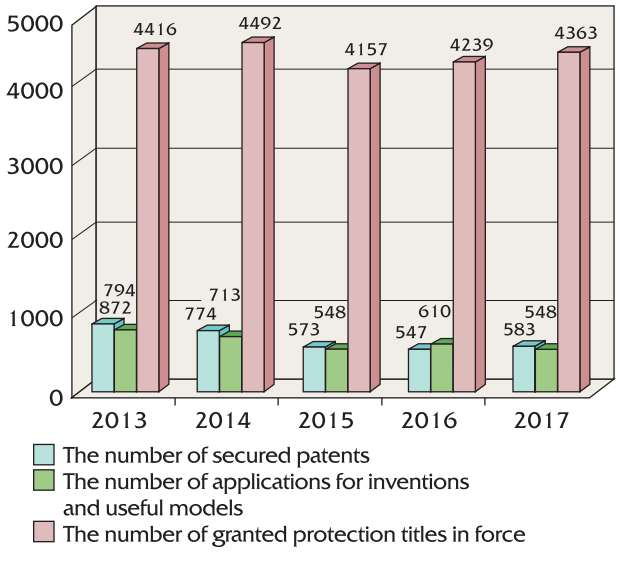
Implemented economic agreements and contracts, the total number



Revenues received by NAS institutions from implemented business agreements and contracts, ₴ million



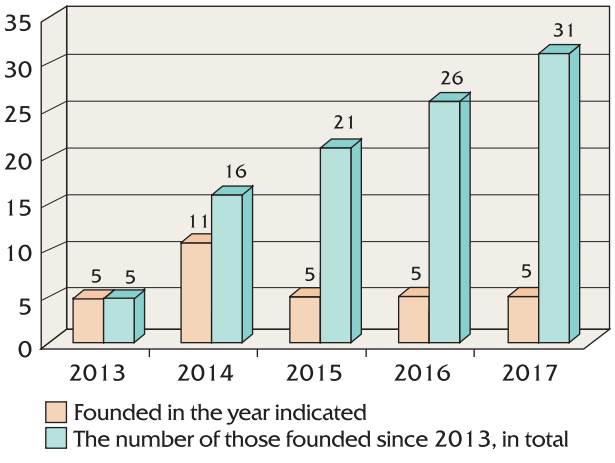
The number of implemented research findings



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	268
Research projects implemented collaboratively with academics	223
Published monographs co-authored with academics	93
Research scientists who worked in education:	1333
including:	
NAS active members	39
NAS corresponding members	82
Published textbooks and manuals for higher education institutions	75
Scientists at the head of chairs in higher education institutions	77
Students of higher education institutions who pursued/are pursuing Master's degree programs at joint research-and-training agencies hosted by scientific organizations:	



Joint research-and-training organizations

in academic year 2015/2016	407
in academic year 2016/2017	440
Students who wrote their graduate papers at research institutions	1225
Academics incorporated to specialized academic councils of research institutions	490
Scientists of research institutions incorporated to specialized academic councils of higher education institutions	610
Newly arrived graduate specialists who attended study groups of the Junior Academy of Sciences in their school days	15
Research scientists and teachers of higher education institutions and MES organizations who upgraded their professional skills at research institutions	445
Theses of academics defended at specialized academic councils of scientific research institutions	192
of those:	
thesis for the doctor-of-science degree	53
theses for the candidate-of-science (PhD) degree	139

International ties

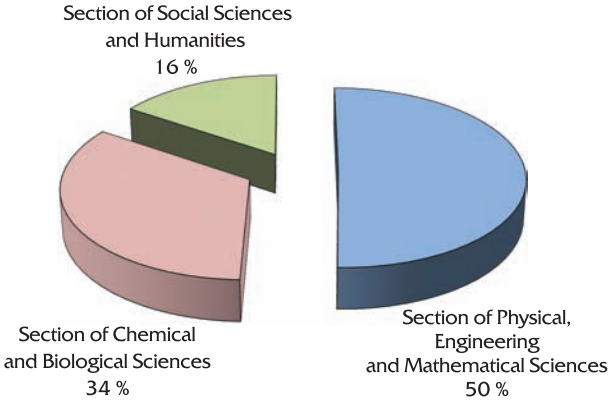
The contractual framework for the international collaboration of the NAS of Ukraine (effective agreements, contracts, memorandums etc.) — a total of 122 documents.

