NATIONAL ACADEMY OF SCIENCES OF UKRAINE

BRIEF ANNUAL REPORT

2014

«VTS Print» Publishers
Kyiv • 2015

Main Results

B. E. Paton,
President of the Academy

2014 was a very difficult year for Ukraine, full of incredible trials for its citizens. Social and political events that happened could not but affect the life of the National Academy of Sciences.

First and foremost, the Academy was faced with a large number of problems stemming from the temporary loss of parts of the Ukrainian territory. Institutes and other Academy organizations that were fruitfully doing important research remained in the Crimea. That necessitated significant corrections in some targeted research areas and projects, and in some cases certain changes in the structure of other Academy institutions and their research subjects had to be made.

The necessity of changing the location of 12 scientific institutions of the Donbas region emerged, as well as the need of financing those institutions, paying salaries to their workers, providing accommodations and jobs for them. NAS Presidium repeatedly discussed these problems at its meetings; according to the discussion results, respective decisions were made. The Academy has been taking all possible measures for preserving the research potential of these institutions and organizing their effective work at new places.

A working group of the NAS of Ukraine for Donbas reconstruction was set up to organize and coordinate the participation of Academy institutions in restoring the infrastructure and production facilities of the partially ruined country's East. It is quite understandable that even today we are to determine in a clear and scientifically reliable way the principal areas of high-technology reconstruction of the region, propose efficient mechanisms, state levers and economic incentives for involving necessary private capital investments for this. It is for this reason that NAS economics scientists have prepared a concept and feasibility study of the priority trends of Donbas reconstruction, including those that rely on R&D of NAS institutions.

The situation that emerged in Ukraine has brought to the foreground the issues of improving Academy's activities, to turn it into a modern effective instrument of S&T progress of the nation, to make its work as close as possible to the needs of the state and society. Last year witnessed persistent work of the Academy towards implementing the Concept of development of the National Academy of Sciences of Ukraine for 2014–2023, which was approved late in 2013. It attached top priority, first of all, to measures aimed at increasing the contribution of our scientists to the international science, to the scientific support to country's modernization and strengthening its defense capability.

No doubt, the previous year was extremely difficult, but, summing it up, one can state that it brought quite a number of new significant results of scientific research at the Academy.

For example, one of the major achievements of our mathematics scientists was the solution of the Hille problem, at which scientists of the whole world had been working for nearly 70 years. Significant steps were made towards developing novel types of converters of solar energy into electrical one that are based on carbon nanotubes. For the first time in the history of astrophysical research, solar radiation power was measured immediately at the moment of energy release in the Sun interior. Main principles of development were formulated and the first successes achieved in studying materials of the radically new class – high-entropy alloys and high-entropy ceramic materials, which have unique high-temperature strength and wear resistance. A high appraisal is also deserved by the electronic Atlas of natural, industrial and social hazards and risks of emergencies in Ukraine. Profound cell and molecular mechanisms of the harmful effect of acid rains on photosynthesis processes were revealed. Important fundamental data that throw light on a possible mechanism of Alzheimer disease development were also obtained.

Socio-humanitarian scholars for the first time worked out a typology of human development that took into account its equilibrium in various aspects, in Ukraine's regions in particular. National reports 'Innovative Ukraine 2020' and 'Socio-economic potential of the sustainable development of Ukraine and its regions' were prepared. Important fundamental socio-publishing projects were successfully implemented.

2014 was declared the Taras Shevchenko Year, so the Academy marked it with a number of editions devoted to Kobzar's personality and his creative work. Published were final volumes of the 6-volume «Shevchenko Encyclopedia» and the 4th volume of the 12-volume «History of the Ukrainian Literature», which addresses exclusively Taras Shevchenko's artistic heritage, the nature of his phenomenal popularity and influence on the minds and feelings of many generations of Ukrainians. The V.I. Vernadsky National Library of Ukraine prepared fundamental scholarly publication «Taras Hrygorovych Shevchenko: Bibliography of Published Works 1840–2014».

An important factor of the significant research achievements of Academy's scholars was a wide use of targeted programs as a form of scientific research organization. Last year, 22 targeted programs were implemented by NAS. After analyzing the results of completed programs, NAS Presidium recognized the necessity of continuing research in such promising areas as novel nanomaterials and nanotechnologies, scientific principles of the rational use of natural resource potential and sustainable development.

The top priority in NAS activities was scientific support to dealing with the major national problems. Today this is, first and foremost, strengthening of the defense potential of our state. The Academy made an inventory of dual4

-purpose developments and technologies; in accordance with its results, NAS sent to the President and the Cabinet of Ministers of Ukraine a list that contained 129

completed developments and 248 proposals towards conducting R&D works in the interests of defense-industrial sector. Of great importance is also the fact that in 2015 a new targeted Academy R&D program for strengthening country's defense capability and security was launched.

One should also note that the NAS of Ukraine is involved in providing direct support to ATO fighters and help to them. Last year, members of the Academy transferred nearly UAH 1.3 million of their private money for the treatment and rehabilitation of the wounded members of the antiterrorist operation. A lot of workers of our institutions joined this charitable contribution.

Ties with domestic producers and foreign customers were promoted. For example, the novel process of deep removal of sulfur impurities from cast iron, which was developed by our specialists, is already widely used at more than 30 metallurgical iron-and-steel works in China. There are no equivalent analogs of this technology in the world. Last year it started to draw interest in Ukraine as well. Its deployment at the 'ArcelorMittal Kryvyi Rih' metal works guarantees a rise in the production of cast iron and steel, and a reduction in the cost of metal products.

Of utmost practical importance is a device developed in collaboration with researchers of the Kharkiv National Automobile and Highway University and Kharkiv National University. It permits the noncontact measurement of the thickness of asphalt road pavement, detection of cracks and other defects under its surface. Now the work is underway to equip the mobile experimental laboratory of the 'Ukravtodor' company with such georadar for monitoring road condition.

Significant results were achieved in investigations of calcium phosphate ceramics, which is an artificial analog of the mineral component of bone tissue. In 2014 alone, nearly a thousand surgeries (of locomotor system, cancer diseases, orthopedic, cranio-facial, and ophthalmological surgeries) for the restoration of bone tissue were performed using 'Biomin' implant material.

The development of energy sector and implementation of energy-efficient technologies is among the most urgent and important tasks for our country. Academy specialists worked out and substantiated mechanisms to increase the reserves and produce fuel-and-energy raw materials for the draft Energy Strategy of Ukraine out to 2035. These mechanisms provide for the rise of respective indicators in 2020 by 30% for oil and by 60% for natural gas, and by 40% for oil and by 95% for natural gas in 2025.

Researchers worked out energy-efficient technologies for the combustion of by-products of coal preparation to reduce the use of high-energy coal by cogeneration plants, burning lignite in boilers that use circulating fluidized bed coal combustion or in high-pressure solid-fuel combined-cycle units with circulating fluidized bed. A water boiler for communal cogeneration plants was developed; it saves up to 40% of natural gas and is 30% less expensive than its foreign analogs.

The work on upgrading and increasing the service life of power plant energy equipment is going on. In particular, Academy specialists worked out a radically new system for thermostressed state diagnostics and evaluation of the degree of wear of high-temperature cogeneration turbines, and 'Regina' hardware and software packages for monitoring the operation of power sector systems. To extend the safe service life of NPP power units, they developed and deployed a novel technology for reconstructing irradiated witness samples of the of WWER reactor vessel metal that meets modern international standards.

The sphere of public health in Ukraine needs an urgent and radical improvement. The procurement of medicines and medical equipment produced abroad is one of the most costly items of the state budget, so the development and practical introduction of domestic pharmaceutical preparations is very timely. This very issue was discussed at a recent joint session of the presidiums of NAS and NAMS of Ukraine, which was also attended by pharmacologists.

Today the Academy already has unique facilities for developing medical preparations and equipment; its scientists are carrying out a wide range of fundamental and applied research that will permit them to produce new technologies and means for the treatment of numerous most common diseases.

Striking examples of successfully deployed developments of our researchers are novel preparations for prevention and treatment of oncological, cardiovascular, neurological and infectious diseases, 'Feroplat', 'Mebiphon', 'Corvitin', 'Calmivid', 'Corektin', 'Flokalin', 'Silix' etc. being among them.

Last year, a technology of vascular screening was patented and introduced to treatment practice. This unique technology is already used for the examination and rehabilitation of fighters wounded in the antiterrorist operation zone, alongside with the portable software and hardware ECG-photometric equipment. Those permit prompt evaluation of the function of cardiac muscle and vegetative regulation, as well as that of peripheral vascular system.

The contribution of Academy's scientists to ensuring the food security of the nation was also significant: they introduced high-yield varieties of winter wheat that were recognized as new achievements in breeding, proposed novel optimal systems of mineral nutrition, plant protection, and fertilizers.

No doubt, a radical renewal is also necessary in other spheres of the economy and social life in general. Academy's scholars can and must play a more noticeable and significant role in the scientific support to this.

In the reporting period, continuous and persistent efforts for financial, logistical and manpower provision of scientific research were made.

The law of Ukraine 'On the State Budget of Ukraine for 2014' approved NAS financing from the general fund of the State Budget at UAH 2,497.8 million. In fact, it remained at the same level as in the previous year, and our institutions were faced with a considerable money deficit, including the deficit of wages fund. Besides, the Government took measures towards reducing budgetary expenditures of state-supported agencies and institutions.

The current year is going to be even more difficult. The Law of Ukraine 'On the State Budget of Ukraine for 2015' approved the financing of the NAS of Ukraine from the general fund of the State Budget at UAH 2,306.2 million, which is by UAH 191.6 million less than in 2014. Such a reduction in the total finance will lead to a decrease in basic finance, in expenditures for targeted programs of NAS departments and all-Academy research programs by approximately 8%.

Unfortunately, the lack of budgetary finance resulted in a very grave situation concerning the renewal of material resources for research. For the fourth year running, Academy's budget had not provided for expenses for the centralized purchase of unique scientific instruments to set up new centers for shared use of research equipment and upgrade and expand the existing ones.

In view of this, even more pleasant and, undoubtedly, important event was the finished construction of the subcritical nuclear research facility 'Neutron source based on subcritical assembly controlled by a linear electron accelerator' at the National Scientific Center 'Kharkiv Institute of Physics and Technology'. It is expected that the new nuclear installation, whose construction was financed by the US Government, will provide Ukraine with new research opportunities in such areas as radiation materials science, nuclear physics, power engineering etc. It will also be able to produce isotopes, primarily, for medical use, viz., for diagnostics and treatment of various cancer diseases. And that is a direct way to the development of nuclear medicine, which is so necessary for meeting the needs of Ukrainian people.

Last year, as before, the Academy took various measures to deal with the personnel problem. The top priority here was given to the involvement of talented youth to research and retention of them in science. Realizing that prospective researchers are to be trained since their school days, Academy scholars are continuously engaged in discovering and supporting gifted schoolchildren. This is done, mainly, at the National Center 'Junior Academy of Sciences of Ukraine'. Such cooperation bears fruit. In 2014 alone, about 40 young specialists who in their school years had attended various study groups of the Junior Academy of Sciences came to work at NAS institutions.

Despite certain financial problems, we continue to develop various forms of addressed financial support to young scientists and their research. Those are grants and scholarships of the NAS of Ukraine, prizes and scholarships of the President of Ukraine, Verkhovna Rada of Ukraine, annual NAS prizes for young scholars. By the way, the Academy increased their amounts in 2014. Of great importance are regular scientific presentations of young scholars at NAS Presidium meetings. Later, opened for them are departmental projects that get additional finance, and the best works are published in the framework of the 'Academic book. Young scholars' project.

The work on setting up councils of young researchers within Academy's departments has become more active. 10 of them have already organized such councils, and in 4 more the process is under way. Last year, departmental councils of young scholars held a number of popular-science events, in particular 'Science Days' in Kyiv and Kharkiv, during which popular-science lectures were given and interesting scientific experiments demonstrated.

At the same time – it should be admitted frankly – extremely important and long-pending problems of involving young people in science still remain unsolved. Those are the inability to provide housing for young researchers, low salaries and fellowships for post-graduate and doctoral candidates, and, what is most important for experimenters, absolutely inadequate upgrading of experimental facilities by procuring state-of-the-art foreign research equipment that does not have analogs in Ukraine.

As far as foreign international ties are concerned, 2014 witnessed a broader participation of the Academy in some international programs and initiatives. Due to our active stand and successful negotiations with relevant structural units of the European Commission, the UC Joint Research Centre in particular, the Academy is in charge of implementing all the 11 areas of the EU Strategy for the Danube region in Ukraine; the respective work has already been started.

In pursuance of the agreement that had been signed between the NAS of Ukraine and the Polish Academy of Sciences, the first competition was held last year. According to its results, the 2014 Prize of the National Academy of Sciences of Ukraine and the Polish Academy of Sciences was awarded to the research team of the NAS Institute of Radio Astronomy and the PAS Space Research Centre.

The long work towards opening the Office of the Polish Academy of Sciences in Kyiv was successfully completed late in 2014, and we hope that in spite of today's difficulties our Academy will also be able to open its office in Poland.

Integration processes also develop through participation of Academy's specialists in numerous international programs and projects. This concerns, in particular, the UNESCO Program 'Man and Biosphere'. In 2014, the Working Group for developing the Draft Strategy was set up, and participants in the Action Plan to implement this program in 2015–2025 were identified. A NAS representative was included in the group.

It should be pointed out that our scientists have been continuously integrated into the activities of numerous international science centers and associations for a long time. This is proved, among other things, by their fruitful work in joint research under projects of ECNR, the International Association for Geospace Studies etc. 86 projects, i.e. nearly a half of all Ukrainian ones, of the recently completed EU 7th Framework Programme were implemented at the Academy.

The presence of NAS scientific periodicals in the international academic space is broadening, though not so fast as we would like it to. Of 87 our journals, foreign publishers re-issue 21 in English. 10 more Academy journals are published in English in Ukraine: these are prepared and published by NAS institutions. The number of journals issued in English is increasing annually. Last year the Center for Mathematical Modelling of Ya.S. Pidstryhach Institute of Applied Problems of Mechanics and Mathematics, in collaboration with the National University 'Lvivska Politechnika', founded a new English-language S&T journal «Mathematical Modeling and Computing», which will give coverage to recent developments in mathematical modelling and information technologies.

Coming to the end of my report, I would like to emphasize once again that the previous and current year is the time of ordeal. Scholars of the National Academy of Sciences of Ukraine have never shirked from the most important challenges of the nation, always contributed to the advancement of science in Ukraine, scientific provision for technological, socio-economic and cultural progress of the nation. Research teams of the Academy will save no efforts to ensure concrete positive changes in the economy of the state, strengthen its defense potential and arrange peaceful life in the country.

R&D in Nanotechnologies and Nanomaterials

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

In 2014, institutions of the NAS of Ukraine completed the implementation of the state targeted S&T program 'Nanotechnologies and nanomaterials' and the NAS integrated targeted program of fundamental research 'Fundamental Problems of Nanostructured Systems, Nanomaterials, Nanotechnologies'.

Contributors of the projects supported in framework of these programs obtained significant basic scientific results that became the groundwork for developing novel nanomaterials, nanodevices and nanotechnologies.

Among these are new methods of controlled functionalization of surfaces and metal nanoparticles by organic monolayers for using them in molecular electronic and electroluminescent devices as well as nanobiotechnologies; results of studying heterostructures with quantum wells and delta-doped barriers that are promising for the development of terahertz devices; synthesis of materials shaped as porous layers and nanopowders based on porous silica, which can be effective luminophores for converting ultraviolet radiation into visible white light.

