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## TO THE 100<sup>TH</sup> ANNIVERSARY OF THE NATIONAL ACADEMY OF SCIENCES OF UKRAINE – THE CRADLE OF DOMESTIC SCIENCE AND TECHNOLOGY

*Purpose. Preparation of short scientifically-historical essay about creation and development of the National Academy of Sciences (NAS) of Ukraine. Methodology. Known scientific methods of collection, analysis and analytical treatment of scientific and technical information, touching creation and development of NAS of Ukraine and resulted in scientific monographs, journals and internet-reports. Results. A short scientifically-historical essay is presented about creation and development of NAS of Ukraine. The main scientific achievements of NAS of Ukraine in various fields of science are presented. It is pointed that a large scientifically-organizational contribution to these achievements brought by present President of NAS of Ukraine, Academician B.Ye. Paton, his 100th Birthday (27 November, 2018) coincides surprising appearance with the 100th anniversary of NAS of Ukraine. An important role of NAS of Ukraine in the development of society and international scientific and technical cooperation was noted. The results of scientific research, achieved over the past few years by the Institute of Technical Problems of Magnetism of the NAS of Ukraine (Kharkiv), as well as by the Institute of Ionosphere of the NAS and Departments of education and science (DES) of Ukraine (Kharkiv) are briefly presented. The research cooperation in the field of electrical engineering of NTU «KhPI» with scientific institutions of the NAS of Ukraine is highlighted. Originality. Certain systematization is executed of known from scientific journals and other mass of scientific and technical materials, touching the results of activity of research workers of institutes of NAS of Ukraine in the last few years. Practical value. Scientific popularization and deepening for the students of higher school, engineer-technical and scientific workers, working in the different sectors of economy of country, scientific and technical knowledge in an area of physical-technical and mathematical sciences, chemical and biological sciences, and also social and humanitarian sciences, extending their scientific range of interests and further development of scientific and technical progress in society. References 28, figures 10.*

*Key words: National academy of Sciences of Ukraine, history of creation and development of Academy.*

*Приведен краткий научно-исторический очерк о создании, развитии и структуре Национальной академии наук (НАН) Украины. Отмечена важная роль НАН Украины в развитии общества и международном научно-техническом сотрудничестве. Приведены основные научные достижения ученых НАНУ в различных областях науки, а также кратко изложены результаты научных исследований, достигнутые за последние несколько лет Институтом технических проблем магнетизма НАН Украины и Институтом ионосферы НАН и МОН Украины (г. Харьков). Освещено сотрудничество ученых-электротехников НТУ «ХПИ» с научными учреждениями НАН Украины. Библ. 28, рис. 10.*

*Ключевые слова: Национальная академия наук Украины, история создания и развития.*



«...Without scientific schools there will be no science. Without science there will be no technology.»

(From the lecture of the outstanding scientist of our time the President of the National Academy of Sciences of Ukraine B.Ye. Paton, 2012)

**Introduction.** Modern generations of humanity will soon become a witness to the unique Ukrainian socio-scientific phenomenon: at the end of November 2018, the National Academy of Sciences (NAS) of Ukraine and its current President, Academician B.Ye. Paton celebrate their 100<sup>th</sup> Anniversaries. This event is symbolic both in its form and in its content. Beginning not only since 1962, when Academician Boris Yevgenovich Paton headed the Academy of Sciences of the Ukrainian SSR (since 1994, the NAS of Ukraine), and throughout all his life this prominent scientist of the modern day was, as they say, «a foot in the foot» with the development of domestic science and technology. Therefore, many years of scientific and organizational activity of Academician B.Ye. Paton as the President of the National Academy of Sciences of Ukraine should be considered as an integral part of the fruitful work of the head of the headquarter of Ukrainian science and technology. Without this important work, it would be impossible to coordinate and direct the multifaceted

activities of the numerous scientific and technical community of the state in the necessary direction.

Humanity at a certain stage of its long-term development has objectively come to the important conclusion that without new scientific and technological ideas and techniques, progress in society becomes impossible. In order to get these ideas and methods, in society we must actively pursue both fundamental and applied scientific research. These studies require highly skilled scientific and technical personnel of a different profile, for which preparation special institutions of society must comply. New methods can be practically implemented in society only with the help of new technology. Therefore, without new technology with higher technical characteristics it is fundamentally impossible to ensure industrial progress of society. In this connection, in a progressive society, a symbiosis of science and technology is needed. To achieve this symbiosis, an appropriate coordinating body becomes necessary. In our opinion, the Academy of Sciences of our state became a similar governing body in Ukraine.

**The goal of the paper** is drawing up a short scientific and historical essay on the creation and development of the National Academy of Sciences of Ukraine and the achievements of its scientists, as well as the fruitful cooperation of the NAS of Ukraine and the NTU «KhPI» of the Ministry of Education and Science of Ukraine.

**1. Brief history of the creation of the National Academy of Sciences of Ukraine.** The NAS of Ukraine as the Ukrainian Academy of Sciences (UAS) was founded on November 27, 1918 by the Hetman P.P. Skoropadsky government, and prominent domestic scientist-geochemist, Academician V.I. Vernadsky (Fig. 1) was a founding member and the first President of the UAS [2].