In 2017, the Academy signed seven new collaboration agreements:

• Collaboration agreement between the Qingdao Xianchu Energy Development Group and the National Academy of Sciences of Ukraine

• The memorandum of mutual understanding and collaboration in science and innovation between the NAS of Ukraine and the Department of Science and Innovation of the Zhejiang province, PRC

• The collaboration agreement between the NAS of Ukraine and the R&D Bureau of Ningbo (the Zhejiang province, PRC)



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

• The memorandum of mutual understanding between the NAS of Ukraine and Harbin Engineering University, PRC

• The agreement on S&T collaboration between the NAS of Ukraine and the Academy of Sciences of the Shandong province

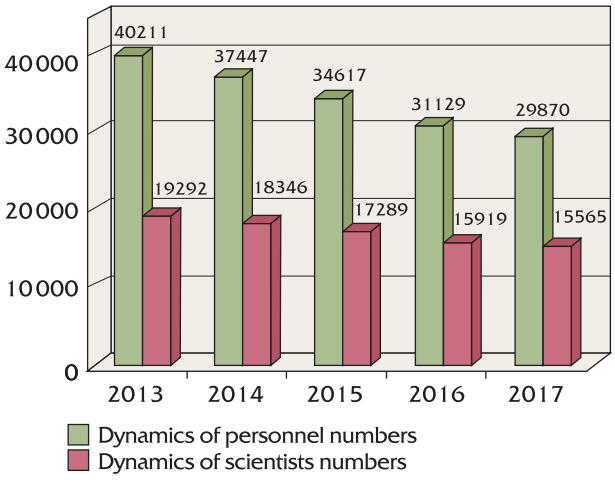
• The framework agreement on the comprehensive collaboration between the National Academy of Sciences of Ukraine and the Academy of Sciences of the Guangdong province

• The memorandum of mutual understanding between the National Academy of Sciences of Ukraine and German Research Foundation

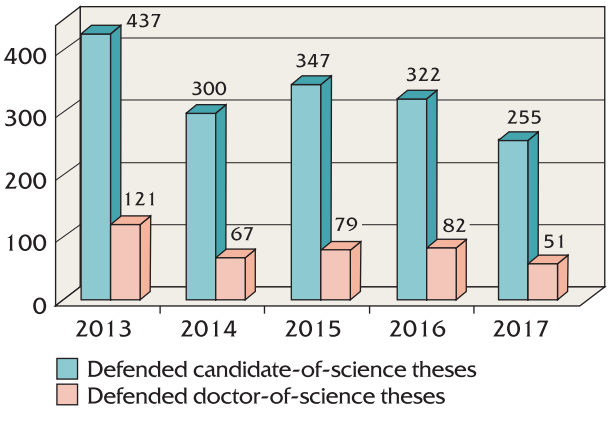
There are about 600 direct agreements and contracts, concluded by NAS institutions with foreign partners.

Personnel data sheet (as of 1 January 2018)

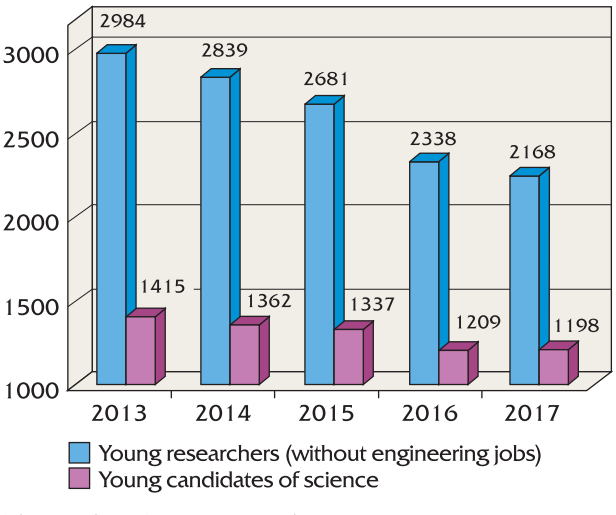
The total number of employees	29870
of them:	
in research institutions	28225
in research-and-production facilities	1304
in services organizations	341
The number of research scientists	15565
of them:	
doctors of sciences	2367
candidates of sciences (PhD)	6838
researchers without an advanced degree	6360
The number of young specialists recruited in 2016	416
The number of those who pursued post-graduate studies	1223
full-time studies included	914
Defended candidate-of-science theses	255
Doctoral fellowships	166
Defended doctor-of-science theses	51