Our materials scientists were able to significantly improve the mechanical properties, corrosion resistance, and biocompatibility of pure nanocrystalline titanium, which permits a wider use of titanium in medicine and engineering; they created nanoceramic materials based on silicon nitride that extend the service life of mechanisms at high temperatures and in corrosive environments, developed high-entropy coatings for improving the wear resistance of cutting tools, and synthesized effective nanolubricants.

In the field of nanoelectronics, resonant tunneling structures based on silicon nanowires and nanowhiskers were developed to be used in ultra-sensitive accelerometers; charts of manufacturing diode chips with nanostructured diffusion barriers and prototype Gunn diodes with output parameters at the level of world analogues were produced; a technology of interference lithography intended for manufacturing optical elements of spectral devices, optical sensors, photodetectors, and polarizers was developed.

In the framework of projects in nanochemistry, technologies of producing structured nanophase catalysts for the removal of toxic contaminants from gas emissions, for oxidation of hydrocarbon fuel in catalytic heat generators, and for producing hydrogen fuel were developed; technologies of building nanocomposite ion exchangers for filtering water, industrial wastewater and liquid foodstuffs were prepared for deployment; nanostructured composite materials for producing photo adhesives, components of marking paints, coatings, and luminescent materials were developed.

In the area of biotechnologies, new nanostructured biomolecule receptors for producing pharmaceuticals and nanomaterials for biomedical applications were synthesized; on the basis of the nanostructured bioactive ceramics obtained, pilot production of implants for bone regeneration and targeted drug delivery was started; a biocompatible nanocomposite for diagnosis and treatment of cancer diseases was created.

In power engineering, nanocomposite electrode materials for supercapacitors were developed; the problem of replacing graphite with silicon in anodes of lithium-ion batteries in order to increase their capacity was solved; nanocomposites for photoelectrochemical solar energy converters were obtained.

A testing laboratory for measuring geometrical parameters of nanostructure surfaces in accordance with UkrSEPRO requirements was set up and already carries out orders of enterprises.

Some of the R&D results have already been introduced in production. In particular, I.Frantsevich Institute for Problems of Materials Science founded a start-up company for producing nanopowders in the amounts of up to 350 tons annually. G.V. Kurdyumov Institute for Metal Physics, in cooperation with MELTA Ltd, launched the production of nanocrystalline magnetic tape. By now about 1 million of high-efficiency transformers and chokes have been fabricated with this tape. The NAS Gas Institute created a pilot facility for producing nanolamellar oil sorbent, which is used for eliminating oil and oil product spills. The 'FED' machine-building plant deployed the technology of superhard coating deposition on plungers of fuel equipment for aircraft, which had been developed at the NSC 'Kharkiv Institute of Physics and Technology'.

Research and development in the field of nanotechnologies and nanomaterials will remain one of the top priorities in more than 40 research institutes of the NAS of Ukraine that specialize in physical, chemical and biological science and engineering. Works in this area will be continued under the NAS targeted program 'Fundamental Problems of the Development of New Nanomaterials and Nanotechnologies', planned for 2015–2019. Deployment of the results obtained will be carried out both in the framework of scientific and engineering projects selected through the Academy competition and in collaboration with industrial enterprises.

Advancement of Research towards Development of Highly Efficient Plant Varieties in the NAS of Ukraine

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

Researchers of the National Academy of Sciences (NAS) of Ukraine have been carrying out long-term cutting-edge studies to elaborate the genetic basis for producing highly efficient plant varieties. The complex of these fundamentals is a promising line of research towards genetic improvement of plants.

E.g., over 140 novel cereal crop varieties and hybrids were developed using the genetic and breeding approaches at the NAS Institute of Plant Physiology and Genetics (IPPG). New crops were introduced to the State Register of Plant Varieties and have been sown annually over the areas of 1.5–5.5 million hectares in all regions of Ukraine and abroad. These novel varieties of winter wheat and maize hybrids demonstrate remarkable genetic potential and resistance to extreme weather; they produce high yields and grain quality as well.

High-yield maize hybrids of the IPPG breeding allowed the cultivated areas in Ukraine to be enlarged; they are superior to the best foreign maize hybrids. In turn, the winter wheat croppage exceeds 6 million tons or amounts to 85% of the Ukrainian population's demand in food grain. Moreover, such wheat varieties as 'Smuglianka', 'Zolotokolosa' and 'Favorytka' produced a record harvest of 124–131 metric centners per hectare for the first time in the history of Ukraine.

The genetic potential of cereal crops has been improved by the molecular-genetics-assisted breeding developed at the NAS Institute of Food Biotechnology and Genomics to identify the genes that confer wheat and barley resistance to various fungal diseases, brown and stem rust included. Scientists of this institute conducted a large-scale screening of the collections of Ukrainian wheat and barley cultivars in order to reveal the genes of resistance, primarily, to diverse strains of the stem rust. The genetic diversity of wild wheat-related species from all over Ukraine as a potential source of genes of resistance to fungal diseases was investigated, which helped identify a pool of useful genes for wheat breeding.

One of the important strategies of enriching plant genetic resources and developing domestic agriculture is plant introduction with further breeding of the most promising varieties. The undoubted leader in this field is M.M. Gryshko National Botanical Garden of the NAS of Ukraine, where 66 useful plant species were successfully introduced; those formed the basis for the development of over 300 novel varieties. It is to be noticed that 292 of them were catalogued in the State Register, which represents over 21% of all species and about 4% plant varieties, including 55 fruit crops, 9 vegetable crops, 19 bioenergy crops, 34 fodder and green manure crops, 13 aromatic, and 154 flowering and ornamental plants. Novel plant varieties have no equals and compare favourably with traditional cultivars in high yields, exceptional nutritional value and ecological plasticity.

Particular mention should be made of the high-yield plant varieties of varied use that were developed by the breeders of other Academy institutions. E.g., Donetsk Botanical Garden of the NAS of Ukraine enlarged the State Register with 67 new plant varieties, namely, 4 vegetables, 9 fruits and berries, 2 forage crops, 2 medicinal, and 50 ornamental plants. In the Kryvyi Rih Botanical Garden of the NAS of Ukraine, 18 new varieties of daylilies were nurtured. The 'Sofiyivka' National Arboretum of the NAS of Ukraine produced 2 pear varieties and continues working on new hazelnut varieties. The NAS Institute of Food Biotechnology and Genomics, in collaboration with the NAS National Botanical Garden, has already produced 5 new varieties of energy crops and are completing breeding of 4 more.

It is of utmost scientific and economic importance to maintain the unique collections (germplasm) of useful plants from all phyto-geographical regions of the world that were accumulated by NAS research institutions. Those are the source of genetic information and reserve seed bank, helping, at the same time, to ensure the protection and conservation of genetic plant resources.

Since the high genetic potential of innovative varieties can only be implemented under well-established seed farming, the work of Ukrainian scientists aimed at forming the seed resource base for large-scale introduction of new varieties seems to be imperative. Researchers of the NAS of Ukraine, in collaboration with the Ukrainian Ministry of Agriculture, have established a network of base farms for growing new varieties throughout the country, which is an essential contribution to food supply in Ukraine. Indeed, the NAS Institute of Plant Physiology and Genetics has concluded and implemented 2 785 license agreements for industrial growing of cereal crops varieties.

It is of vital importance to take steps towards radical improvement and advancement of genetic studies for furthering Ukrainian genetic and breeding research. At the moment, that requires a coherent policy able to ensure an effective support to the development and large-scale adoption of new domestic varieties with high genetic potential, productivity and ecological plasticity. Furthermore, it is expected that the government will set agricultural production among national economic priorities that will enhance the role of Ukraine as a major world grain producer and exporter.

Socio-Humanitarian Dimension of Changes in the Ukrainian Society

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

In the reporting year, the efforts of researchers of the NAS Section of Social Sciences were focused on interdisciplinary studies of social transformations in Ukraine, determining their main trends and mechanisms of correction, providing proposals towards the development of state policy instruments to minimize the negative effects of imbalances in the society and economy.

Scientists of the NAS Department of Economics in the preparation of the National Report 'Innovative Ukraine 2020' developed basic provisions of nation's innovative development strategy under further integration of Ukraine into the European and global economic, scientific and technological space.

It was proved that modern forms of resolving institutional contradictions between globalization and spatial and territorial localization of economic activities are interstate integration, profound decentralization and regionalization of power, financial and organizational autonomy of non-profit institutions.

Methodological approaches were validated with a view to identifying dangerous macroeconomic imbalances in Ukraine under current unstable conditions of the global and domestic economies.

Institutional principles were formed to maintain the stability of public finances and expand the fiscal space of economic reforms, ensure budget decentralization, introduce international standards into the public finance management system for improving their transparency.

Proposals for changes in the legislation of Ukraine concerning the rights and freedoms of internally displaced persons were substantiated. Problems of civil society development were systematized, and proposals towards civil society formation under conditions of systemic crisis and war conflict were validated. Main principles of nationalization, requisition, confiscation as special grounds for terminating the property rights were determined.

The methodology for forecasting structural changes in Ukraine's economy under the integration process was refined, and the medium-term forecast scenario of the national economy under the implementation of the EU–Ukraine Association Agreement was worked out.

Scholars of the NAS Department of History, Philosophy and Law determined main trends in the perception of economic, social, political, informational, spiritual and cultural processes by the country's citizens. Varied levels of public confidence in the government institutions were discovered; the nature of relations between ethnic groups in the society was determined; migration intentions of the population were analyzed; prevailing emotional sentiments in the society were found.

Theoretical and practical frameworks of new space-time approach to the analysis of regional peculiarities of Eastern and Southern Ukraine were developed; historical sources of imbalances and asymmetries in the development of these regions were studied; the processes of forming political orientations, mentality and historical memory of the local population were analyzed.

Of great scientific and practical importance is the development of valid proposals for public authorities towards improving the constitutional law of Ukraine and domestic legal framework to prevent and combat separatist violence.

A number of fundamental works was published: «Taras Shevchenko: Bibliography of 1840–2014 Editions»; the 1st volume of collective monograph «East and South of Ukraine: Time, Space, Society»; the 23rd volume of the 50-volume Collected Works of Mykhailo Hrushevsky; sociological monitoring of the NAS Institute of Sociology «Ukrainian Society. 1992–2014. State and Dynamics of Change». The 14th and 15th volumes of the «Encyclopedia of Modern Ukraine» were prepared for publication.

Scholars of the NAS Department of Literature, Language and Art Studies completed and published the fundamental academic work «Shevchenko Encyclopedia» in 6 volumes, finished the work on Complete Works of T.H. Shevchenko in 12 volumes; its final volumes were published in the reporting year. Among the outstanding research outcomes of the Department one should mention the 4th volume of the fundamental 12-volume study «History of Ukrainian Literature».

The linguistics institutions also created a number of important works. These include the monograph by NAS Academician H.P. Pivtorak «Ukrainians: Where We and Our Language Come From. Studies, Facts, Documents». Among lexicographical works one should note the 5th volume of the fundamental academic «Dictionary of Ukrainian Language» in 20 volumes.

Researchers analyzed drivers and key features of popular protest that arise from Ukrainian ethnic psychology, and the national idea embodied in the millennia-old culture of Ukraine. A version of this idea, its main characteristics and possible ways of modernization were proposed. The book «Independence and Ukrainian National Idea» was prepared and published (A.Ye. Kravchenko).

In the short term, the efforts of researchers of the NAS Section of Social and Human sciences will be focused on the studies of highly relevant issues of state development, social and socio-economic progress of Ukraine. The leading place among them is taken by the scholarly support to profound structural reforms, the development of effective mechanisms to overcome social tensions, economic crisis and political confrontation in the country, ensuring national economic, social and information security in the conditions of accession to the European space and the presence of internal and external opposition to it.

NAS of Ukraine in International Programmes

A.G. Zagorodny, Vice-President of the Academy

The core of the NAS international cooperation activities is a variety of direct bilateral links. Annually hundreds of projects are implemented, joint scientific events held and studies carried out, using the technological facilities and methodological possibilities of partners. At the same time, participation in international programmes, which implies the coordination with research teams of various countries, highlights the potential and experience of our Academy's experts and demonstrates certain peculiarities in organizing international cooperation.

Continuous participation of the Committee for Systems Analysis, operating under NAS Presidium, as the Ukrainian member organization in the activities of the International Institute for Applied Systems Analysis (IIASA), joining a number of previous projects at the level of individual institutions, enabled the Academy to shift to another mode of cooperation – participation in implementing the joint research project 'Integrated modeling of food, energy and water (FEW) security management for sustainable social, economic and environmental development'. This project is of universal nature in terms of its relevance for the safe use of FEW resources for all countries. Its annual books of proceedings describe methodological approaches to and changing trends in the major threats and would be of use for managerial decision-making on security and sustainable development.

The participation of Academy experts in the NATO programme 'Science for Peace and Security' is of great significance. The projects supported under this programme deal mainly with detecting hazardous substances and preventing the negative impacts of disasters. They embrace such research areas as studies of sensory properties of novel materials and their applications, environment protection, and the use of information and computer technologies. Last year, NAS institutions carried out the total of about 20 research projects in the framework of this NATO programme.

2014 demonstrated a high degree of Academy's involvement in UNESCO research programs. That is seen, in particular, in its participation in the sessions of the UNESCO Executive Council, as well as in those of the International Coordinating Council of the 'Man and the Biosphere' program, in Ukraine being elected a member of the UNESCO Executive Council for the period up to 2017, and including the NAS representative in the UNESCO-MAB Strategic Group. Last year the Academy also worked out proposals towards setting up the Interagency Committee on the Implementation of UNESCO International Hydrological Program and the Program on Hydrology and Water Resources of the World Meteorological Organization in Ukraine. The participation of NAS scientists in elaborating the MAB Strategy for the next decade became the proof of their experience in MAB Program implementation.

The visit of I. Bokova, UNESCO Director-General, to NAS and her participation in the special session of NAS Presidium devoted to the 60th anniversary of Ukraine's UNESCO membership, became a distinctive event demonstrating a high level of cooperation between our Academy and UNESCO.

Among the significant achievements of several Academy institutions are their active participation in CERN research. In particular, the equipment for electron-positron CLIC (Compact Linear Collider) has been developed and updated, the analysis of experimental data obtained within the ATLAS project was continued, the search for exotic particles beyond the Standard Model was conducted, participation in HERA-B, LHCb, GSI, MEDIPIX, EURECA collaborations was supported, etc.

It is worth noting that NAS has been entrusted with the scientific support to and management of the EU Danube Strategy (EUSRD) implementation in Ukraine. The trans-boundary Strategy of climate adaptation in the Danube Delta has been developed jointly with Moldavian and Romanian partners. The timely implementation of measures for adaptation to climate change will permit preserving natural and industrial potential of the region, raising its competitiveness and providing sustainable development. The FP 7 EC project Danube-INCO.NET, aimed at supporting EUSDR in research and innovations, was focused for Ukraine on two priorities, namely, 'Knowledge society' and 'Region's competitiveness'.

The summarizing of the FP 7 EC, which has already been completed, shows the dominant role of NAS institutions among all Ukrainian participants. They were involved in more than 90 projects of the 170 ones implemented in Ukraine, the research subjects of those covering nearly all fields of NAS activities.