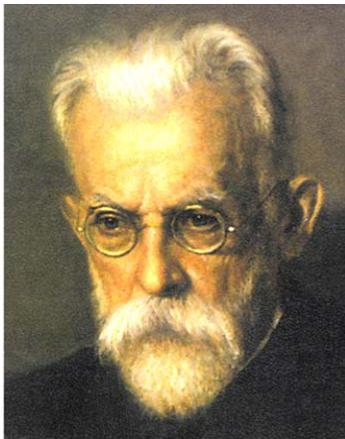


Fig. 1. The first President of the UAS, prominent domestic scientist-geochemist Academician V.I. Vernadsky (12.03.1863 – 06.01.1945)

During the long history as the Presidents of the Academy were elected [2]: M.P. Vasilenko (1921-1922), O.I. Levitsky (1922), V.I. Lipsky (1922-1928), D.K. Zabolotny (1928-1929), O.O. Bogomolets (1930-1946), and O.V. Palladin (1946-1962). Since 1962 the Academy is headed by B.Ye. Paton (Fig. 2).



Fig. 2. The current President of the National Academy of Sciences of Ukraine, outstanding scientist in the field of electric welding of materials, Academician of NAS of Ukraine B.Ye. Paton (born on November 27, 1918)

The name of the Academy was changed four times [1]. In 1918-1921 it was named as the Ukrainian Academy of Sciences (UAS). From 1921 to 1936 as the All-Ukrainian Academy of Sciences (AUAS). In the period 1936-1991 as the Academy of Sciences of the Ukrainian SSR (AS of the Ukrainian SSR). From 1991 to 1993 as the Academy of Sciences of Ukraine (AS of Ukraine), and since 1994 as the National Academy of Sciences of Ukraine (NAS of Ukraine) [1]. The UAS was the oldest of the republican Academies during the

existence of the USSR. In the first year of its activities (until 1920), it consisted of only three scientific Departments: for history and philology, for physics and mathematics, and for social sciences, which covered 3 Institutes, 15 commissions and the National Library [1]. For comparison, we note that now the National Academy of Sciences of Ukraine has 3 sections, 14 branches, about 170 Institutes and other scientific institutions, which employs about 16 thousand researchers [2].

Many scientific schools have been formed at the NAS of Ukraine. Their founders were [2]: prominent mathematicians D.O. Grave, M.M. Krylov, M.M. Bogolyubov, Yu.O. Mitropolsky; mechanics S.P. Tymoshenko, O.M. Dinnik, M.O. Lavrentyev, G.S. Pisarenko; physicists K.D. Sinelnikov, A.K. Walter, L.V. Shubnikov, V.E. Lashkaryov, O.I. Akhiezer, O.S. Davydov, A.F. Prihotko, O.Ya. Usikov; power engineers V.M. Khrushchev, G.F. Proscura; astronomers O.Ya. Orlov, M.P. Barabashov, Ye.P. Fedorov, S.Ya. Braude; geologist P.A. Tutkovsky; material scientist I.M. Frantsevich, V.I. Trefilov; chemists L.V. Pisarzhevsky, O.I. Brodsky, A.V. Dumansky, V.I. Atroshchenko; medical doctors D.K. Zabolotny, O.O. Bogomolets, V.P. Filatov, M.G. Kholodny, I.I. Shmalgauzen, M.M. Amosov. There are the world-famous Ukrainian electric welding schools of Ye.O. Paton and B.Ye. Paton [3] and cybernetics school of V.M. Glushkov, economic and humanitarian schools that were headed by [2] economists M.V. Ptukha and K.G. Woblyi; historians M.S. Grushevsky and D.I. Yavornytsky; lawyer V.M. Koretsky; philosopher V.I. Shinkaruk; orientalist A.Yu. Krymsky; linguistics L.A. Bulakhovsky, V.M. Rusanivsky; literary critics S.O. Efremov and O.I. Biletsky.

Note that Academician B. Ye. Paton is the only head of the state Academy of Sciences in the world, who is its contemporary (the day of foundation of the Academy of Sciences of Ukraine and the day of his birth surprisingly coincide – November 27, 1918) [3]. Personal communication with this person-statesman leaves many years unforgettable impression (Fig. 3).



Fig. 3. Meeting of scientists of the NTU «KhPI» with the President of the National Academy of Sciences of Ukraine, Academician B.Ye. Paton after the award of the State Prizes of Ukraine in the field of science and technology for 2006 (Kyiv, Mariinsky Palace, February 2007)

**2. Structure, management and basic functions of the National Academy of Sciences of Ukraine.** According to the current legislation, the National

Academy of Sciences of Ukraine is the highest state-owned scientific institution in Ukraine [4]. The self-government of the Academy is to independently determine the subjects of research and the forms of their organization and conduct, the formation of structure, the solution of scientific and organizational, economic and personnel issues, the implementation of international scientific relations, election and collegiality of management [4]. The Academy unites true members (Academicians), Corresponding Members and foreign members, all scientists of its institutions. It organizes and implements fundamental and applied scientific research on the most important problems of the natural, technical, social and human sciences [4]. The highest authority of the National Academy of Sciences of Ukraine is its General Meeting, consisting of true members (Academicians) and Corresponding members. In the period between sessions of the General Meeting, the Presidium of the National Academy of Sciences of Ukraine conducts the Academy's work, which is elected by the General Meeting for a term of 5 years. The Presidium of the National Academy of Sciences of Ukraine currently employs 32 people, including [4]: the President, five Deputy Presidents, Chief Scientific Secretary, 14 Academics-secretaries of Departments and 11 other members. As of 01.01.2018, the National Academy of Sciences has 177 true members (Academicians), 352 Corresponding Members and 98 foreign members, and the total number of employees at the National Academy of Sciences of Ukraine at that time amounted to 29870 people, including 15529 research workers. Among them, 2362 Doctors of Sciences and 6807 Candidates of Sciences [4].