The number of employees

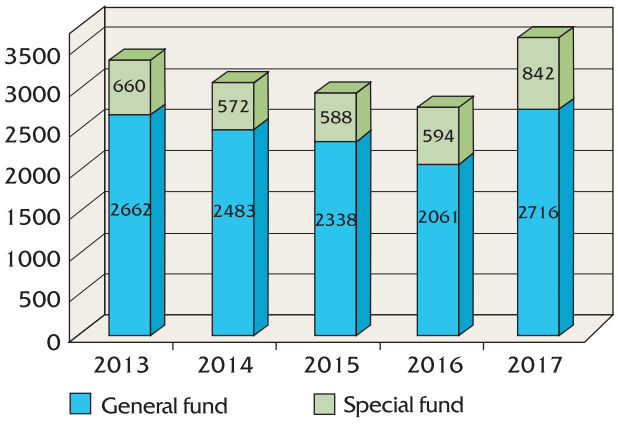


Dynamics of research scientists training

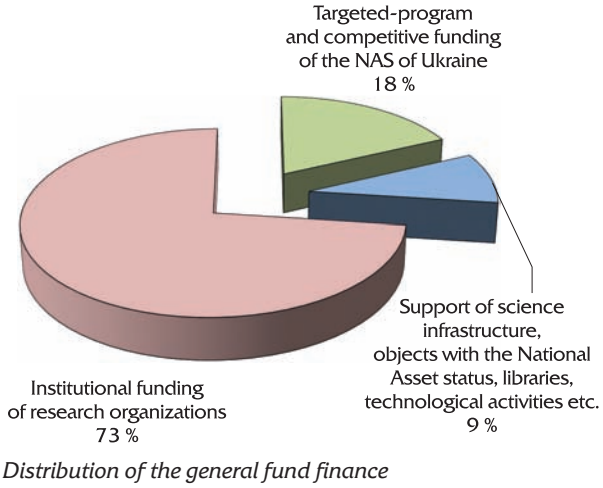


The number of young researchers

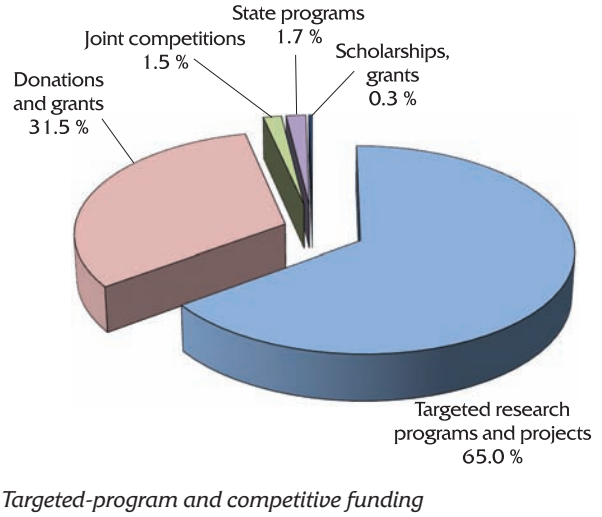
Financial provision for research



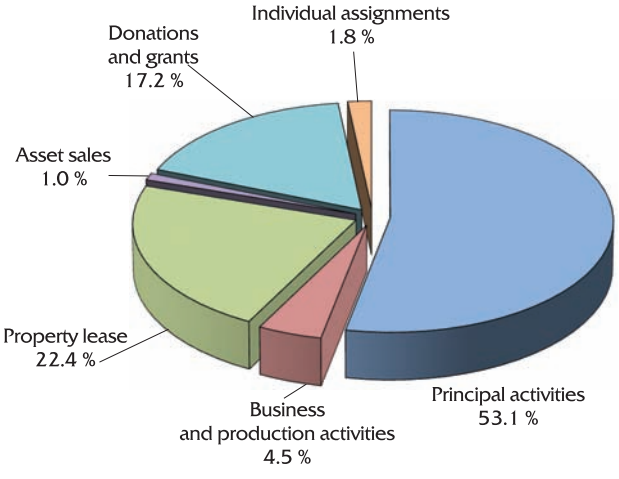
The total amount of NAS funding, ₴ million