As far as the immediate prospects of NAS participation in international programmes are concerned, we consider 'Horizon 2020' and 'Euratom' as the most important ones. The association to the former is almost decided at the government level. The latter is of great importance for the safety of peaceful use of nuclear energy, research in the field of fusion and joint development of advanced technologies in the nuclear sphere. It should be noted that despite Ukraine formally remaining out of this programme, NAS institutions were involved in the realization of 3 projects. Now, relying on the extensive experience of nuclear fuel diversification for domestic nuclear power plants, the implementation of new projects begins in collaboration with EU partners to support the licensing of USA-produced nuclear fuel for WWER reactors in EU countries.

Activities of NAS General Meeting and Presidium

V.L. Bogdanov,
Acting Chief Scientific Secretary of the Academy

In the reporting year, the General Meeting and Presidium of the NAS of Ukraine focused their activities on further advancement of modern trends in science and technology, scientific provision for dealing with important challenges of the socio-economic, socio-political and humanitarian development, deployment of R&D results, the efficient implementation of the Concept of NAS development.

The annual reporting meeting of the NAS of Ukraine summarized Academy's work in 2013 and set priority tasks for the near future. It placed the main emphasis on the essential improvement of NAS activities and increasing its contribution to solving state problems.

Last year, meetings of NAS Presidium considered and analyzed issues of the national scope. Substantiated were the areas of Academy institutions' participation in the R&D support to the nuclear power sector of Ukraine that is aimed, first and foremost, at the safe exploitation and extension of the operation life of active NPP generating units.

The Presidium gave special focus to creating and commissioning, in cooperation with the Argonne National Laboratory (USA), of the unique nuclear facility at the National Science Center 'Kharkiv Institute of Physics and Technology'. That is a neutron source based on a subcritical assembly, which will be used in research in radiation materials science and radiation medicine and is a very promising tool in developing new safe power sources.

In the sphere of power engineering, Presidium also considered numerous issues of safe exploitation of powerful energy units, in particular, the development of a procedure for a significant vibration reduction, production and mass manufacturing of modern high-voltage electric cables intended for 330 kV, which are in great demand. Provision of Ukraine with its own energy resources that would rely on promising oil and gas deposits and alternative sources of natural gas (shale gas, methane of coal deposits, gas-hydrates of the Black Sea) was considered.

According to the results of the discussion by NAS Presidium of the ways to solve the problems of involuntary migrants from Donbas, relevant analytical data and proposals were prepared and sent to the Government. Also considered were issues of restoring the infrastructure and reconstructing the industrial sphere of Donbas, transferring Academy institutions and organizations situated in the ATO zone to the territory that is controlled by the Ukrainian authorities.

A joint session of the presidiums of the NAS of Ukraine and the NAMS of Ukraine, attended by major producers of medical drugs, discussed the issue of great social and economic importance – the development and production of domestic medical preparations in close collaboration of research institutions of both academies and leading pharmaceutical enterprises.

Continuous attention on the part of Presidium was given to the participation of Academy institutions in the nation-wide events for the preparation to and commemoration of the 200th anniversary of T.H. Shevchnko's birth.

Top priority was given to analyzing the status and prospects of the advancement of purpose-oriented fundamental and applied research, its financial provision and logistics. In particular, a positive assessment was given to studies in laser physics that produced world-level results confirmed by high citation index in prestigious scientific editions. International recognition was also won by studies towards the development of novel scintillation materials that can register record-breaking low ionizing radiation, research of the Universe with the world-largest decameter radio telescope and УРАН interferometer system.

Cutting-edge developments that are competitive in the international markets include state-of-the-art technologies of welding heavy-duty products, methods for predicting the state of metal and welded joints of nuclear reactor vessels, modern mining machines and technologies for mining, processing and cleaning coal and other mineral raw materials, novel methods and equipment for long-term information storage on sapphire disks. Of great importance for numerous industries is the development of modern chemical power sources and their mass manufacturing under the scientific supervision of NAS scientists.

In the reporting year, NAS Presidium directed a lot of its work towards significant improvement of Academy's activities. The plan of implementing the tasks and measures of the Concept of NAS development in 2014–2023 was discussed in detail and approved, its realization was regularly monitored. Measures for forming and implementing new integrated research programs, promoting ties with foreign scientific organizations, optimizing the network and updating the areas of research of scientific institutions were discussed. Besides, a new procedure of assessing the reports of Academy scientific institutions about their research and research-organizing activities was adopted. According to it, reports of 12 institutions were heard, and resolutions for improving the efficiency of their work were adopted.

Mathematics

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

In 2014, the efforts of scientists of the Department were aimed at important fundamental research in mathematical sciences. A number of significant results were obtained.

Experts in the field of differential equations and dynamical systems constructed the theory of boundary-value problems for operator equations with generalized invertible operator in Banach and Hilbert spaces. The correlation between the properties of a topological semigroup of all continuous self-mappings and the possible values of topological entropy of its elements was established. The unique solvability in various functional spaces for a problem with integral conditions for the time variable and the conditions of almost-periodicity in spatial coordinates for linear equations with partial derivatives was studied.

In the field of mathematical physics and functional analysis, a new approach to the study of Bogolyubov transformation, which is well-known in mathematical physics, was proposed and developed. The Hille problem concerning the possibility of representing a semigroup of linear operators in the Banach space by the exponential function of its generators was solved. A method of reducing the Cauchy problem for non-Archimedean pseudodifferential equations on the class of radial functions to integral equations similar to the classical Volterra ones was developed. A method that enhances the stability of algorithms of inverse problem solutions and allows one to minimize the error caused by the inaccuracy of observational data was proposed. The method was validated by numerical solutions of some inverse problems of the theory of small vibrations of mechanical systems. A mathematical model of two-dimensional photonic metamaterial with given lacunae in the spectrum was constructed. The central limit theorem for the linear statistics of the eigenvalues of really symmetric matrix models in the case where the trial function has a jump was proved. The analytical-numerical method for solving nonlinear equations of the Hammerstein type, which is based on the concept of generating polynomials, was generalized. The method of Maxwell's equations integration in a Riemann space was proposed on the basis of the first-order spinor formalism, and the explicit isotropic solutions of the equations in certain spaces were obtained. The homomorphisms of the algebra of symmetric analytic functions on a complex Banach space with symmetric structure were studied. The conditions of Arens regularity of a symmetric tensor product of Banach algebras and the conditions of symmetric regularity of the tensor products of Banach spaces were established.

In the theory of probability and mathematical statistics, the study of the problem of large deviations for random evolutions in the scheme of asymptotically low diffusion was continued. Some new types of singularly perturbed pseudodifferential operators that correspond to stable processes were constructed and their properties studied. The investigation of two-parameter multiplicative dynamical operator stochastic systems with independent increments was advanced significantly, and algorithms were developed for solving operator differential stochastic equations, which are perturbed by both independent multiplicative dynamical stochastic systems and those dependent on them.

In algebra, geometry and topology, the Poincaké–Hopf theorem was proved for singular manifolds whose singularities are generated by semi-free actions of a circle. A new method for studying vector bundles and derived categories over noncommutative manifolds was proposed. For the first time, a reduction method was developed, which allows one to explicitly describe the domain where the invariant bi-Poisson structures on the co-tangent orbit bundles of the adjoin representation of Lie groups have the Kronecker property. Relying on it, the integrability of geodesic flows for a wide class of invariant metrics on the homogeneous spaces of the orthogonal group was proved.

In the field of mathematical problems of mechanics, a number of specific multimodal nonlinear mathematical models were created on the basis of non-classical variation principles of mechanics. These models are oriented to the solution of problems of the dynamics and stability of fluid-filled mechanical objects of the booster-rocket type for space vehicles, tankers, tank-cars, etc. The Green function of the thermoelasticity problem for a half-space with fixed boundary was constructed, and its stress-strain state under heat release in a disk-like domain, which is parallel or perpendicular to the boundary, was studied. A method to solve the axisymmetric dynamical problem of elasticity theory for a layered ring loaded by normal forces varying in time was proposed, and the calculation of stresses in plates with an arbitrary number of layers was carried out. For some modes of the technological heating of piecewise homogeneous thermosensitive shells in the presence of heat sources and a force load, a version of the method of optimizing these modes was developed with the use of local variations method. A mathematical model of elastic wave interaction with a layered structure that contains a porous medium layer saturated with gas and water was developed. On the basis of the perturbation method, a procedure to determine a finite number of the eigenfrequencies and the amplitudes of nonlinear vibrations of the elongated layered cylindrical panels with a generatrix of an arbitrary form is developed.

In mathematical modeling and computational and applied mathematics, the sufficient conditions of convergence of the Marchenko asymptotic series for the eigenvalues of the Sturm–Liouville problem with a polynomial potential were found using the functional-discrete method.

Information Science

P.I. Andon,
Acting Academician-Secretary of the Department

Scientific research at the NAS Department of Information Science is carried out by 1,000 highly qualified scientists, 12 NAS academicians and 17 NAS corresponding members. The Department consists of seven institutes. It provides scientific and methodological guidance for two more institutes and one center, it also collaborates closely with many Ukrainian universities.

Some specific examples of numerous important scientific results of 2014 should be mentioned.

In the area of control systems, under parametric uncertainty and in the presence of limited measurement interferences, solutions to the problems of suboptimal control synthesis for nonlinear systems (spacecraft, in particular) were obtained in the analytical form. Methods and algorithms were developed for moving objects control under uncertainty to solve the 'soft landing' problem with providing the agreement of objects' coordinates and velocities. Optimal ellipsoidal upper values of the accessibility of continuous and discrete dynamical systems with limited external disturbances were developed.

In mathematical modeling, scientists proposed analytical and statistical models of call center's call-processing as a service system with application returning; on that basis they developed algorithms for evaluating probability characteristics of the call-processing center. Mathematical models of unsteady fluid motion in a multicomponent soil environment were constructed as initial boundary problems with non-ideal contact coupling conditions (with discontinuous solution) for elliptic pseudoparabolic equation.

In the theory and computer technologies of information security, new powerful antinoise codes for data transmission and information compression were developed, alongside with novel methods of indeterminate cryptography. Department's scientists constructed a hybrid steganosystem that significantly improves the stability and capacity of steganographic channel. They proposed a set of models and tools that allow computer network vulnerabilities to be determined in advance.

A draft strategy of the national security of Ukraine was worked out. It requires a new model of new-generation global equilibrium search for solving problems on the maximum weighted section of high-dimensional graph. Researchers proposed a new technique for long-term forecasting of the function of the state of non-linear, non-autonomous controlled processes and fields of various nature, as well as a methodology and tools for system forecasting and prediction of negative social trends and natural disasters. They developed methods for addressing tasks of combinatorial on-line optimization that take into account environment changes under uncertainty.

In the area of information technologies and systems, developed was a model of tool complex for ontological application, as well as architectural and structural setup of unified knowledge-oriented system with ontology-driven architecture. Theoretically established for the first time were convergence conditions for a certain class of learning processes of neural networks, and proposed was a method of generalized reverse operator for controlling non-linear multidimensional systems under uncertainties. Developed were theoretical backgrounds of merging unequal and heterogeneous information received from numerous sources in network-centric systems.

Scientists constructed a prototype of spatial model of human being and developed means to control animation process on its basis, as well as an information technology for implementing the Ukrainian finger sign language. They developed a novel complex of models and methods for constructing electronic networking educational environment with improved characteristics of flexibility and equilibrium. They produced the ontology of rational choice task and a technology of knowledge extraction in the process of semantic content analysis of network-distributed information arrays.

In the field of programming, logic-based mathematical principles of entity computer science were worked out. A radically new method of conceptual relativization was developed. A specification language was proposed for applied systems and verification algorithms oriented towards their analysis, which permits a compact description of the whole range of possible behaviors (stories or tracks) of the systems investigated. For the first time, relying on variability and verification mechanisms, researchers generalized the automatic compound method for web services to provide adaptability of the service obtained to changing consumers' needs and use conditions.

In the field of high-performance computing facilities, upgraded and improved was the energy efficiency of the SKIT supercomputer complex, and its data storage system was increased to 150 terabytes.

Mechanics

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

In 2014, efforts of scientists of the Mechanics Department of the National Academy of Sciences of Ukraine were focused on fundamental and applied research aimed at the development of scientific and technological potential of the nation. New significant results that are of great importance for the economy of Ukraine were obtained.

Computational methods were developed and the stress-strain state was investigated for elastic composite shells with reinforced holes; main characteristic mechanical effects which cannot be foreseen *a priori* were discovered. Effective numerical-and-analytical approaches were developed to study nonstationary deformation of an elastic half-plane and the control problem of nonstationary oscillations of the acclivous spherical shell consisting of thin elastic and electroelastic layers.

Peculiarities of the influence of elastic and geometric parameters on the distribution of stress and displacement fields, as well as dynamic characteristics of anisotropic inhomogeneous shells, were established. Methods were developed to solve axisymmetric problems of thermal conductivity and thermoplasticity for structural elements of revolution under thermomechanical reloading. For a set of trajectories of dynamical system with aftereffect under impulsive perturbations, the principle of comparison with the matrix-valued Lyapunov function was formulated and sufficient conditions for various types of stationary solution stability were established. Equations of nonlinear deformation of a body with tension crack on the piece-wise diagram of material deformation were constructed.

A synergetic effect of flows of monatomic oxygen and ultraviolet radiation of the solar spectrum on the accelerated degradation of spacecraft polymer materials was found in physico-chemical modelling of the interaction between a spacecraft and the Earth ionosphere. It was shown that in the spacecraft missions over 2 years at altitudes above 400 km the degradation of geometrical, weight, and thermal and optical characteristics of polymers increases several times, resulting in a reduced spacecraft life. Dependencies were derived to predict variations in polymer properties in orbit.

Relying on the regularities in static and long-term deformation of heat-resistant materials for a limited time of investigation, a method was proposed for extrapolation of long-term strength curves to the lifetime values exceeding the available experimental data by a factor of 25-50; a modified version of Yu.N. Rabotnov's theory, which takes into account nonlinear damage accumulation, was also developed. This significantly increased the accuracy of calculating the long-term strength for the long-term service life prediction, as compared to the known theories, and reduced the costs of experiments. The results obtained can be implemented for the design, manufacture and extension of the equipment service life in heat-and-power industry.

Researchers determined the effect of the degree of aero mix stream twist on separation of the disperse phase that is ignited and burns in the cylindrical channel of aerodynamic reactor and the multiplication of plasma source energy at the reactor outlet, depending on the initial parameters of the fuel mix (temperature, particle concentration, chemical composition, etc.). They obtained rational geometric parameters of the reactor as a part of thermal power plant burner, namely, the length at which the highest multiplication of the plasma torch energy is achieved, the reactor diameter at which the ignition and combustion of heavy particles of coal fuel mixture occur, and determined conditions when there is no slagging of the inner surface of the reactor during energy conversion of low-reactive coal of the ASH type.

Compositions of regular inhomogeneities on the streamlined surface were proposed that are capable of generating quasi-steady longitudinal vortical structures of specified scale. A principal possibility of reducing drag on such surfaces was shown. A calculation procedure was developed for the engineering protection of territories from pollution and underflooding by ground water with using radial drainage and artificial geochemical barriers.

Scientists carried out interdisciplinary studies of the mechanical and electrochemical properties of new-generation and conventional lead alloys for chemical current sources (stationary and lead-acid starter batteries) which are able to work in conditions of active mechanical action, such as vibrations and strong overload, as well as in unstable discharge-charging processes. The results obtained are relevant for designing and manufacturing general-purpose batteries and batteries for specialized and military equipment, as they allowed the stability and durability of the batteries to be improved.