The National Academy of Sciences of Ukraine has 3 sections (physical, technical and mathematical sciences; chemical and biological sciences; social sciences and humanities), which combine 14 Departments of science [4]: mathematics; informatics; mechanics; physics and astronomy; earth sciences; physical and technical problems of materials science; physical and technical problems of energy; nuclear physics and energy; chemistry; biochemistry, physiology and molecular biology; general biology; economy; history, philosophy and law; literature, language and art studies. There are 5 regional research centers in the Academy with double subordination to the Ministry of Education and Science of Ukraine [4]: Donetsk (Pokrovsk city), Western (Lviv city), Southern (Odessa city), Northeast (Kharkiv city), Prydniprovsky (Dnipro city), as well as the Center for Evaluation of Scientific Institutions and the Development of Regions (Kyiv city). The Departments of the National Academy of Sciences of Ukraine include relevant research institutes and other scientific institutions (observatories, botanical gardens, arboretums, preserves, libraries, museums, etc.), which are the main link in the structure of the Academy.

Scientists of NAS of Ukraine are active participants in international programs supported by such foreign and international foundations and organizations as [4]: European Commission, STCU, NATO, UNESCO, DFG, CRDF, etc. The grants of these organizations, obtained on a competitive basis, annually

support implementation of about 300 research, coordination and supporting scientific exchanges scientific and technical projects. It should be noted that in accordance with the Association Agreement with the EU, relations with the research centers of the EU countries and European Commission organizations are expanding, in particular regarding participation in EU programs on research and innovation «Horizon 2020», Euratom, as well as fruitful interaction on an ongoing basis with Joint Research Center of the European Commission (JRC) [4, 5]. The National Academy of Sciences of Ukraine conducts independent scientific evaluation of strategic, forecast and program documents (doctrines, concepts, strategies, etc.) as well as state-level materials on the instructions of the President of Ukraine, the Verkhovna Rada of Ukraine, the Cabinet of Ministers of Ukraine and/or on its own initiative, develops proposals on the principles of state scientific and scientific and technical policy, forecasts, information and analytical materials, suggestions, recommendations on socio-political, socio-economic, scientific and technical, innovation and human development of state, carries out scientific and technical examination of numerous draft of laws.

**3. Main scientific achievements of the National Academy of Sciences of Ukraine.** On May 18, 2017, the President of Ukraine signed the Decree No. 136/2017 on the 100th Anniversary of the National Academy of Sciences of Ukraine, scheduled for November 2018. What results does the Academy meet with its anniversary?

NAS of Ukraine is one of the prominent scientific centers of the world, which enriched the national and world science with valuable discoveries and inventions. Thus, the Academy's physicists in the 20th century carried out a number of important scientific studies in the field of theoretical and experimental physics, as well as in the study of the physical properties of semiconductors (for example, germanium diodes and triodes) [1, 4]. The fundamental scientific works of physicists of the Ukrainian Institute of Physics and Technology (UFTI, Kharkiv, now the NSC «KhPTI») are widely known from that period: by Academicians O.I. Leipunsky and A.K. Walter in the field of physics of the atomic nucleus and powerful accelerators of charged particles, as well as by Academician K.D. Sinelnikov in the field of vacuum physics, vacuum metallurgy and high-temperature plasma [6]. In 1965, this Institute built the largest linear electron accelerator in Europe for energy up to 2000 MeV [6]. In addition, Kharkiv scientists during this period built the world's largest radio telescope type UTR-2 (Fig. 4), which is located near the village Grakovo (Kharkiv region) [7]. The UTR-2 radio telescope has a T-shaped arrangement of antennas with a total area of 150,000 m<sup>2</sup>. It is today one of the most powerful scientific and technical research tools in the world to investigate the Universe. It should be noted that with the help of the UTR-2 radio telescope, which now belongs to the Institute RIAN of the NAS of Ukraine, an atlas of the back of the Moon was created. This merit belongs to the native of the Kharkiv region, the famous Soviet scientist-astronomer, Academician of the Academy of Sciences of the Ukrainian SSR, Professor of the Kharkiv State University M.P. Barabashov [7].



Fig. 4. General view of the object of national heritage of Ukraine «Radio telescope UTR-2 with the system of interferometers URAN» of the Radio Astronomical Institute of the National Academy of Sciences of Ukraine (Grakovo village, Kharkiv region)

Works by Academicians M.M. Krylov and M.M. Bogolyubov and their students are an outstanding contribution to the study of approximate methods of mathematical analysis and the theory of dynamical systems. These well-known in the world Ukrainian mathematicians have created a substantially new section in the field of mathematical physics – nonlinear mechanics. A significant contribution to domestic and world science is the research work by Academician G.F. Proscura on aerohydrodynamics and by Academician M.O. Lavrentiev on the geometric theory of functions of complex variable and its practical application for solving urgent modern technical problems of hydrodynamics and aerodynamics.

At the Institute of Electrical Engineering of the Academy of Sciences of the USSR (now Institute of Electrodynamics of the National Academy of Sciences of Ukraine, Kyiv) for the first time in the USSR a small electronic computer was created. In many technical branches, the Academy of Sciences of the USSR came out first in the USSR (for example, in powder metallurgy and electric welding). Scientists-chemists of the Academy of Sciences of the USSR were the first in the USSR to receive «heavy water» for the needs of nuclear physics and energy, as well as the corresponding isotopes of hydrogen and oxygen for a complex of promising experimental nuclear-physical studies [1, 4, 8]. The materials science Institutes of the Academy successfully developed the technological processes that enabled the new branches of development of the economy. Significant scientific results were obtained at the Institutes of chemical technology, biochemistry, physiology and theoretical medicine, general biology.