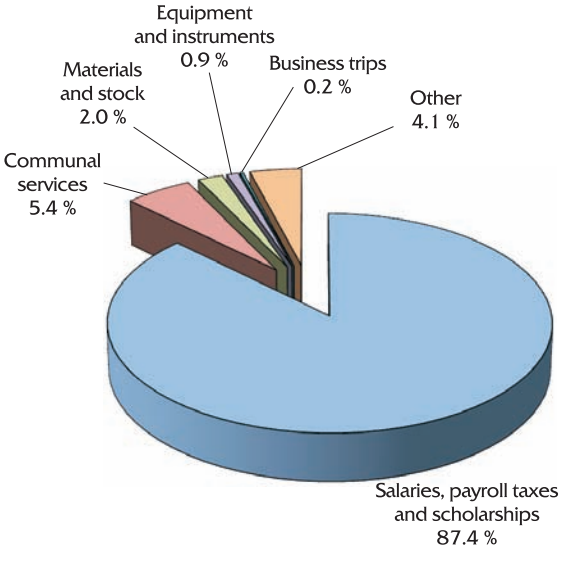
Distribution of the general fund finance



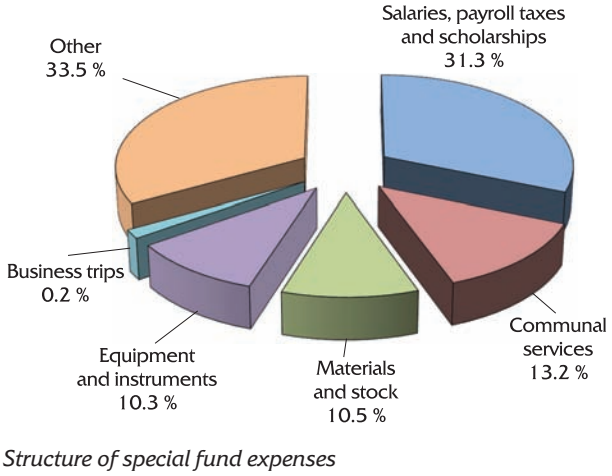
Targeted-program and competitive funding



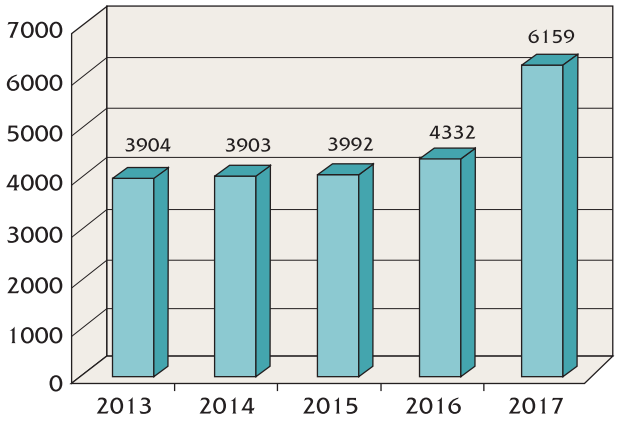
Structure of revenues to the special fund



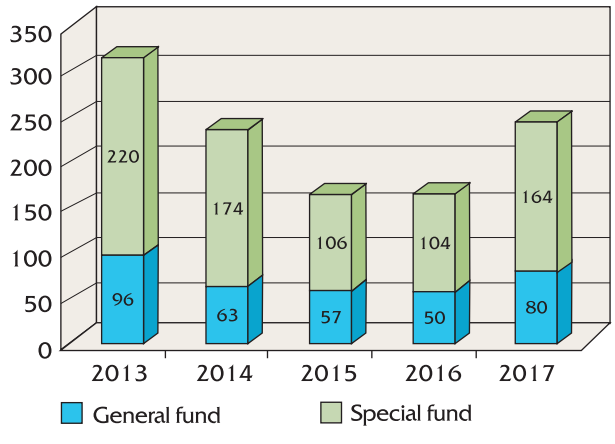
Structure of general fund expenses



Structure of special fund expenses



Average monthly salaries of employees, ₴



Expenses for procurement of equipment and materials, ₴ million

CONTENTS

Переклад англійською мовою
І.І. Рахманової

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01004, Київ, вул. Терещенківська, 4

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