A number of important achievements of Mechanics Department's scientists were honored with awards.

O.M. Guz, NAS Academician, was awarded with the V.I. Vernadsky Gold Medal of the NAS of Ukraine.

V.G. Karnauhov was awarded with the Diploma of the Verkhovna Rada of Ukraine.

NAS Corresponding Member V.I. Nikishov, V.V.Boyko, I.T. Selezov, V.V. Khomitsky were awarded the State Prize of Ukraine in Science and Technology for collaborative work as members of a research team.

Physics and Astronomy

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

In 2014, scientists of the Department of Physics and Astronomy were active in research both in the fields of physics and astronomy where our country already has recognized science schools and traditions, and in some new areas which have been recently started and are at the stage of formation. 18 institutions of the Department, as well as a number of higher education establishments, took part in those research efforts. The experimental and theoretical results obtained show a significant contribution of Ukrainian scientists to solving problems in modern physical science. A distinctive feature of many research efforts made in the reporting year was addressing the vital challenges of the present and, what is especially important, work towards improving the defense potential of our country and meeting the needs of its space industry.

In accordance with the main areas of Department's activities, the focus of the research carried out by its scientists was on topical problems, among which a lot of attention was given to nanophysics and nanoelectronics, as well as to practical application of the results obtained.

In the area of fundamental interactions and microscopic structure of matter, analyzed were the structures of the so-called mirror nuclei ^{10}Be and ^{10}C by using the four-cluster model (two alpha particles and two nucleons). As a result, scientists managed to propose the potentials of internuclear interaction containing nonlocal collisions. The corresponding theoretical results enabled them to describe the data of the TOTEM experiment on the Large Hadron Collider concerning the elastic scattering of protons with energies ranging from 7 to 19 GeV.

Investigations in the area of solid-state physics, which are traditionally actively conducted by institutions of the Department, addressed, in particular, the technology for manufacturing diode sensors of IR radiation based on p-n-junctions in InSn, and development of the method for the production of a casting alloy of nickel with silicon carbide. The use of this method provides an almost an order-of-magnitude improvement of its wear resistance and, hence, the extension of service life of aircraft engines.

Worthy of notice among the results obtained in the area of low-temperature physics is the discovery of the quantum interference effect of oscillations of the critical current flowing in superconducting structures located in the external magnetic field. This effect can find application in high-precision engineering devices. Besides, scientists produced quasi-optical elements that show transparence for input signals in the microwave range and are essential components of supersensitive cryoelectronic systems.

Investigations in the field of optics and laser physics were developed further. In particular, the phenomenon of interference of different-color ultrashort light pulses was predicted and observed; on this basis, static and dynamic holograms were recorded for the first time.

In the area of nanophysics and nanotechnologies, the surfaces with controlled properties covered by molecules with switching effects were produced, which opens up prospects for manufacturing new-generation microdevices. Methods for increasing luminescence of colloids by incorporating quantum dots or metal nanoparticles into them were proposed, this being highly relevant for optoelectronics. Researchers demonstrated the possibility of controlling the interlayer exchange coupling in magnetic heterostructures that are important for information and communication technologies.

In the area of radio physics and electronics, a magnetron of the millimeter range was developed by using metamaterials, this providing a substantial increase in its efficiency; a successful test of satellite radio diagnostics of the sea surface pollution was carried out.

In the area of soft matter physics, a method for measuring the superlow chirality of liquid crystals and their changes caused by irradiation was implemented; a numerical procedure for determining the structure, asymmetry and curvature of biological membranes was proposed.

Studies in physics of plasma processes were focused on the investigation of diffusion of particles in the wave field with random phase jumps, this being important for understanding the transport phenomena in turbulent plasma.

Research efforts in the area of astronomy, astrophysics and radio astronomy were aimed at determining the content of primary He in galaxies, measurement of IR spectra of the galaxies with low metallicity, and application of the procedures for simultaneous radio astronomical observations using both domestic (UTR-2+URAN-2) and foreign (LOFAR) devices. Ionospheric processes were also studied in collaborative experiments, in particular, those with experts from Norway. The Peak Terskol Observatory traced the dangerous large asteroid which approached the Earth on 3 October 2014.

A number of studies completed by scientists of the NAS Department of Physics and Astronomy received the deserved acknowledgement. In particular, four teams were awarded the prizes named after prominent NAS scientists. Young scientists became laureates of the Prize of the President of Ukraine. The first common prize of the NAS of Ukraine and Polish AS was presented to O.V. Dudnik and E.V. Kurbatov, associates of the NAS Institute of Radio Astronomy. The Prize of the Academies of Sciences of Belarus, Moldova and Ukraine went to M.Ya. Vallakh and D.V. Korbutyak, NAS Corresponding Members from the NAS V.E. Lashkarev Institute of Semiconductor Physics. A high state award – the Order of Yaroslav the Wise III Class – was presented to A.G. Naumovets, NAS Academician; O.B. Shpenyk, NAS Academician, became the Holder of the Hungarian Order Knight's Cross.

Earth Sciences

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

In 2014, scientists of the NAS Department of Earth Sciences and its Bureau focused on the further advancement of research related to increasing the amounts of mineral resources, their efficiency and environmental safety, using the results obtained in various industries. Some important fundamental and applied achievements won awards and prizes.

The State Prize of Ukraine in Science and Technology was awarded to V.O. Driban, V.O. Kanin and V.R. Shneyer, employees of Ukrainian State R&D Institute of Mining Geology, Geomechanics and Surveying of the NAS of Ukraine, for their work 'Providing technological and environmental safety in the development of coal mines (theory and practice)'.

For a series of works 'Geoenvironmental conditions of formation and development of hydrocarbon deposits and peloids of the Black Sea', V.O. Yemelyanov, A.A. Pasynkov, O.Z. Savchak were awarded the NAS P.A. Tutkovsky Prize.

A fundamentally new scheme of phase-geochemical zonation of subsurface naftidogenesis was developed, which significantly changed the understanding of the hydrocarbon potential of large and extra-large depths. The development of the hydrocarbon potential of large depths within the central segment of the Dnieper–Donets basin was proposed as the top-priority direction of exploration for oil and gas in Ukraine. It was shown that this direction rather than the development of shale gas within Yuzivske and Oleske areas will permit a significant increase in gas production in the coming years and a shift to other areas of planned exploration, which in the future could fully meet the needs of Ukraine in natural gas (NAS Academician O.Yu. Lukin).

The content of palladium and rare earth elements in mineral waters was determined for the first time in Ukraine. The experimental study of their effect on blood and immune systems of irradiated experimental animals was started. For the first time, scientists identified the mineral waters whose effects on biota are due to the structure of the water itself (NAS Academician V.M. Shestopalov, N.P. Moiseyeva, A.Yu. Moiseyev).

In collaboration with European experts (from the Netherlands, Poland, the United Kingdom, Romania) and 'Ukrgeofizyka' State Company, unique studies of deep structure and lithosphere geodynamics of the Carpathians were carried out; as a result of them radically new data were obtained. The research was conducted by deep seismic sounding along the Georift-14 'RomUkrSeis' profile (Vinnytsya–Chernivtsi–Luhosh), which is 650 km long, using TEXAN and DATA CUBE (365 units) seismic stations at 11 explosion points (NAS Academician V.I. Starostenko, V.D. Omelchenko, O.V. Lehostayeva, D.V. Lysynchuk, D.M. Hryn).

The «Atlas of Natural, Technological and Social Hazards of Emergencies» (online version) was compiled for the first time in Ukraine. There are 143 maps and 6 sections: potential emergency background, natural hazards, technological hazards, social dangers, emergencies in Ukraine, prevention of emergency situations (NAS Academician L.G. Rudenko, A.I. Bochkovska, T.I. Kozachenko, C.A. Polyvach, S.O. Zapadnyuk, V.S. Chabanyuk).

The typing of mud volcanoes with descriptions of their deep geological structures was done. A new catalogue of the Black Sea mud volcanoes was produced, with extended area coverage – those on the shelf, continental slope, in the deep basin of the Black Sea, the Kerch Strait and the Sea of Azov. In total, 60 mud volcanoes were described (NAS Academician Ye.F. Shnyukov, L.V. Stupina, Yu.I. Inozemtsev).

For the first time in Ukraine, a targeted modeling system to analyze and quantify the pollution within river basins from the point and distributed sources was developed and is being tested. It can be recommended as a basic tool for the implementing three of the six guidelines included in the Association Agreement between Ukraine and the European Union (EU Water Framework Directive, the Directive on Nitrates and Sewage) (NAS Corresponding Member V.I. Osadchyi, N.M. Osadcha, Yu.B. Nabyvanets).

In 2015, the main efforts of Department's scientists will be aimed, primarily, at the development of scientific principles of the integrated approach to and evaluation of mineral deposits development that would provide the maximum involvement of Ukraine's own mineral resources, which is of utmost importance in the present difficult situation; on working out geological and economic approaches to assessing the prospects of mineral resources and development of their sites; development of the technological range of research into promising, including alternative and man-made, mineral resources, dual-nature developments, ecological, meteorological, geographic, remote and other studies.

Physical and Technical Problems of Materials Science

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

In 2014, scientists of the NAS Department of Physical and Technical Problems of Materials Science obtained a number of significant research results that are of great importance for the economy.

New operating algorithms of the equipment for high-frequency bipolar welding of live tissues were developed and tested, and new instruments and procedures for electrosurgical interventions were designed. A modified version of the equipment was developed; its application produces a milder effect of current on the tissue. The effect of the main technological characteristics of the process was studied in joining dissimilar tissues of gastrointestinal tract. Established was the theoretical possibility of joining dissimilar pairs of tissues (small intestine, gullet, stomach, large intestine). Optimal parameters of welding process providing the highest quality of the joint were determined. Tentative recommendations for the clinical application of the technology of welding dissimilar tissues of gastrointestinal tract were developed. The system can also be used in ophthalmologic or neurologic surgeries. Histological studies of nerve tissue welded joints confirmed the theoretical possibility of producing a sound joint of nerve epineurium. The method was recommended for clinical application.

Patterns of hydrogen-induced cold cracking that develop in delayed fracture mode based on delayed growth of initiating crack up to critical size were established. Relying on the mechanism of brittle fracture of metal, a physico-mathematical model of crack formation in welded joints was developed in terms of continuum mechanics by considering accumulation and growth of crack-like defects. Numerical realization of mathematical equations of the model consists of several moduli: calculation of temperature fields in welding, calculation of stress-strain state allowing for defect initiation and growth, and calculation of hydrogen diffusion. The limit value of brittle strength was determined experimentally using a modified implant sample; it was compared with the calculated value, which was the basis for assessing the risk of their formation.

A radically new method of alloying metal melts of Cu, Ni, Ag and some alloys of non-metallic electronegative elements of VI-VII groups of the periodic system with a high electron affinity – O, S, Se (VI group) and F, Cl, Br (VII group) – was developed. The addition of these elements to molten metal improves the adhesion and wetting of non-metallic materials of ion or ion-covalent nature: oxides, fluorides, saline compounds (in particular, Al_2O_3, MgO, $BaTiO_3$, etc.) by these alloys. The application of this method allows the efficient control of wetting processes using such alloys as brazing ones for joining ceramic materials. The method is effective in application of oxygen, as it allows conducting the process in the air environment.

Nanoindentation method was used to study plastic flow initiation under nanodeformation of boron carbide. An abrupt elastic-plastic transition during the immersion of Berkovich indenter was observed as a result of homogenous initiation of dislocations in the contact area; that allowed the first-ever experimental assessment of yield strength of defect-free boron carbide, which coincided with theoretical evaluation.

Engineering methods were developed to evaluate residual structural strength of building structure elements in long-term operation that were damaged by cracks and restored using injection technologies. These methods were based on the proposed concept of the strength analysis of bodies containing cracks filled with injection material.

Department's scientists developed a technology of heating the upper part of large steel ingots with simultaneous plasma-kinetic impact on the liquid phase. The new technology has no analogues in the world and allows gas shrinkage and liquation defects in ingots to be reduced and the output of quality metal products to be increased by 10%.

Peculiarities of sintering nanopowders of Y_2O_3-Al_2O_3-Nd_2O_3 multi-component oxide with stoichiometry of YAG:Nd^{3+} alumo-yttrium garnet were determined; they provide optimal characteristics of single-phase laser ceramics of respective composition. It was shown that the compaction of the material in the process of phase transformations is determined by the suppression of mobility of ceramic grain boundaries by sintering additive. The method of reaction sintering of nanopowders allows synthesizing highly-concentrated, optically-transparent ceramics. Differential efficiency of micro-laser on its base is up to 40% under diode pumping. The results obtained are important for mastering new active laser media based on optical ceramics, including those of complex architecture.

Methods to provide dynamic stability of contact structures under temperature cycles, mechanical shocks, and vibration were studied, which allows creating highly reliable thermoelectric devices for operation under extreme conditions. The technology for preliminary cleaning of the surface of extruded thermoelectric material was developed; it provides high reliability of contact layers and improves the efficiency of thermoelectric devices by 10–15% as compared to the currently available world analogues. Models of technological equipment and devices were developed that allow producing composite contact structures in samples of extruded thermoelectric material of different size and shape.

Academician B.E. Paton, the President of the National Academy of Sciences of Ukraine, became the laureate of the 'Commonwealth Star' International Award; he was also honored with the Gold Medal of the National Academy of Law Sciences of Ukraine.

V.L. Mazur, Corresponding Member of the National Academy of Sciences of Ukraine, was awarded the Order of Merit II Class.

Physical and Technical Problems of Power Engineering

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

In 2014, research efforts of scientists of the NAS Department of Physical and Technical Problems of Power Engineering (DPTPPE) were aimed at solving urgent scientific and technical problems of power engineering, taking into account grave economic problems in Ukraine.

Last year, important studies on the use of nanotechnologies and nanomaterials in power engineering were completed. A number of significant results were obtained.

In particular, thermal-physics fundamentals were developed and a computerized unit for studying heat flows in nanoliquids was produced; that resulted in a discovery of 20–30% higher thermal conductivity of nanoliquids. The use of nanoliquids in boiling coolant systems allows a 2–3 times increase in the critical heat flux.

A range of research into the thermal properties and structure-formation patterns of polymer micro-composites containing carbon multi-layered nanotubes, aluminum, and copper as nanosized fillers were carried out. With using the proposed method of dispersing in solution to produce the nanocomposites mentioned on condition of insignificant filler content, scientists were able to obtain materials for power equipment that have significantly improved thermal conductivity.

Taking into account the difficult situation in the country, experts of the DPTPPE carried out research for stabilizing energy and humanitarian support under the emergency in the eastern region of Ukraine. Scientists of the Department developed and successfully tested a set of measures towards safe and efficient burning of imported coal with off-design characteristics in boilers designed to burn powdered anthracite. Such measures were implemented at the Trypilska and Zmiyivska TPPs, as well as the Chernihivska, Sumska, and Darnitska TECPs.

New designs of heating and cooking stoves with extra thermoelectric modules to generate electricity were tested. High performance and low rates of pollutant emissions were obtained. Design documentation was developed for stoves of various capacities (4, 6 and 8 kW) that are intended for camping, head-quarters and medical tents.

A domestic industrial technology to produce new high-protein hydrolyzed dry product was developed. The results of the dry-product clinical test at the Medical Center of Ukrainian Armed Forces showed that the introduction of this product into the set of treatment procedures for wounded servicemen who needed long-term treatment did improve their condition and accelerate the healing of gunshot wounds and burns.