The multifaceted and powerful contribution to the development of world science and our state of the National Academy of Sciences of Ukraine does today. Modern achievements of the Academy's scientists in 2017 which are indicated in the final annual report of the President of the National Academy of Sciences of Ukraine, Academician B.Ye. Paton [9] confirm that the NAS of Ukraine continues to perform its statutory duties in a worthy manner. Thus, in the difficult labor conditions of 2017, with significant underfunding of the Academy, scientists of the National Academy of Sciences of Ukraine received the following significant fundamental and applied results in various fields of science [9], including:

- new solutions of the Mathisson-Papapetrou equations have been obtained, which have revealed previously unknown features of the motion of fast particles with their own rotation moment around the black Schwarzschild hole in the Sitter space model;
- new highly effective combinations of cybernetic algorithms are developed, which enable the specialists to parallelize the process of solving complex discrete optimization problems of large dimension;
- a fundamentally new method of transporting drugs in human blood has been developed, the essence of which is to bind specially modified molecules of medicinal preparations with lipoprotein particles of plasma of human blood;
- two extremely important breakthrough discoveries in the field of extragalactic astronomy and cosmology have been made (this is the opening of two galaxies, one of which is the galaxy with the smallest content of chemical elements heavier than the helium, and the other is a galaxy whose radiation is so powerful that it can ionize neutral intergalactic environment in the era of reionization of the Universe);
- new functional nanomaterials were created based on the integration of important functional characteristics of graphene, graphene oxides, inorganic semiconductors with the properties of conjugated electrical conductive polymers;
- new unknown previously condensed pyrimidine derivatives have been obtained that effectively suppress the harmful human papillomavirus;
- a number of compounds effective against pathogens of multi-resistant tuberculosis have been discovered and studied by biochemists;
- it has been proven that acetylcholine receptors play an important role in activating regulatory  $\beta$ -lymphocytes, suppressing the synthesis of antibodies and activating the processes of regeneration of the liver;
- biologists studied the molecular-genetic properties of the five enterobacterium viruses, which are considered as promising agents of phagotherapy of burns of fruit plants;
- a new concept of the organization of protected areas of polyfunctional type with various flexible protection regimes, which provides introduction of ecosystem principle instead of territorial, is grounded;
- a three-dimensional computer model of the Moho (or Mohorovičić) surface is built on super-supercomputers SKIT intended to accurately locate and evaluate stocks of ultra-deep oil and gas deposits, which are often expensive to exploration through traditional drilling;
- an effective information technology of the classification of the ground cover has been developed under the research program of the NAS of Ukraine «Aerospace Observations for Sustainable Development and Security», which enables to receive scores of areas for the scale of the whole country and is a key component of the integrated assessment of the development of a «smart city» in the context of comfort and security of residence in it;
- scientists in the field of mechanics together with specialists of the State Enterprise «M.K. Yangel Design

Office «Pivdenne» developed a special module for the removal of the third stage of the carrier rocket, which, among other things, is proposed to be used to remove from the orbit of the third stage of the carrier rocket «Cyclone-4M» and spacecrafts that worked out the term of their active existence;

- material scientists have created an automated broad-spectrum complex that allows specialists to remotely control the quality of structures of metal and composite materials in real-time;

- thermophysics scientists have developed a multi-stage technology and installation for the production of insulating ultra-fine basalt fiber, which is important for the further creation of a new environmentally safe, durable and fire-proof thermal insulation for civil engineering;

- chemical scientists have proposed highly effective methods for the processing of plant waste and sediments of the Bortnitskaya Aeration Station;

- biochemists of the country tested a new hemostatic agent, intended for use by patients with congenital pathologies of hemostasis, in particular hemophilia;

- a technology is developed for obtaining a recombinant creatinine deaminase – a sensory element of the sensor for creatinine, which serves as a biomarker for renal insufficiency and an indicator of the efficiency of the hemodialysis process;

- a highly effective innovative technology for restoring speech of post-stroke patients is developed, the feature of which is the personified activation of the patient's body reserves;

- the first National biodiversity information network (UkrBIN) was developed in our country;

- economists have created an information and analytical system for forecasting the development of domestic energy;

- nuclear scientists, energy specialists and nuclear safety experts substantiated the term and showed the possibility of prolonging the safe operation of the nuclear reactor of power unit No. 2 of the South-Ukrainian NPP for at least 20 years in the over-project period, that is, until 2048, and the nuclear reactor of power unit No. 4 of the Rivne NPP at least until 2026;

- the RODOS system developed by the domestic scientists, which is intended to predict and support the decision-making on reacting to radiation accidents at Ukrainian nuclear power plants, has proved its efficiency;

- the process of introduction into the industrial production of the drug «Metovitan», which performs energy-stimulating, cardioprotective and hepatoprotective functions, and prevents the aging of the body, is completed;

- with the participation of cybernetics, networks for group work of domestic robotized ground and air combat systems were developed;

- scientists accomplished a large complex of works on the creation of: import substitution elements, including a semiconductor element base for the maintenance of high-precision weapons; technologies for prolonging the life of aviation and armored vehicles; materials of heat-resistant composites for combustion chambers of gas turbine

engines; components of solid rocket fuel; technology of laser and arc welding of thin-walled elements of a steering wheel and nozzle of guided missiles and for underwater welding of shells of warships in extreme conditions; technologies of strengthening and processing of smoothbore and threaded channels of different caliber trunks; technologies of creation of composite transparent and layered structures from ceramics and alloys of light metals for the protection of light-armored machinery; technologies of coating creation that minimize the visibility of vehicles in microwave, RF and IR bands of electromagnetic waves.

**4. Kharkiv Academic science.** Kharkivites are proud of the fact that their city is now the second in the country after Kyiv on the strength of Academic science. Thus, in Kharkov there are 13 research Institutes of the National Academy of Sciences of Ukraine, which represent 3 Sections and 6 Departments of the National Academy of Sciences of Ukraine. They are the B.I. Verkin Physical-Technical Institute of Low Temperatures (PTINT), the O.Ya. Usikov Institute of Radiophysics and Electronics (IRE), the Radio Astronomy Institute (RIAN), the Institute of Ionosphere of the National Academy of Sciences and the Ministry of Education and Science of Ukraine (ION), which are members of the Department of Physics and Astronomy. The members of the Department of Nuclear Physics and Energy are the National Science Center «Kharkiv Physical-Technical Institute» (NSC «KhPTI», former UFTI) and the Institute of Electrophysics and Radiation Technologies (IERT). The members of the Department of Physical and Technical Problems of Materials Science are the Research and Technological Complex «Institute of Single Crystals» (RTC «ISC»), the Institute of Single Crystals (ISC), the Institute of Scintillation Materials (ISMA). The Department of Biology, Physiology and Molecular Biology is represented by the Institute of Problems of Cryobiology and Cryomedicine (IPCC), and the Department of Economics by the Research Center for Industrial Development Problems (RC «IDP»).

Close to the readers of the Journal «Electrical Engineering and Electromechanics» the technical sciences in Kharkiv are represented by the A.M. Podgorny Institute of Mechanical Engineering Problems (IPMach) and the Institute of Technical Problems of Magnetism (ITPM), which are part of the well-known for us Department of Physical and Technical Problems of Power Engineering (DPTPE) of the National Academy of Sciences of Ukraine.

Academic Institutes have a powerful and unique scientific and experimental base. So, in Kharkiv there are 6 scientific objects that make up the National heritage of Ukraine [10]. These are such objects as «Nuclear and Physical Installations» of the NSC «KhPTI»; «Complex for physical research at ultralow temperatures» of the PTINT; «Cryomagnetic radio spectroscopic complex of millimeter wavelength range» of the IRE; «Radio telescope UTR-2 with the system of URAN interferometers» of the RIAN (Fig. 4),

«Ionospheric probe» of the IION (Fig. 5); «Hydrodynamic stands» of the IPMach, and the «Magnetodynamic complex» of the ITMP.

**Institute of Ionosphere of the National Academy of Sciences and Ministry of Education and Science of Ukraine.** It is close to the NTU «KhPI» on the history and territorial location. It was founded in 1991 on the basis of the Department of Radio Electronics of the NTU «KhPI». This institute has a unique ionospheric observatory, the ionospheric probe of which is the object of the national heritage of Ukraine [11]. The general view of this unique object – the incoherent scattering (IS) radar with a parabolic antenna type NDA-100, whose diameter is equal to 100 m, is presented in Fig. 5 [12].



Fig. 5. Object of national heritage of Ukraine «Ionospheric probe» of the Institute of Ionosphere of the National Academy of Science and Ministry of Education and Science of Ukraine (Zmiev city, Kharkiv region)

Since 1996, in this observatory of the Institute of Ionosphere, in conjunction with the Haystack Observatory of the Massachusetts Institute of Technology and the Arecibo Observatory of the Cornell University (USA), regular studies of the height-time dependence of the relative concentration of light ions by the method of incoherent scattering were conducted in accordance with the International Geophysical Calendar, which made it possible to detect in the ionosphere of the Earth longitudinal and latitudinal variations in the concentration of hydrogen ions [12]. These studies are important for the safety of flights in near-Earth orbits of satellites of various applications and other spacecrafts, forecasting the state of radio communications and weather [11, 12].

**Institute of Technical Problems of Magnetism of the National Academy of Sciences of Ukraine.** ITPM is the only one Academic research institution in the city of Kharkiv working in the field of electrical engineering. The institution was founded in 1970 [13] and functioned until 1991 as the Kharkiv branch of the All-Union Research Institute of Electromechanics – the main organization in the USSR for the development of «low-magnetic» ship electrical equipment. In 1992, this institution as a legal entity in the status of a separate Department of Magnetism of the Institute of Electrodynamics became a member of the National Academy of Sciences of Ukraine, which in 2005 was transformed into the Scientific and Technical Center for Magnetism of Technical Objects (STC MTO of the NAS

of Ukraine) with the rights of a research Institute. In 2010, the institution celebrated its 40th anniversary (Fig. 6).



Fig. 6. Scientific presentation by the Corresponding Member of the NASU V.Yu. Rozov which is devoted to the 40th anniversary of the founding of the STC MTO of the NAS of Ukraine (Kharkiv, 2010)

In 2013, this institution was renamed the Institute of Technical Problems of Magnetism (ITPM) of the National Academy of Sciences of Ukraine. ITMP of the NAS of Ukraine is the only research institution in Ukraine and the world that performs theoretical and experimental scientific researches of static and low frequency (with frequency 0-5000 Hz) magnetic field created by various technical objects (ships, vehicles, orbital spacecrafts, trunk pipelines, electrical engineering, building constructions, etc.). Investigations are carried out according to the following approved scientific directions: the theory of magnetism of technical objects; definition of magnetic characteristics of technical objects; control of the magnetic field of technical objects; reduction of electromagnetic effects of objects of electric power to the person and the environment. The results of the research of the ITPM in these directions correspond to the international standards of high level due to the unique scientific staff of the Institute, an integrated approach to solving the scientific problems of magnetism of various technical objects, as well as the widespread use of the powerful and unique experimental base of the Institute – its «Magnetodynamic complex» in carrying out both fundamental, as well as applied research (Fig. 7).