In 2014, scientists of the DPTPPE also obtained a number of significant results in traditional areas of fundamental and applied research.

For the first time, theoretical principles were developed and a new tiered system of mathematical models (optimization and imitation ones, as well as those to be used in specialized calculations of the life cycle of technological objects) was produced in the deterministic-stochastic setting; it enabled specialists to provide consistent forecasts of the economic development and energy sector of the country under increasing uncertainty of their operation to ensure the necessary levels of long-term demand for energy and fuel.

A new method for regional-structure regularization of solving inverse heat-conduction problems was developed; it is based on the a priori information on the results of the problem, which leads to constraints on identified parameters and is an additional regulation factor.

A theory of three-phase measuring channels of voltage and current vector parameters was developed. It was shown that the representation of three-phase measuring channel with a model due to accounting for additional errors of measuring the current and voltage of the damaged phase improved the precision of locating the short circuit in the power line by 2–3 times.

Researchers theoretically determined and experimentally studied mechanisms of forming dangerous for human health effects of the natural attenuation of static geomagnetic field in modern residential and public buildings, which is due to magnetization of their steel structural elements. Relying on these studies, they developed scientific principles of technologies for designing and constructing 'magnetically-clean' houses, whose implementation would provide a level of the geomagnetic field in living quarters that is close to the natural one and creates comfortable environment for people.

For a computer system intended for representation of acoustic images of the internal structure of materials and media, a simulation software system of the holographic echoscopy type was developed; it takes into account physical and geometric features of the registration of hologram amplitude and phase components of sound hologram in a holographic echoscopy system.

For the first time in Ukraine, scientists of the DPTPPE produced an integrated multi-level system of electric power recording that takes into account quality parameters of electric power. It covers the United Power System of Ukraine and controls its electrical connections with the neighboring countries.

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

NAS Corresponding Member N.M. Fialko, NAS Corresponding Member A.S. Beshta, and V.G. Procopov, Yu.F. Tesic, V.A. Novsky, O.L. Karasinsky were awarded the State Prize of Ukraine in Science and Technology.

The NAS G.F. Proskura Prize went to NAS Corresponding Member A.F. Zharkin, O.D. Podoltsev and I.P. Kondratenko.

Nuclear Physics and Power Engineering

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

In 2014, scientists of the NAS Department of Nuclear Physics and Power Engineering obtained new important scientific results.

For the first time in the history of astrophysical studies, researchers succeeded in measuring the power of solar radiation immediately at the moment of energy release from the Sun interior; besides, they carried out a direct spectroscopic observation of solar neutrinos from the p-p cycle and measured neutrino fluxes within the framework of the Borexino collaboration.

Research into the ground state and collective excitations of the Bose–Einstein condensate of atoms and their diatomic bound states was carried out. The system was demonstrated to exist in two phases, namely, the state of coexistence of two condensates, and the state of the condensate of bound atomic pairs in the absence of monatomic condensate.

The impact of superfluidity on the kinetic properties of collective motion in heavy nuclei was investigated. The rigidity factor and the mass coefficient associated with monopole pair vibrations in the low-frequency region of nuclear excitations were calculated.

Two new baryon resonances involving heavy b-quarks in proton-proton collisions at energies of 7 and 8 TeV were first observed in the LHCb experiment (Large Hadron Collider, CERN).

The work at CERN on the integration of the program functional of Panoramix and Bender packages was completed. That provided a qualitatively new level of visualizing the physical analysis data of the LHCb experiment.

The possibility of considerable enhancement (by several orders of magnitude) of laser emission intensity during scattering of ultrarelativistic electrons by ions in the laser field was predicted theoretically for the first time ever.

Models were constructed to describe critical phenomena, where a spontaneous breaking of discrete supersymmetry occurs with the appearance of the modulated phase.

Obtained for the first time were data on structural material swelling at ultrahigh radiation doses and superhigh concentrations of transmutative gases, viz., helium and hydrogen.

A three-dimensional simulation model was developed for the in-vessel baffle reflector shield of the WWER-1000 type reactor. Neutron fields of the baffle reflector and radiation damage values were calculated as functions of the exposure time. Variations in the isotopic composition of the baffle reflector exposed to neutron irradiation for 1, 5, 10, 20 and 30 years were analyzed.

Substantiation was provided for the safe service life of reactor vessels at Zaporizhska NPP: units 2 and 4 – safe operation until at least 2045 and 2046, respectively, and at Khmelnytska NPP: unit 2 – until 2022.

In the framework of the Ukrainian Nuclear Fuel Qualification Project, being executed under the international agreement between Ukraine and the USA, and under the program of collaboration with Westinghouse company, the implementation of the strengthened fuel assembly structure FA-WR designed by Westinghouse (as specified by the licensing program) was completed. A batch of FA-WR (42 pieces) was loaded into the reactor core of Yuzhnoukrainska NPP Unit 3.

With a view to implementing peace initiatives of Ukraine set forth at the Washington Summit in 2010, the research facility 'Neutron source based on the electron accelerator-controlled subcritical assembly' was constructed at the National Science Center 'Kharkiv Institute of Physics & Technology'. The facility is planned to be put into operation on 31 March, 2015.

To improve the efficiency of investigations related to nuclear and other radioactive materials detected beyond the range of the regulatory control, a pilot database design was produced for nuclear criminalistics in Ukraine.

Based on the new energy-efficient process with the use of the Tonak technique, the experimental prototype of the facility was created for treating liquid radioactive waste of nuclear-fuel cycle.

A mathematical model was developed and used to justify and optimize the network of sites for integrated automated radiation monitoring of the Dniprodzerzhinsk urban-industrial agglomeration territory. The model takes into account technogenic load levels, as well as geological, landscape, geochemical, structural and tectonic peculiarities of the study area.

The NAS Leipunskyi Prize was awarded to L.S. Ozhigov, A.S. Mitrofanov, and Ye.O. Krainyuk, researchers of the National Science Center 'Kharkiv Institute of Physics & Technology' for the series of works 'Exploitation damages and physical degradation mechanisms of structural secondary-circuit materials of the NPP units with WWER-1000 reactors'.

The President-of-Ukraine Prize for Young Scientists was given to O.A. Lebid, V.O. Tsybulnyk, O.O. Levitska, and V.M. Nedoreshta, researchers of the Institute of Applied Physics, for the series of works 'Resonant and coherent effects of quantum electrodynamics in strong laser fields'.

Chemistry

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

In 2014, NAS Chemistry Department and its Bureau focused on fundamental research into complex problems of chemistry development, application of the results obtained in different spheres of national economy, improvement of science-management activities, and training of scientific successors.

A number of important fundamental scientific results meeting international standards were obtained.

For the first time shown was the possibility of mechano-chemical production of graphene-like germanium and boron nitride in the presence of chemically inert exfoliators, which allows specialists to obtain stable dispersions such as 2D particles – promising materials for electronics and opto-electronics (NAS Academician V.D. Pokhodenko).

The possibility to act as efficient electro-catalysts in the processes of activation of halogen-containing alkanes, freons in particular, was found for nano-composite materials based on nitrogen-containing carbon nanotubes covered with particles of Ni, Ag and other metals, which opens up the possibility of their application in the synthesis of various derivatives (ethylenes, carbonic acids, etc.) in power-saving conditions (NAS Academician V.G. Koshechko).

A method was found to regulate fluorescent properties of optic liquid-crystal composites of cadmium caprylate with hetero-nano-inclusions of CdSe+CdS by the staged formation of nucleus/cover structures through changing the content and correlation of components; it was determined that nano-composite with CdSe/CdS hetero-particles of 2/1 content is characterized by the most intensive excitonic emission line (NAS Academician S.V. Volkov).

The dependence of lyophilic and physico-mechanical properties of organo-inorganic composites on the chemical structure of polymer matrix and inorganic components as well as modifier nature was determined. The composites obtained could be used as high-performance super-sorbent agents, UV-absorbing materials and construction materials (NAS Academician E.V. Lebedev).

pH-sensitive micellar nano-reactors on the basis of functionalized surface-active substances (SAS) – derivatives of 2-oximinomethylimidazolium – were constructed for splitting acyl-containing substrates. The results obtained give us new information about control of the systems reactivity and the development of the principles for creating new pH-sensitive supramolecular ensembles (NAS Academician A.F. Popov).

A new state standard that has no analogs — the State Standard of Ukraine (SSU) 7525:2014 'Drinking water. Requirements and methods of quality control' – was elaborated and approved. The expediency of using micromycetes as sanitary-model microorganisms for water disinfection was proved. State Standard 7487:2013 'Water quality. Method of micromycetes detection in water' was elaborated and adopted.

Species composition of drinking water microflora was analyzed on gene 16S rRNA successions with methods of molecular biology. The identified bacteria types belong to *Firmicutes* phylum, *Bacilli* class, i.e. gram-positive microorganisms which are not pathogenic for humans.

A radically new system ("Cluster") was developed and certified; it allows water and aerosol structure to be analyzed with laser diffraction method (NAS Academician V.V. Goncharuk).

To determine the effect of the configuration of integrine chiral antagonists αIIbβ3 on their anti-aggregation properties, the synthesis of optically active peptidomimetics containing the residue of 1,2,3,4-tetrahydroisoquinoline acid as N-final fragment and as C-final part of β-arylalanines (Ar = phenyl, p-chlorophenyl, p-fluorophenyl) was conducted. Racemic arylalanines and their enantiomers were used. The peptidomometic enantiomers obtained show 98% optical purity, S-enantiomers exceed racemates in anti-aggregation activity by 10 times (NAS Academician S.A. Andronati).

A technology for modification of cellulose and lignocellulose matrix by nano-clusters of d-metals ferrocyanides was developed and optimized with a view to obtaining poly-functional bio-sorbents with combination of absorbing ability towards organic ecotoxicants, the majority of heavy-metal toxic ions with high selectivity for radio-cesium (~105 g/l) extraction from complex technological solutions and biological liquid media (NAS Academician M.T. Kartel).

New methods of synthesis were developed, and samples of β-fluorine-containing γ-amino-oily acids – pregabaline analogs – were obtained; they are promising reagents for biochemical research of neural activity and neuropathology diagnostics (NAS Academician V.P. Kukhar).

Clinical tests of new carbonic hemosorbents were successfully conducted. Applications for their registration were submitted in Ukraine under the following trade marks: "CARBON" and "CARBON+" (NAS Academician V.V. Strelko).

A spin-coating synthesis method was developed for high-density nano-crystalline films of barium hexaferrite (BHF) of M-type that are 200 – 400 nm thick with equal distribution of ions in the film and anisotropic particle shape. Due to the quick regime of films thermal treatment (500° C/min), a magnetic s-pin texture is realized in them, which is promising for their use in the systems of highly dense communication with low noise level (NAS Academician A.G. Bilous) .

The main factors determining catalytic properties of acid-modified samples of natural zeolite – clinoptilolite of Sokirnitsy field – in the reaction of glycerin and acetone were found. The dominating product is corresponding 1,3-dioxolan. The catalysts obtained practically do not reduce their activity (glycerin conversion is ≥ 95%) for 6–7 work cycles (NAS Academician G.L. Kamalov).

Biochemistry, Physiology and Molecular Biology

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

In 2014, scientists of the Department of Biochemistry, Physiology and Molecular Biology of the NAS of Ukraine achieved great success in solving fundamental problems of biology, medicine and ecology. A lot of attention was given to new biotechnologies, issues of fundamental and practical medicine. A number of important scientific results of the international level were obtained.

Researchers of the O. V. Palladin Institute of Biochemistry of the NAS of Ukraine showed that the high-level expression of heparin-binding growth factor (sHB-EGF) is characteristic of cells of monocytic origin, and the lowest one – of B cells. Relying on the data obtained, an assumption can be made about the ability of the main types of immune cells (monocytes, B and T cells) to express the growth factor sHB-EGF which can play an important role in the formation of immune response, including nonspecific immunity.

Scientists of the O.O. Bogomolets Institute of Physiology of the NAS of Ukraine investigated the effect of μ-opioid agonist DAMGO and endomorfine receptor-1 on P-type calcium currents playing an important role in synaptic transmission. It was established that these agonists at nanomolar concentrations can cause the potentiation of P-type calcium current. Experiments with opioid receptor antagonists showed that this effect is mediated by the same μ-opioid receptors.

Researchers of the D.K. Zabolotny Institute of Microbiology and Virology studied the genetic effects of non-ionizing electromagnetic radiation (EMR) of the radio frequency range. It was established at the units of various organization levels that high (40.68 MHz) and ultra-high (2450 MHz) frequencies lead to double-stranded DNA breaks but do not cause chromosome aberrations and single-stranded breaks.

Research conducted at the NAS Institute of Molecular Biology and Genetics demonstrated that oncogenic isoform eEF1A2 elongation factor 1A is less prone to olihomerization than common eEF1A1. It was discovered that eEF1A2 loses its ability to interact with calmodulin in a calcium-dependent manner, which may affect the controllability of its interaction with tRNA and actin.

Scientists of the R.E. Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology of the NAS of Ukraine for the first time established the role of protein metabolism of endogenous iron in the formation of molecular subtypes of breast cancer. It was shown that the highest level of expression of ferritin and hepsydyn is observed in tumors of patients with breast cancer of the basal subtype, which is characterized by the aggressive course and low sensitivity to anticancer therapy.

Scientists of the NAS Institute for Problems of Cryobiology and Cryomedicine established structural and functional characteristics of the heterogeneous population of bone marrow cells that were cultured in doped and electret oxide nanocoatings. Demonstrated was the possibility of directed regulation of the functional capacity of bone marrow cells with adhesive potential, depending on the properties of nanocoating on which they were cultivated.

Scientists of the NAS Institute of Cell Biology showed that the intensified expression of the modified genes involved in the biosynthesis of purine *de novo* in strains that are overproducers of riboflavin leads to a 2.5–4-fold growth of productivity of this vitamin biosynthesis. A scheme of genetic engineering design of yeast strains was developed; it is capable of accumulating flavinadenine dinucleotide in the culture fluid.

It was found at the International Centre for Molecular Physiology of the NAS of Ukraine that dynorphins with properties similar to CPP destabilize the integrity of cell membranes in practically all types of mammalian neurons, as well as in HEK-293 cells.

Researchers of the Department of Biotechnological Problems of Diagnostics at the NAS Institute for Problems of Cryobiology and Cryomedicine found that the presence of MSCs in the system of mutual cultivation inhibits the proliferation of tumor cells.

In the field of medicine, researchers conducted a detailed study of the pathogenesis of cardiomyopathies development; they validated, developed and implemented new methods of reconstructive surgery on the heart in ischemic cardiomyopathy; determined the frequency of classical risk factors in patients with angiographically confirmed atherosclerotic lesions of the coronary arteries; identified key molecular genetic markers of different subtypes of neuroectodermal brain tumors; developed a set of measures and recommendations towards preventing and reducing the medical, social and economic losses due to occupational diseases.

Cooperation of the Department's Institutes with institutions of medical and biological profile that operate under other ministries and departments continued. On 24 December a joint meeting of the Presidium of the National Academy of Sciences of Ukraine and the National Academy of Medical Sciences of Ukraine was held with participation of the Ministry of Health of Ukraine, the State Service of Ukraine on Drugs and Association 'Drug Manufacturers of Ukraine'.

The implementation of targeted NAS research programs 'Fundamentals of Molecular and Cellular Biotechnologies', 'Fundamental Problems of Nanostructured Systems, Nanomaterials, Nanotechnologies', research programs concerning the issues of sustainable development, environment management and conservation were finished. Contributors of research projects successfully completed their tasks. The implementation of other programs is going on.