For the period of work in the NAS of Ukraine, the specialists of the ITPM on the basis of generalization of features of various classes of technical objects (ships, armored vehicles, pipelines, spacecrafts and electric power equipment) as sources of magnetic field, formed a new scientific direction – «magnetism of technical objects» which is aimed at studying the totality of magnetic properties of technical objects and phenomena associated with the interaction of technical objects and the environment through a magnetic field. In the framework of this direction, fundamentally new scientific achievements of the world level, which have been introduced into the defense and space domestic industries, fuel and energy complex and medical ecology, have been obtained.



Fig. 7. A unique magnetometric stand of the object of the national heritage of Ukraine «Magnetodynamic complex» of the Institute of Technical Problems of Magnetism of the National Academy of Sciences of Ukraine (Kharkiv)

Among the most important applied results of the ITMM, it is possible to note the creation and introduction in the Magnetodynamic complex of the Institute of industrial technology of a high-precision measurement of the magnetic characteristics of spacecrafts developed by the State Enterprise «Design Office «Pivdenne» [14]. The developed technology became an integral part of the technology of the creation of domestic spacecrafts and allowed to provide high-quality magnetic control of spacecrafts of types «Microsatellite», «EgiptSat-1», «Sich-2» (Fig. 8), «Microsat», «Sich-2-1» and the development of a number of advanced spacecrafts in terms of their magnetic characteristics.



Fig. 8. Determination of the magnetic characteristics of the flying sample of the spacecraft «Sich-2» at the magnetometric stand of the Institute of Technical Problems of Magnetism of the National Academy of Sciences of Ukraine (Kharkiv, 2010)

The industrial practical technology of demagnetization of welding joints of large diameter pipes has been developed and introduced on main pipelines of Ukraine and other countries (see Fig. 9) as an important practical result of the research activity of the ITPM of the National Academy of Sciences of Ukraine. This allows to significantly improve the quality of electric welding during repair work by eliminating the phenomenon of «magnetic blast» of the arc [15]. Approximately 80 demagnetizing devices have been currently introduced. Developed over the past five years at the ITPM methods and means for the determination and normalization of the magnetic field of industrial frequency in residential buildings and workplaces of power engineering objects, as well as technogenic hypogeomagnetic field have Important social significance. A number of important and

relevant developments have been completed in this direction, among which the following can be noted:



Fig. 9. Repair works on the main gas pipeline DU 1200×12 mm «Urengoy-Pomari-Uzhgorod» using the technology of demagnetization of welding joints developed at the ITPM of the National Academy of Sciences of Ukraine (Ternopil, 2017)

1. A new method for modeling and calculating the magnetic field of a three-phase power transmission line, which, unlike the known ones, allows to use the purely effective values of the magnetic flux density, which are subject to both normalization and measurement by standard devices is developed [16, 17]. This approach greatly simplifies both the experimental check (verification) of the calculation of the level of the magnetic field, and its sanitary-hygienic assessment. The results of the work formed the scientific basis of the new normative document of the Ministry of Energy and Coal COV-H EE 20.179:2008 «Calculation of electric and magnetic fields of transmission lines. Methodology» (as amended), which was put into effect by the order of the Ministry of Energy and Coal of 01.07.2016 No. 423.

2. A new method for reducing the magnetic field of high-voltage transmission lines is proposed – a method of vector compensation of the magnetic field that does not require additional alienation of land plots and allows, by an optimal spatial distribution of split phase wires of the transmission line, to reduce orderly the level of their magnetic field [18]. Recommendations on the implementation of this method have been transferred for implementation to the energy sector of Ukraine (State Enterprise «NEC Ukrenergo»).

3. A new method for the synthesis of active screening systems of technogenic magnetic field of industrial frequency, developed by high-voltage overhead lines in nearby residential buildings [19, 20], was developed and experimentally grounded. The implementation of the proposed method, which is carried out in a closed structure, forms the scientific basis of the latest domestic technology of reducing the magnetic field of the industrial frequency to a safe level in residential premises. This technology has significant economic advantages over the well-known foreign technologies of active screening of the magnetic field of overhead lines that are widely used in the world.

4. The theoretical basis for the construction of new systems of contour screening of the magnetic field of high-voltage cable lines, which, in comparison with the best world models, has 30 % fewer elements with high screening efficiency (up to 10 units) is developed [21-23].

The research results formed the scientific basis of the first domestic technology for the design of environmentally friendly cable lines with voltage up to 330 kV, developed by order of the State Enterprise «NEC Ukrrenergo» and implemented in the normative document of the Ministry of Energy and Coal COY-H MEB 40.1-37471933-49:2011 «Design of cable lines with voltage up to 330 kV. Instruction» (new edition), which was put into effect in 2017 by the order of the Ministry of Energy and Coal of January 26, 2017 No. 82.

5. The mechanism of biotrophic attenuation of the natural static geomagnetic field in the premises of modern residential buildings, which was caused by the magnetization of their steel structural elements, was for the first time investigated. Recommendations on the design of «magnetically clean» residential and public buildings, which have no negative influence on the population, including the use of the construction of residential buildings of special low-magnetic steel with a relative magnetic permeability of not more than 70 units instead of standard rolled steel with magnetic permeability of about 300 units are developed [24-26].

In recent years, the ITPM cooperation with NTU «KhPI» has been growing. For example, in 2014, the third in Ukraine doctoral Specialized Scientific Council D 64.050.17 in defense of Theses in the specialty 05.09.05 «Theoretical Electrical Engineering» was jointly created and ensured functioning. Since 2014, the joint publication of the scientific and practical Journal «Electrical Engineering and Electromechanics» (Certificate KB No. 2121-10821PR of 07.10.2014) has been started, which in 2017, due to the growth of its scientific level, is included in the leading world scientometric base Web of Science, and is still the only one in the NTU «KhPI» scientific journal of the highest level. In 2017, the joint training in the postgraduate course of the NTU «KhPI» of specialists of the third (educational and scientific) level of higher education of the Doctor of Philosophy in the specialty 141 «Power Engineering, Electrical Engineering and Electromechanics» was started, which is carried out under the joint scientific guidance of the scientists of the NTU «KhPI» and the ITPM of the NASU. For more than 10 years together with the NTU «KhPI» an annual International Symposium «Problems of Electric Power Engineering, Electrical Engineering and Electromechanics (SIEMA)» is held. Traditional collaboration between the ITPM of the NASU and the NTU «KhPI» is expanding under the agreements on scientific and technical cooperation. Joint research is conducted with Departments of Engineering Electrophysics, Automated Electromechanical Systems, Electrical Apparatus, Theoretical Fundamentals of Electrical Engineering of the NTU «KhPI», internship of lecturers, lectures for students and their pre-diploma practice.

**5. Cooperation of the NTU «KhPI» with the Institute of Electrodynamics of the National Academy of Sciences of Ukraine.** Proceeding from the professional interests of the main readers of the Journal «Electrical Engineering and Electromechanics» – experts in the field of electrical engineering, the closest to them are the Institutes of the Department of physical and technical problems of energy of the National Academy of Sciences of Ukraine of the electrical engineering, including the Institute of Electrodynamics of the NAS of Ukraine (Kyiv).

The staff members of the NTU «KhPI» are first of all connected with the IED of the NAS of Ukraine by the joint conduction of the International Scientific and Technical Conference «Power Electronics and Energy Efficiency» (CEE), which since 1993 and at this time, together with the IED, is held by the Department of Industrial and Biomedical Electronics of the NTU «KhPI». During this time, due to the scale, high scientific and organizational level of the CEE Conference, it became a powerful catalyst for the scientific and technical «forces» of the NTU «KhPI» and the IED on solving energy saving problems by using power and information electronics, a real «forge» of joint training of highly skilled personnel [27 , 28]. Managers of the work of the Conference are: from the IED Academicians of of NAS of Ukraine B.S. Stogniy, A.K. Shidlovsky, O.V. Kirilenko and from the NTU «KhPI» Corresponding Member of the National Academy of Sciences of Ukraine Ye.I. Sokol Fig. 10).



Fig. 10. Participants of the CEE'2010 Conference: Professor B.V. Klepikov, Academician O.V. Kirilenko, Academician B.S. Stogniy, Corresponding Member Ye.I. Sokol (Alushta, 2010)

Successful cooperation of such scientific institutions of the National Academy of Sciences of Ukraine of the electrical engineering profile as the Institute of Electrodynamics and the Institute of Technical Problems of Magnetism with NTU «KhPI» confirms the prospect of deeper integration in our state of University and Academic science.

**Conclusions.** The 100th anniversary the National Academy of Sciences of Ukraine marks by new outstanding scientific achievements, which confirm that without science in the modern society technical progress is unthinkable. In order for Ukraine to become one of the high-tech countries of the world in the future, domestic science and, first of all, the technical one should become one of the priority directions of development at the state level. The level of its state financial support should be consistent with the indicators adopted in the leading countries of the world – at least 1.7 % of GDP.

The joint scientific potential of the National Academy of Sciences of Ukraine and the University science still allows to raise the technological level of our country to the world one. However, for the practical realization of this high-purpose scientific and technological task of state importance, the consolidation of society and the unwavering will of the country's leadership in its achievement are necessary. We very much hope that in the next 100 years the National Academy of Sciences of Ukraine will enter, experiencing the necessary support of the state.