General Biology

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

Despite the difficult political and economic situation in our country, institutions of the Department of General Biology continued their work and, as before, focused their efforts on studies of the structural and functional principles of biological systems, research and preservation of animal and plant kingdoms, as well as the development and application of state-of-the-art biotechnological methods and techniques.

In particular, geneticists and plant breeders, on the basis of various complementary molecular genetic marker systems and their adaptation for multiplex polymerase chain reactions, developed scientific principles of a molecular biotechnology of wheat breeding for high performance and baking quality. Using methods of molecular marking of wheat genes allowed them to identify genotypes with alleles of high molecular weight glutenins, which are among the strongest ones by their positive impact on the flour quality compared to other identified Gli/Glu alleles.

Cell biologists demonstrated that various species of plants (including genetically transformed ones) preserved *in vitro* culture are valuable sources of new natural compounds. It was found for *the first time that exposure of* Arabidopsis thaliana seedlings to UV-B significantly increases the β-tubulin nitrotyrosylation level. New inducers of defense reactions of wheat and tomato plants to biotic stress were discovered. It was found that a combined action of biotic elicitor and nitrogen oxide induces systemic resistance of winter and spring wheat to the pathogenic agent of brown rust. For the first time in Ukraine, a method was developed for *in vitro* transformation of immature maize embryos using *Agrobacterium tumefaciens.* It was experimentally confirmed that the bar gene, which causes resistance to non-selective Basta™ herbicide in maize transformants, can be inherited by next generations of plants.

The discovered participation of epigenomic mechanisms in radiobiological reactions of plants from the Chornobyl Exclusion Zone opens up entirely new opportunities for radioprotection of organisms by regulating the processes of DNA methylation and demethylation.

Botanists proposed new methodological approaches to assessing the stability of habitats and risks of their losses, as well as new environmental bioindicators. For developing the ecological network of the left-bank forest-steppe, the key areas of the national and regional levels were identified and characterized with their rare plant communities. The theory of self-organization of living systems was complemented with new provisions regarding the role of the genetically determined program of ontogeny and phenotypic plasticity in the formation of plant community.

Department's researchers continue to focus their efforts on effects of global climate changes and the responses of plants and animals to these phenomena. In particular, significant northward expansions of geographic ranges of certain insect species of the Mediterranean origin and winter activity of some arthropods were found. Hydrobiologists discovered that rising temperatures of water environment result in structural and functional alterations of major biotic communities of freshwater ecosystems, and in physiological and biochemical changes in hydrocele organisms, which enables them to adapt to new conditions.

In 2014 our botanists, mycologists and zoologists described as new for science over 150 taxa of plants, fungi, and animals representing both extant and fossil components of the flora and fauna.

Living collections of energy-producing and aromatic plants were significantly replenished; at the moment they contain over 1 000 taxa. Twenty-three cultivars of agricultural, ornamental and other useful plants were bred, as confirmed by relevant intellectual property certificates. In the reporting year, Department's institutions received 49 patents and other intellectual property certificates, and signed nearly 2900 license agreements.

Using bees as model organisms, a unique biotechnological method was developed for a significant increase in reproduction of insect pollinators of plants. The method is based on epigenetic regulation of oogenesis in young females through their short-term narcotisation with carbon dioxide.

Demonstrated were positive effects of plant extracts, silicon-containing minerals and cultural fluids of micromycetes on the plant resistance to pathogens of the *Fusarium* genus, the development of agronomically useful microorganisms, as well as on allelopathic, biochemical and agrophysical characteristics of soils. Experimentally established differences in the isotope content in soil and plants are the basis for improving the elemental composition of fertilizers and for developing a new study area – revealing the role of isotopes of biologically important elements in living organisms.

Using phytocomponents, researchers synthesized nanoparticles of silver, gold, and cadmium sulfide quantum dot nanoparticles that can be used in biological research, in particular in microscopy, for intensifying the signals of fluorescent staining agents or as fluorescent probes.

Unfortunately, temporary losses that occurred in the structure of the Department (O.O. Kovalevsky Institute of Biology of the Southern Seas of the NAS of Ukraine, the Karadag Nature Reserve of the NAS of Ukraine), and in the staff of the NAS Donetsk Botanical Garden and the NAS Ukrainian Steppe and Lugansk Nature Reserves, had a negative impact on the last year's research results of the Department of General Biology. In the future, the Department will continue its efforts towards minimizing the negative effects of those adverse changes and will focus on continuing fundamental and applied research projects, including those that could be determined by the emerging needs of our time.

Economics

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

In the year under review, 2014, the efforts of researchers of the NAS Economics Department were aimed, primarily, at determining the main areas of institutional transformations and mechanisms to correct them; validating the essence of economic policy in terms of the instruments of state economy regulation in order to minimize the negative effects of imbalances in major economy sectors; determining methodological principles of modeling the social and economic processes related to the problems of internally displaced persons in Ukraine.

A number of significant results were obtained. On the basis of logical and historical methodology, it was proved that modern forms of resolving institutional contradictions between globalization, which is implemented mainly through information and financial mechanisms as well as the increasing role of transnational corporations, and the spatial and territorial localization of economic activities are the gradualistic interstate integration, profound decentralization and regionalization of power structures, financial and organizational autonomy of non-profit institutions.

Theoretical framework and methodological approaches were developed to identify dangerous macroeconomic imbalances in Ukraine under current unstable situation of the global and domestic economy; a scenario forecasting of macroeconomic conditions was done using the mathematical models developed.

A systemic hierarchy of methodological tools to detect and identify transformational changes in employment, their social potential and impact on human development was constructed (problem–risk–threat–potential), which allows a holistic assessment of dominant innovative changes in the forms, types and modes of employment in terms of their capacity to form strategic prospects for sustainable human and social development of Ukraine.

The conceptual basis of the state policy was developed to improve the finance of real sector enterprises due to changes in institutional development and the extent of disparities in the financial system of Ukraine. Practical public policy measures to improve the investment climate and financial recovery of the real sector in Ukraine were substantiated.

The features of the transformation mechanism of monetary economy in Ukraine were determined. They are: the chronic imbalance of demand and supply of money; imperfection of the money supply mechanism; a limited impact of monetary policy tools on national currency stability; and strengthening the 'bankocentric' characteristics of the financial sector.

The expediency of extending the system of guaranteeing the rights of Ukrainian people to the property, which forms the basis of economic sovereignty, was grounded.

In particular, it was proposed to introduce a legal circulation of the 'public domain' category as a set of material and intangible goods the exclusive rights for which are held by Ukrainian people. Main principles of nationalization, requisition, confiscation as special grounds for the termination of property rights were defined.

Proposals for changes in the Ukrainian legislation concerning the rights and freedoms of internally displaced persons were substantiated. Issues of civil society development were systematized, and proposals for civil society formation under conditions of systemic crisis and military conflict were grounded.

An evolutionary model of tax regulation of investment and innovative economic development was developed. A scientific and methodological approach was proposed to assess the impact of local taxation on industrial development.

Risks and benefits for industrial production resulting from the implementation of the Association Agreement between Ukraine and the EU, as well as proposals towards neo-modernization of domestic industry, were identified.

A methodology was developed to assess natural wealth that takes into account components of the capital stock, physical resources, the actual market value and latent economic benefits.

A concept of regional policy in the context of the convergent model of regional development was proposed.

A scientific and methodological approach to the assessment of the shadow economy at the regional level was developed. The information support of the project – software for implementing a set of mathematical and economic models of the shadow economy at the regional level was designed and implemented.

A methodology for forecasting structural changes in Ukraine's economy due to integration processes was worked out, and a medium-term forecast scenario of the national economy was constructed, taking into account the implementation of the EU–Ukraine Association Agreement.

In the short term the efforts of economists will be focused on: determining the mechanisms of interactions between institutions and economic activities in the reproductive dynamics to identify ways of ensuring the development of Ukraine; substantiating methodological approaches to and developing model tools for testing situational changes in macro trends of economic growth in Ukraine; adapting the monetary policy of Ukraine to new conditions of the global economy; assessing the impact of the implementation of the EU–Ukraine Association Agreement on the development of economy sectors and commodity markets.

History, Philosophy and Law

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

In 2014, scholars of the Department produced significant theoretical results in integrated theoretical interdisciplinary studies of the consolidation of Ukrainian society, democratization and reformation of the political system of Ukraine, in developing legal, social and cultural mechanisms of conflict-free solution of urgent social and political problems, establishing the values of civil peace, solidarity and justice in the Ukrainian society and political sphere.

Department's scholars placed a special emphasis on social and political transformations in Ukraine related to the Revolution of Dignity, as well as events in the Crimea and the Donbas region, the crisis of relations between Ukraine and Russia, the process of the European integration of Ukraine. Besides, a lot of attention was given to the analysis of public participation in the processes of social consolidation in the new political reality, external aggression and strengthening separatist movements.

Noticeable results were obtained in implementing numerous large-scale scholarly and publishing projects. To commemorate the 200th anniversary of Taras Shevchenko's birth, researchers of the V.I. Vernadskyi National Library of Ukraine prepared fundamental scientific publication «Taras Shevchenko: Bibliography of Editions from 1840 to 2014» (V.Yu. Omelchuk et al.), which is the first work containing bibliographic data about nearly all Shevchenko's publications in the original language and in translations.

Scholars of the NAS Institute of the History of Ukraine initiated the academic publishing cycle «Studies in the Regional History of Ukraine», they published the 1st volume of the two-volume collective monograph «East and South of Ukraine: Time, Space, Society» (by NAS Academician V.A. Smolii, NAS Corresponding Member H.V. Boryak, L.D. Yakubova et al.), the collective work «Crimea since Antiquity to the Present: Historical Studies» (by NAS Academician V.A. Smolii, NAS Corresponding Member O.P. Reyent, O.I. Hurzhii, Ya.V. Vermenych et al.), the reference book «Crimea: Way through Ages: History in Questions and Answers» (by NAS Academician. V.A. Smolii, NAS Corresponding Member H.V. Boryak, S.V. Kulchytskyi et al.), issued a number of popular brochures about the history of the Donbas region and Ukrainian Steppe.

The sociological monitoring data «Ukrainian Society. 1992-2014. Current State and Change Dynamics» (by NAS Academician V.M. Vorona, NAS Corresponding Member M.O. Shulha et al.) were published by the NAS Institute of Sociology. The staff of the NAS Institute of Encyclopedic Research published the 14th volume of the «Encyclopaedia of Modern Ukraine» (by M.H. Zheleznyak et al.). Scholars of the NAS I. Krypiakevych Institute of Ukrainian Studies issued the 7th volume of the multivolume edition «Galicia: History, Politics, Culture» (by M.R. Lytvyn, I.H. Pater et al.). Researchers of the NAS M.S. Hrushevsky Institute of Ukrainian Archeography and Source Studies published the 23rd volume of the 50-volume edition of M.S. Hrushevsky's works (by H.V. Papakin, M.M. Kapral, I.B. Hyrych, A.V. Felonyuk et al.). The Lviv Branch of the NAS M.S. Hrushevsky Institute of Ukrainian Archeography and Source Studies published the 1st volume of the «Atlas of Ukrainian Historical Cities» (by M.M. Kapral et al.), depicting Lviv.

For the state authorities, institutions of the Department prepared analytical data, expert opinions, proposals and recommendations on: implementation of measures aimed at supporting and developing Ukrainian identity and the plan of studying the famines of the 1st part of the 20th century; foundation of the state agency to deal with international relations and language policy; ensuring the rights of the Crimean Tatar people; implementation of programs and activities for the adaptation of the Ukrainian legal system to the EU legislation, the draft Concept of reforming the Ukrainian police system.

The Concept of improving the system of state legal responsibility to the civil society and person in Ukraine, as well as the national legal framework for preventing and combating separatist actions, were developed. Proposals towards implementing measures to neutralize destructive external influences in the Ukrainian information space were made.

Department's institutions prepared remarks and proposals to the draft Laws of Ukraine 'On Amendments to Certain Ukrainian Legislative Laws regarding the Implementation of Constitutional Control concerning Draft Constitutional Laws of Ukraine', 'On the Rights and Freedoms of Citizens in the Temporarily Occupied Territory of Ukraine', 'On National Anti-Corruption Service'.

Researchers of the NAS I.F. Kuras Institute of Political and Ethnic Studies, in collaboration with the Ministry of Education and Science of Ukraine, Association of Political Sciences of Ukraine, Ukrainian Academy of Political Sciences, organized the 5th National Congress of Politics Research 'Ukraine's Strategy: Political Discourse'.

In 2015, institutions of the Department will focus on studying urgent problems of the national and social development of Ukraine, especially on scholarly support to the implementation of structural reforms, development of effective mechanisms to overcome social tension and political clashes, establishment of public dialogue at the national and regional level, and the national security in the information sector. Particular attention will be given to scholarly and popular publications on history, culture and the current state of the Donbas region and the Crimea. The efforts of Department's Bureau and institutions will be directed towards integration of the East and the South of Ukraine with other regions, scholarly support to the consolidation of the Ukrainian society.

Philology Studies, Art Criticism, Ethnology

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

In the year under review, scholars of the NAS Department of Literature, Language and Art Studies aimed their efforts at fundamental and applied issues of the development of literature, language, art, traditional every-day culture, and computer linguistics. They addressed major challenges of scholarly backup to the national and cultural revival of Ukraine, provided the unbiased analysis of various stages in the development of Ukrainian spiritual culture in the past and in the context of globalization processes of the early 21st century.

The practical outcome of the abovementioned tasks was the publication of 66 monographs and collected writings, 13 study textbooks and manuals for university students and schoolchildren, 15 reference books and dictionaries, 23 academically treated and commented belles-lettres and artistic works, over 1600 publications in research proceedings and periodicals.

The high academic level of Department's research is proved by awarding NAS F.M. Kolessa Prize to M.Y. Khai, a specialist in ethnic music, for the series of works on musical instruments culture of Ukrainians. For his outstanding service to the Ukrainian nation, ethnography scholar R.F. Kyrchiv was awarded the Honorary Diploma of the Verkhovna Rada of Ukraine.

Literature scholars of the Department carried out research into literature theory, history of the Ukrainian and foreign literatures, comparative literature studies, today's functioning of belles-lettres, and prepared encyclopedic and academic publications of literary heritage. They analyzed the current state and trends in the development of Ukrainian and foreign literatures at the beginning of the 21st century, various aspects of textological studies of Ukrainian classical literature. Published were a number of collective and individual studies, including «Ukrainian Culture: Evolution of Crisis Consciousness» (ed. by NAS Academician M.H. Zhulinsky), «Literature Studies of Shevchenko's Works in Diaspora and Polish Reception of T.H. Shevchenko» (NAS Corresponding Member R.P. Radyshevskyi), «"To the Dead, Living, and Unborn" and to Himself: Shevchenko's Wording of the Past, Present and Future and His Own Existence» (Ye.K. Nakhlik), «Spontaneity in the System: European Metaphysical Poetry of the 17th – First Half of 20th Centuries: Motive and Theme Complex, Poetics, Stylistics» (T.M. Riazantseva), «Myth and Poetry of "Lisova Pisnia" by Lesia Ukrainka» (L.I. Skupeyko), collections of significant scholarly writings «Gogol Studies» (issue 21), «STUDIA SOVIETICA» (issue 3), «Ukrainian Literature of the 19th – Early 20th Centuries: Belles-Lettres in Nation's Progress», commented editions of selected works by T. Shevchenko, B. Hrinchenko, Ye. Sverstiuk et al. Completed was the publication of the 6-volume «Shevchenko Encyclopedia», which is a project of the national scope and significance; published was the 4th vol. of the 12-volume «History of Ukrainian Literature».