## REFERENCES

1. Available at: [https://en.wikipedia.org/wiki/National\\_Academy\\_of\\_Sciences\\_of\\_Ukraine](https://en.wikipedia.org/wiki/National_Academy_of_Sciences_of_Ukraine) (accessed 12 June 2017).
2. Available at: <http://www.nas.gov.ua/EN/About/Pages/history.aspx> (accessed 08 September 2017).
3. Available at: [https://en.wikipedia.org/wiki/Borys\\_Paton](https://en.wikipedia.org/wiki/Borys_Paton) (accessed 22 April 2018).
4. Available at: <http://www.nas.gov.ua/EN/About/Pages/default.aspx> (accessed 02 May 2018).
5. Available at: <http://files.nas.gov.ua/text/infNASU/nasudovidnyk2016.pdf> (accessed 26 October 2017).
6. Baranov M.I. *Antologija vydajushhijhsja dostizhenij v nauke i tehnikе: Monografija v 3-h tomah. Tom 3* [An anthology of the distinguished achievements in science and technique: Monograph in 3 volumes. Volume 3]. Kharkiv, PhPB Panov A.N. Publ., 2016. 415 p. (Rus).
7. Available at: <https://all-ukraine.com.ua/ru/object.html?id=2864> (accessed 13 July 2017). (Rus).
8. Malicjkyj B.A., Ghrachev O.O., Kubaljsjkyj O.N., Kornilov V.A., Rybachuk V.P., Khorjevyn V.I., Videnina N.G., Gholovashhenko L.R., Ovcharova L.P. *Nacionaljna akademija nauk Ukrajinu: statystychnyj i naukometrychnyj analiz efektyvnosti naukovogho potencialu* [National academy of sciences of Ukraine: statistical and scientific-metrical analysis of efficiency of scientific potential]. Kyiv, Phoenix Publ., 2016. 228 p. (Ukr).
9. Available at: <http://files.nas.gov.ua/text/report/2017ua.pdf> (accessed 13 April 2018). (Ukr).
10. Available at: <http://www1.nas.gov.ua/infrastructures/NationalProperty/Pages/default.aspx>. (Ukr).
11. Available at: [https://ru.wikipedia.org/wiki/Институт\\_ионосферы\\_НАН\\_и\\_МОН\\_Украины](https://ru.wikipedia.org/wiki/Институт_ионосферы_НАН_и_МОН_Украины) (accessed 28 February 2018). (Rus).
12. Available at: [https://ua.igotoworld.com/ru/poi\\_object/66097\\_institute-of-ionosphere.htm](https://ua.igotoworld.com/ru/poi_object/66097_institute-of-ionosphere.htm) (accessed 15 June 2017). (Rus).
13. Rozov V.Yu. To the 40th anniversary of the Science and Technology Center of Magnetism of Technical Objects of the NAS of Ukraine. *Technical electrodynamicity*, 2010, no.3, pp. 74-80. (Rus).
14. Rozov V.Yu., Getman A.V., Petrov S.V., Erisov A.V., Melanchenko A.H., Horoshilov V.S., Shmidt I.R. Magnetism of spacecraft. *Technical electrodynamicity. Thematic issue «Problems of modern electrical engineering»*, 2010, chapter 2, pp. 144-147. (Rus).
15. Volokhov S.A., Dobrodeiev P.N., Mamin G.I. Integrated demagnetization of pipes at arc welding. *Technical electrodynamicity*, 2012, no.4, pp. 19-24. (Rus).
16. Rozov V.Yu., Reutskiy S.Yu., Pelevin D.Ye., Yakovenko V.N. The research of magnetic field of high-voltage ac transmissions lines. *Technical Electrodynamicity*, 2012, no.1, pp. 3-9. (Rus).
17. Rozov V.Yu., Reutskiy S.Yu., Piliugina O.Yu. The method of calculation of the magnetic field of three-phase power lines. *Technical electrodynamicity*, 2014, no.5, pp. 11-13. (Rus).
18. Rozov V.Yu., Reutskiy S.Yu., Pelevin D.Ye., Pyliugina O.Yu. The magnetic field of power transmission lines and the methods of its mitigation to a safe level. *Technical electrodynamicity*, 2013, no.2, pp. 3-9. (Rus).
19. Kuznetsov B.I., Nikitina T.B., Voloshko A.V., Bovdyj I.V., Vinichenko E.V., Kobilyanskiy B.B. Synthesis of an active shielding system of the magnetic field of power lines based on multiobjective optimization. *Electrical engineering & electromechanics*, 2016, no.6, pp. 26-30. (Rus). doi: **10.20998/2074-272X.2016.6.05**.
20. Rozov V.Yu., Grinchenko V.S., Pelevin D.Ye., Chunikhin K.V. Simulation of electromagnetic field in residential buildings located near overhead lines. *Technical electrodynamicity*, 2016, no.3, pp. 6-8. (Rus). doi: **10.15407/techned2016.03.006**.
21. Rozov V.Yu., Kvytsynskiy A.A., Dobrodeiev P.N., Grinchenko V.S., Erisov A.V., Tkachenko A.O. Study of the magnetic field of three phase lines of single core power cables with two-end bonding of their shields. *Electrical Engineering & Electromechanics*, 2015, no. 4, pp. 56-61 (Rus). doi: **10.20998/2074-272X.2015.4.11**.
22. Rozov V.Yu., Dobrodeiev P.N., A.A. Kvytsynskiy A.A. Double-circuit passive shielding of the magnetic field of high-voltage cable lines in junction zones. *Technical electrodynamicity*, 2017, no.1, pp. 23-28. (Rus). doi: **10.15407/techned2017.01.023**.
23. Rozov V.Yu., Tkachenko O.O., Yerisov A.V., Grinchenko V.S. Analytical calculation of magnetic field of three-phase cable lines with two-point bonded shields. *Technical electrodynamicity*, 2017, no.2, pp. 13-18. (Rus). doi: **10.15407/techned2017.02.013**.
24. Rozov V.Yu., Zavalnyi A.V., Zolotov S.M., Gretsikh S.V. The normalization methods of the static geomagnetic field inside houses. *Electrical Engineering & Electromechanics*, 2015, no.2, pp. 35-40 (Rus). doi: **10.20998/2074-272X.2015.2.07**.
25. Rozov V.Yu., Levina S.V. Modeling of the static geomagnetic field indoor dwelling houses. *Technical electrodynamicity*, 2014, no.4, pp. 8-10. (Rus).
26. Rozov V.Yu., Reutskiy S.Yu., Levina S.V. The study of the effect of weakening of static geomagnetic field by steel columns. *Technical electrodynamicity*, 2014, no.1, pp. 12-19. (Rus).
27. Sokol Ye.I., Kipenskii A.V., Krivosheev S.Yu. Educational and methodical work and research activities of the Department of Industrial and Biomedical Electronics of the National Technical University «KhPI». On the occasion of the 55-th anniversary of the foundation. *Bulletin of NTU «KhPI». Series: New solutions in modern technologies*, 2018, no.26(1302), vol.1, pp. 3-12. (Rus).
28. Dolbnja V.T., Sokol Ye.I., Krivosheev S.Yu. *Kafedra promyshlennoj i biomedicinskoj elektroniki NTU «KhPI». Istorija. Dostizheniya. Perspektivy* [Department of Industrial and Biomedical Electronics NTU «KhPI» History. Achievements. Prospects]. Kharkiv, Golden Pages Publ., 2013. 224 p. (Rus).

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