Department's linguistic scholars conducted research in the areas of theoretical and general linguistics, Slavic etymology, comparative and structural-and-mathematical linguistics, current functioning of the Ukrainian language and its practical introduction to all spheres of social life. They published 9 dictionaries, the 4-volume «Russian–Ukrainian Dictionary» and the 5th volume of the fundamental academic 20-volume «Dictionary of the Ukrainian Language» being among them. Also published were such fundamental works as «Ukrainians: Where We and Our Language Come From. Studies, Facts, Documents» (NAS Academician H.P. Pivtorak), «Theory of Grammar and Text» and «Modern Linguistics: Views and Assessments» (NAS Corresponding Member A.P. Zahnitko), «The Ukrainian Language: Its Present and Historical Prospects» (NAS Corresponding Member O.B. Tkachenko), a number of collected scholarly works, the textbook «The Ukrainian Language» for the 6th form of secondary schools (NAS Corresponding Member S.Ya. Yermolenko, V.T. Sychova, M.H. Zhuk), the textbook «Linguoculturology» (NAS Corresponding Member A.P. Zahnitko, I.V. Sakharuk).

Department's art, folklore and ethnology scholars published 42 collective and individual monographs covering individual genres of folklore, Ukrainian ethnic culture, ceremonialism, culture of Ukrainian borderline territories. In particular, they published «Field Notebooks. Folklorist Studies. Reviews» (NAS Corresponding Member A.I. Ivanytskyi), «Funny Story as Folklore Genre» (I.I. Kimakovich), «Ukrainian Ethnic Culture in the Context of Globalization Challenges» (H.B. Bondarenko), «Fiest Year of Ukrainians (from Ancient Times till Today)» (O.V. Kurochkin), «Water Symbolism in Traditional Ceremonies of Cherkasy Oblast Residents» (L.M. Goroshko), «Studies of Ukrainian–Polish Ethnocultural Borderline Area» (R.F. Kyrchiv). A number of folklorist and ethnographic expeditions to 14 oblasts of Ukraine and to the Republic of Belarus were organized.

Significant research-organization efforts of the Department were aimed at preparing and holding 63 international and all-Ukrainian conferences, workshops, plenums, and other scholarly forums.

Coordination of Research-and-Publishing Activities of the NAS of Ukraine

Ya.S. Yatskiv,
Member of Academy Presidium

2014 was declared the Taras Shevchenko year. The success of organizing the events of the Shevchenko year and celebration of the 200 anniversary of his birth was promoted by academic publications dedicated to Kobzar's personality and his works. Among such fundamental encyclopedic projects one should mention the issuing of the final volumes of the 6-volume «Shevchenko Encyclopedia» and the fourth volume of the 12-volume «History of the Ukrainian Literature» devoted entirely to Taras Shevchenko. This volume provides a scholarly interpretation of the Kobzar's literary legacy, combined with the story of his life and creative career, of the nature of his phenomenal popularity and influence on the minds and feelings of many generations of Ukrainians.

Science provides the basis for national progress in different areas and its development relies on swift scientific communication and timely presentation of research outcomes. Even at the time of major challenges that the state and society are currently faced with, scientists seek to publish the results of their work as papers and articles in electronic and paper scientific periodicals, and monographs.

Special emphasis should be placed on the monograph edited by NAS Academician A.G. Naumovets «Nanoscale Systems and Nanomaterials: Research in Ukraine», which presents results of research and development performed by NAS institutes under the State targeted S&T program 'Nanotechnology and nanomaterials' in 2010–2014, the multi-author book «Nanomaterials for Medical Purposes» (NAS Frantsevich Institute for Problems of Materials Science), presenting outcomes of research in a most relevant and cutting-edge study area; the monograph «Risk Analysis of Emergency Situations on the Basis of Satellite Data. Models and Technologies» (Space Research Institute of the NAS and the SSA of Ukraine).

The effective protection of information as an important element of the national security of the country was analyzed in the publication «Integrity and Availability of Information Networks» (the NAS Institute of Information Registration Problems), recommendations for improving the system of executive action against service crimes were presented in the monograph «Counteraction against Crimes in Official Service (Issues of Criminology, Criminal Law and Criminal Procedure)» (NAS V.M. Koretsky Institute of State and Law).

In the reporting year, the NAS 'Naukova Dumka' PH issued 65 books (16 450 copies) amounting in total to about 1200 printer's sheets. 'Akademperiodyka' PH issued 22 books (about 6 500 copies) having in total nearly 700 printer's sheets. Thus, in 2014 the number of books issued under the State order amounted to about 18% of the total number of books published by the Academy.

In 2014, NAS institutions issued over 600 scientific monographs and 140 collections of studies, about 400 educational, reference and popular-science editions. In 2014, foreign publishers issued 74 scientific monographs prepared by NAS scientists. The publication of the first volume of «Encyclopedia of International Law» deserves a special mention.

Current works of scientific staff were published in 87 scientific journals, one popular-science magazine and 42 collections of studies of the NAS of Ukraine, as well as in serial books of NAS institutions, their total numbers being about 230. Ten NAS scientific journals in English are published in Ukraine by Academy institutions on their own. Foreign publishers translate and publish in English 21 journals, two of those – «Ukrainian Biochemical Journal» and «Visnyk Zoologii» – are issued in the electronic form.

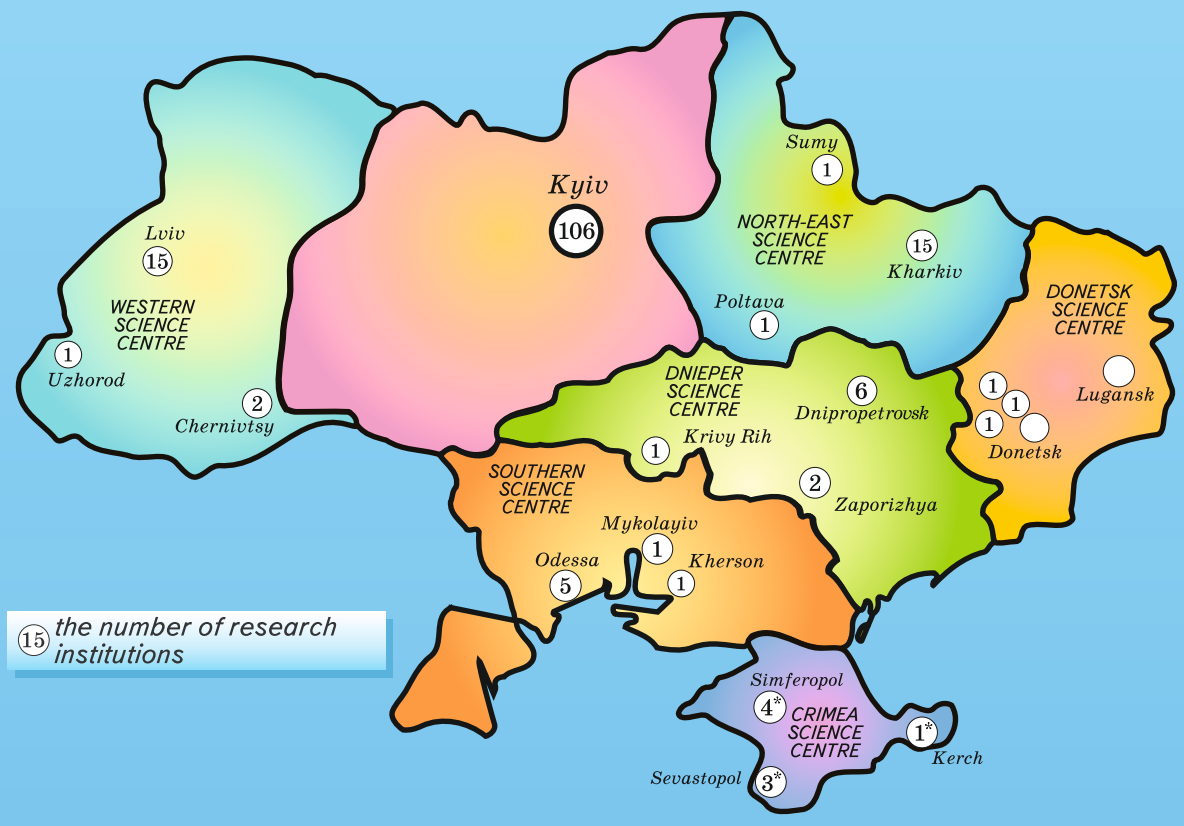
The National Academy of Sciences of Ukraine, being the main scientific institution of the nation, takes care that the whole range of research is provided with quality national periodicals, and at present – with quality electronic scientific periodicals properly positioned and competitive in the global information space. The achievement of this objective at the moment is not possible without the scientific periodical possessing a modern Web resource with the right anglicized section and without entering the global response and scientometric data base.

One of the steps towards incorporating into international scientometric base is the introduction of the digital object identifier (DOI). Digital IDs for scientific production on the fee-for-service basis are provided by the CrossRef agency, which is PILA (Publishers International Linking Association, Inc.) – the international non-profit association of publishers of academic and professional literature. CrossRef operates and maintains a regularly updated database of published works and digital identifiers that show the location of specific articles on the Internet.

In the year 2014, the NAS Research-and-Publishing Council supported the joint initiative of the 'Akademperiodyka' PH and the 'Ukrinformnauka' subscription agency concerning the conclusion of an agreement with the Association of PILA and joining the CrossRef. From now on, 'Ukrinformnauka' has all the necessary authority to receive from and provide DOI digital identifiers to academic periodicals in Ukraine. The publisher institution of each of the NAS editions can receive the DOI if it concludes an agreement with the 'Ukrinformnauka' agency.

For obtaining and successful functioning of the digital ID mechanism, the publisher institution needs to create a Web resource of the scientific journal in accordance with the mandatory requirements of the CrossRef. The NAS 'Akademperiodyka' PH has developed all necessary standard technology solutions and is ready to provide methodological advice and practical assistance to Academy scientific periodicals in improving or establishing their own properly equipped Web resources.

Regional Structure of the National Academy of Sciences of Ukraine



• Reorganized:

Odessa Division of the O.O.Kovalevsky Institute of Biology of the Southern Seas into the Institute of Marine Biology

Hydroacoustic Branch of Marine Hydrophysical Institute into Hydroacoustic Branch of the S.I.Subbotin Institute of Geophysics

• Transferred:

Donetsk O. O. Galkin Institute of Physics and Engineering to Kyiv

Institute for Physics of Mining Processes to Dnipropetrovsk

Ukrainian State R&D Institute of Mining Geology, Rock Mechanics and Mine Surveying to Dnipropetrovska oblast

L. M. Litvinenko Institute of Physical-Organic Chemistry and Coal Chemistry to Kyiv

Donetsk Botanical Garden to Donetsk oblast

Donetsk Science Centre to Donetsk oblast

Institute for Machine Intelligence Problems to Kyiv

Institute for Economic and Legal Research to Kyiv

Institute of Industrial Economics to Kyiv

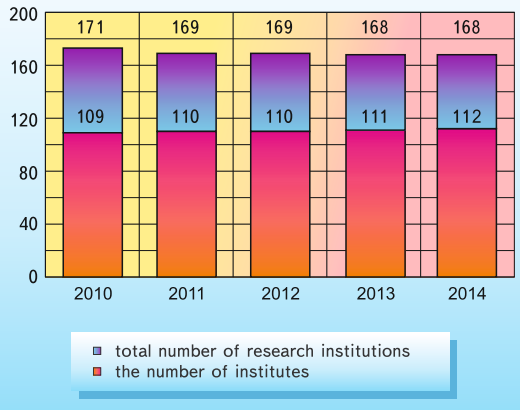
Ukrainian Steppe Natural Reserve to Zaporizhska oblast

Institute of Applied Mathematics and Mechanics to Donetsk oblast

* The status of NAS institutions situated in the Crimea AR is determined by the law of Ukraine

«On ensuring the rights and freedoms of citizens and the legal regime on the temporarily occupied territory of Ukraine»

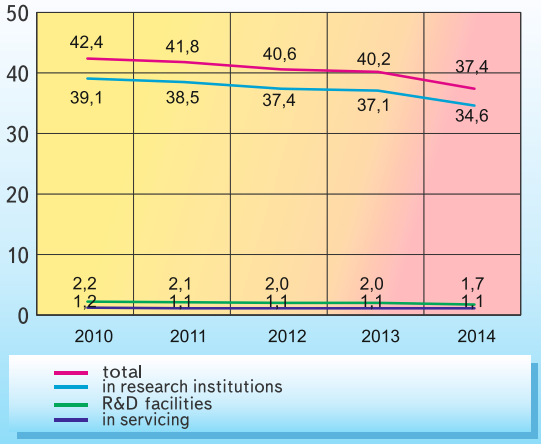
Total number of research institutions



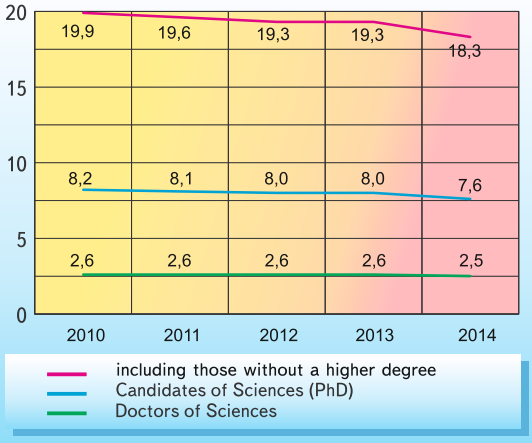
Total number of employees	**37447**
including:	
in research institutions	**34609**
in R&D organizations	**1732**
in service organizations	**1106**

R&D employees	**18346**
including:	
Doctors of Sciences	**2530**
Candidates of Sciences (PhD)	**7603**

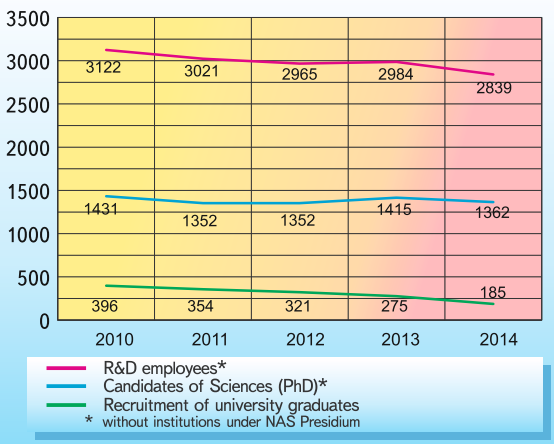
Number of employees (thousand)



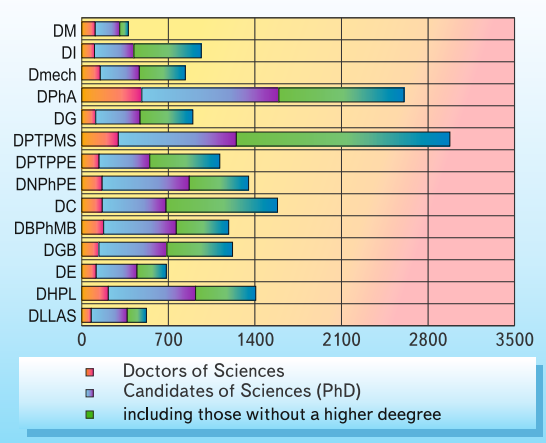
Number of R&D employees (thousand)



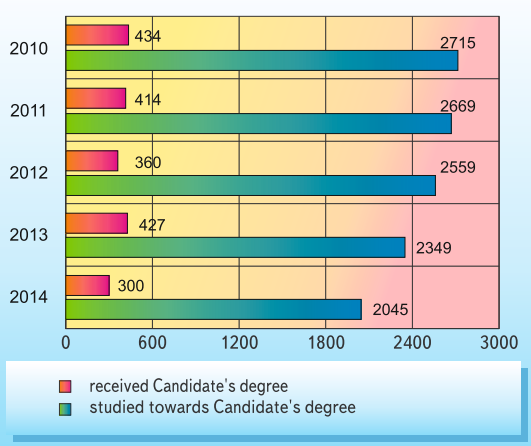
Number of employees under 35

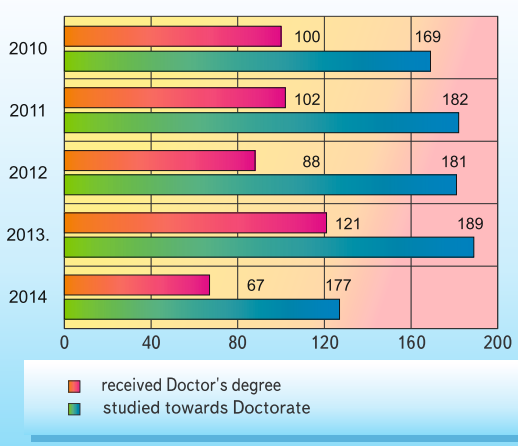


Distribution of scientists by departments



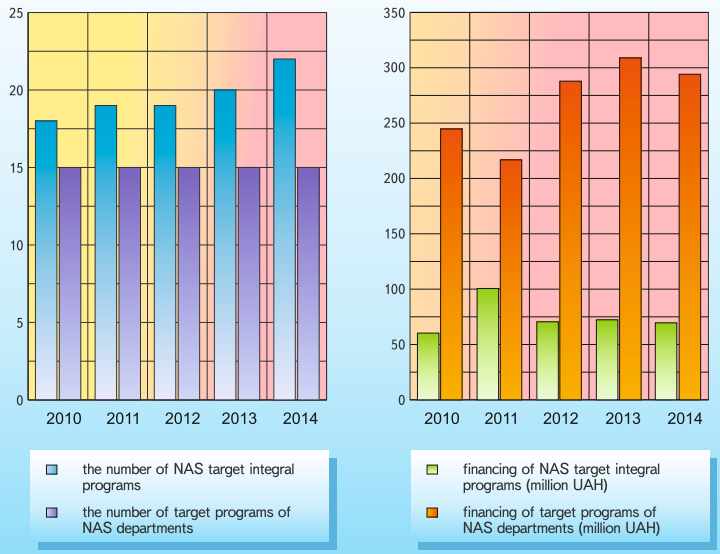
Training of research personnel



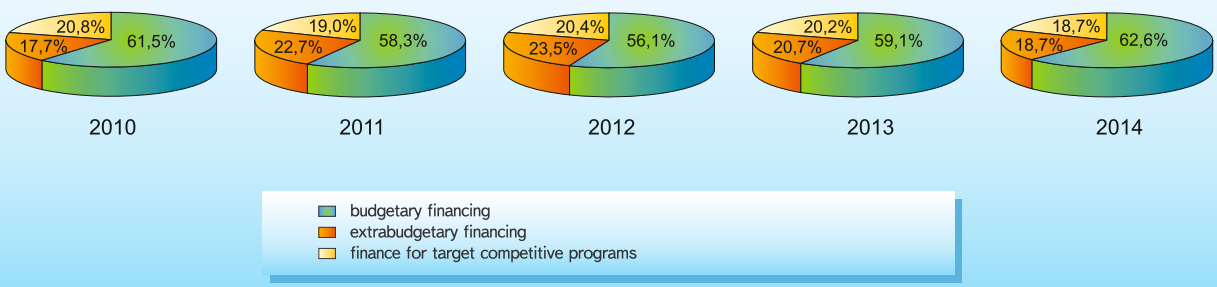


Budget	thousand UAH
Total financing	3054511,6
General fund of the state budget	2482717,2
Basic funding from the State budget	1865309,0
Target programs finance	570071,9
Budget finance for personnel training	11383,9
Budget finance for health protection	35952,4
Extrabudgetary revenues	571794,4
Total expenditures	3003673,9
Expenditures on wages	2296022,5
Expenditures on equipment and instruments	147134,4
Expenditures on capital construction and reconstruction	2380,7
Expenditures on utilities	194081,3
Other expenditures	364055,0

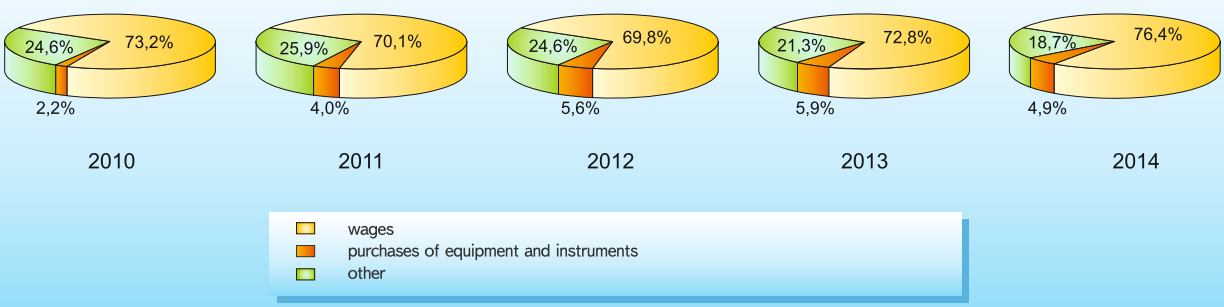
Target programs subjects



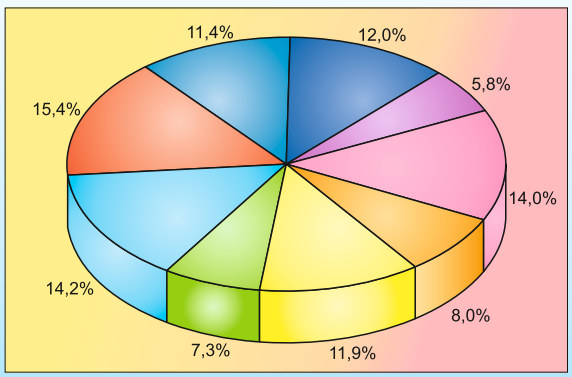
Distribution of finance by sources



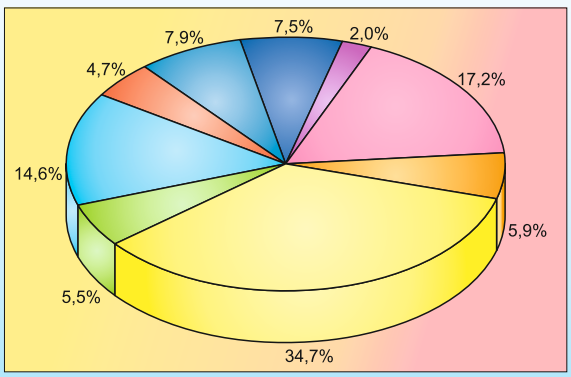
Distribution of expenditures by principal items



Distribution of basic budgetary finance

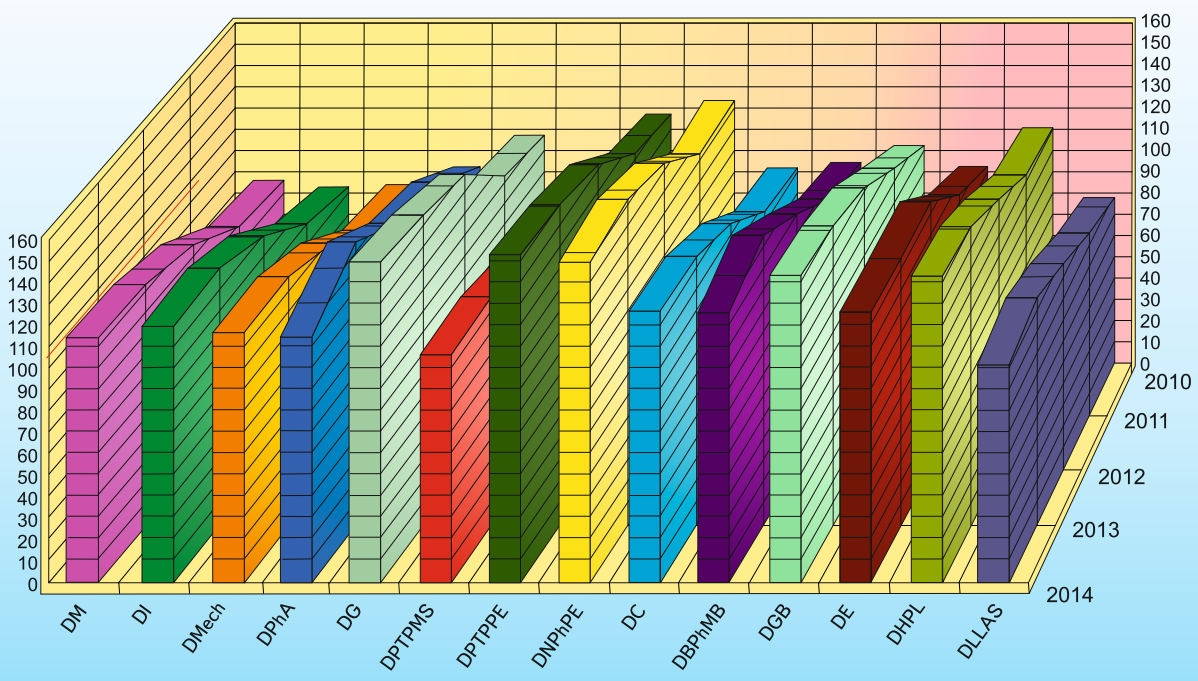


Distribution of extrabudgetary finance



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

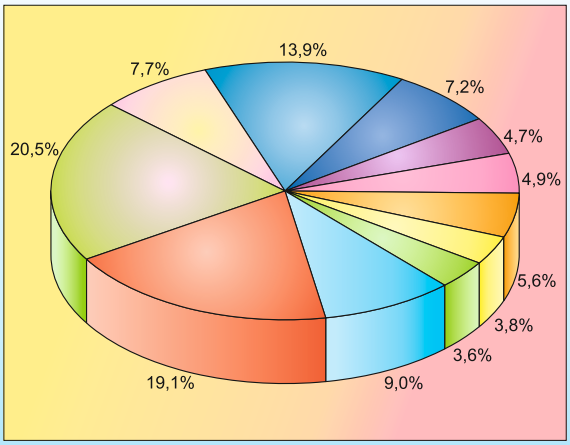
Distribution of budget finance per 1 researcher among Departments (thousand UAH)



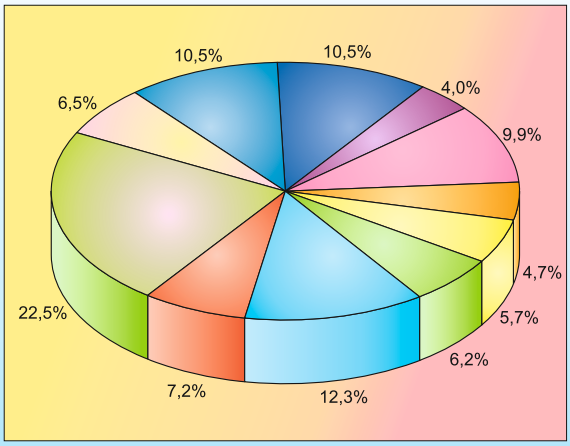
Publication of Academic Materials

In 2014 the publication of journal «Cybernetics and Computer Engineering» was started

Monographs

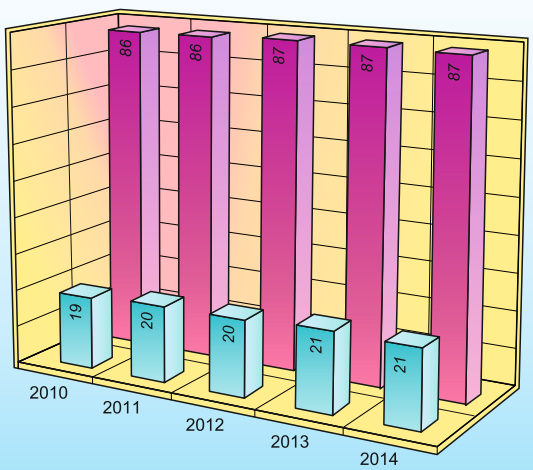


Papers



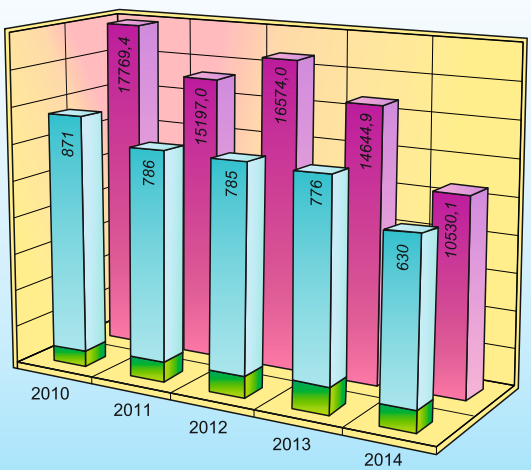
Mathematics, Mechanics, Informatics
Physics and Astronomy
Earth Sciences
Materials Sciences
Power Engineering
Nuclear Physics and Power Engineering
Chemistry
Biological Sciences
Economics
History, Philosophy and Law
Literature, Language and Art Studies

Academic Periodicals



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

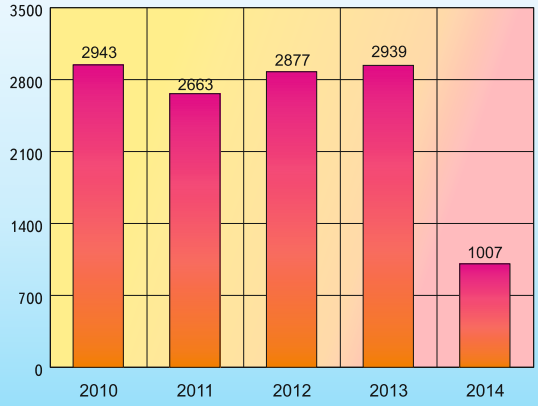
Publication of Academic Books



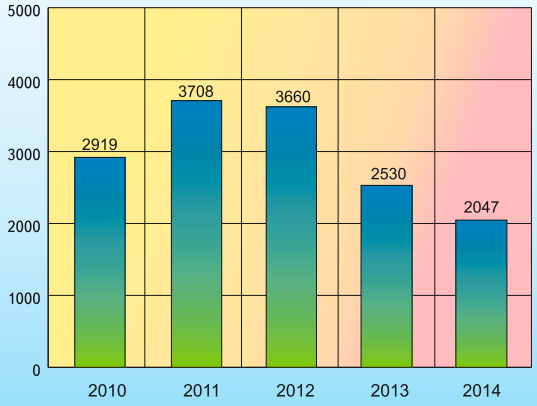
volume
the number of titles (incl. abroad)

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

Foreign Scientists Received in Ukraine



Ukrainian Scientists Sent on Mission Abroad



Contents