NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF ARMENIA

R E P O R T
ON MAJOR RESEARCH OUTCOMES
FOR 2024

Yerevan - 2025

The Report is prepared by the

Scientific Organizational Department on the basis of materials submitted by the NAS RA

Divisions of Sciences,

Research Organizations and Sub-Divisions

CONTENTS

INTRODUCTION

The Academy, as the highest scientific institution of Armenia, has navigated a significant path for over eight decades, achieving major scientific breakthroughs and gaining global recognition. Serving as the coordinating body for scientific research in the country, NAS RA conducts fundamental and applied research aligned with international standards across multiple disciplines, including physics and astrophysics, mathematics and mechanics, chemistry and biology, geosciences and seismology, environmental protection and biotechnology, computer science and artificial intelligence, Armenian studies, and social sciences. NAS RA has played a vital role in strengthening Armenia's defense, developing the country's economy and healthcare system, discovering new sources of energy, raising public awareness of science and education.

Today, NAS RA remains at the forefront of scientific and technological development, effectively cooperating with academies, universities, science and technology and research centers, and state and private organizations worldwide. Cooperation agreements and Memoranda of Understanding have been signed with the Academy of Athens, leading scientific institutions in China, the Islamic Republic of Iran, Bulgaria, as well as the St. Petersburg branch of the Russian Academy of Sciences. The Academy's institutions actively participate in international grant programs such as Horizon 2020, Horizon Europe, ISTC, and ANSEF and so forth.

In the reporting year, research teams within NAS RA secured 355 competitive grants through the Committee of Higher Education and Science of the Republic of Armenia. The number of NAS RA publications in international scientific journals increased by more than 1.4 times compared to the previous year. NAS RA Divisions jointly with their institutions have held 72 international conferences, and the Academy researchers have actively participated in international scientific events. The Presidium of the Academy directly funded 79 scientific business trips, ensuring full support for all scholars presenting reports at international conferences. 1 doctoral and 15 candidate dissertations were defended, 7 directors of NAS RA organizations were elected and reelected.

The Specialized Problem Councils formed at the NAS RA have begun to operate actively, and a number of effective discussions have been held on such issues of public importance as biodiversity, food security, regional seismic safety, hazardous waste disposal at the "Nairit Plant" CJSC, the introduction of wind energy, sensor technologies in Armenia, the creation of a radon monitoring network in the Republic, the coordination of cooperation with the military-industrial complex, and urban greening initiatives. Scientists, manufacturers, representatives of state agencies and the private sector have actively participated in the discussions. A major public investment project, Scientific and Experimental Center/Cluster for Preclinical and Translational Research, proposed by NAS RA, is currently under the government review.

In 2024, NAS RA held its first awards ceremony, honoring six research groups for achievements in fundamental and applied sciences, spanning physical-mathematical and technical sciences, chemistry, life and Earth sciences, social and humanitarian sciences (sponsored by *Martin Starr LLC*). The awards were expanded this year to include a category for medical research, sponsored by *LIQVOR LLC*.

Acknowledging the growing importance of popularization of science at the current stage of development of science and technologies, in 2024 NAS RA established a dedicated department for the popularization of science, which with strong institutional backing from the Ministry of Education, Science, Culture, and Sports, has held conferences, seminars, exhibitions, and interactive sessions with participation of university students and lecturers, high school students, teachers and educators.

Emphasizing the significance of science for the development and progress of Armenia, building on its rich already established scientific traditions, taking into account the key role of the Academy in the general scientific and educational system of the Republic, the leadership of NAS RA expresses full readiness to continue its mission for the glory of the progress of the country's scientific thought, economic development and strengthening of its defense capabilities.

President of NAS RA, academician A.Saghyan

DIVISION OF MATHEMATICAL AND TECHNICAL SCIENCES

Academician-Secretary - academician L.Aghalovyan
Scientific Secretary - L. Martirosyan

The Division of Mathematical and Technical Sciences includes the Institutes of Mathematics, Mechanics, for Informatics and Automation Problems, as well as the Department of Hydromechanics and Vibrotechnics.

The Division includes 8 academicians, 6 corresponding members, 24 foreign members, 5 honorary doctors.

During the reporting year 3 general meetings of the Division were held.

At the annual general meeting held on April 12 the candidacies for the vacancy of the director of the Institute of Mechanics were discussed.

At the annual general meeting held on April 20 L.Aghalovyan's report "On the main scientific and scientific-and-organizational results of the Division for 2023" was discussed and approved. Scientific reports of DSc(phys.-math.) G.Karagulyan (Institute of Mathematics), corr.-memb. A.Avetisyan (Institute of Mechanics), as well as cand.(phys.-math.) I.Karapetyan (Institute for Informatics and Automation Problems) were presented.

At the annual general meeting held on October 4 the candidacy of cand.(phys.-math.) L.Dashtoyan for the vacancy of the director of the Institute of Mechanics was discussed and submitted to the Presidium of NAS RA for discussion and election. L.Dashtoyan was elected the director of the Institute of Mechanics.

20 meetings of the Bureau were held. The following issues were discussed and approved: the working plan of the Division for 2024; the project of the process of consolidation of the state Universities of RA and unification with research organizations; the number of postgraduate vacancies and their distribution among the Institutes for 2024-2025 academic year; the results of admission to the postgraduate school, research advisers and scientific topics of the postgraduate students; applications for admission of postgraduate school for the 2025-2026 academic year. The following applications were disccussed: applications for the programs of basic financing of scientific and scientific-technical activities; applications for scientific and scientific-and-technical state target program for 2024; applications of the Institutes of the Division for funding to purchase necessary equipment as well as applications for scientific trips.

The "special purpose" works, carried out at the Institute of Informatics and Automation Problems, were discussed. Works of the same kind were also discussed with representatives of the working group on science and education of the National Assembly of the RA.

An extended discussion was held on mechanics and related disciplines taught at Yerevan State University, the National Polytechnic University of the Republic of Armenia, the National University of Architecture and Construction of the Republic of Armenia, as well as on modern requirements for them.

The staff of the new Scientific Council of the Institute of Mechanics was approved. The candidacy of DSc(tech.) H.Astsatryan for the vacancy of the director of the Institute for Informatics and Automation Problems was discussed and submitted to the Presidium of NAS RA for discussion and election. H.Astsatryan was elected the director of the Institute for Informatics and Automation Problems.

The main results of the activity of scientific organization of the Division for 2024, as well as other scientific-organizational issues were discussed..

The following scientific journals are published on the Division specialities: "Proceedings of NAS RA - Mathematics" (6 issues), "Proceedings of NAS RA- Mechanics" (4 issues), "Proceedings of NAS RA and NPUA (series of technical sciences)" (4 issues), "Mathematical Problems of Computer Science" (2 issues), as well as the electronic "Armenian Mathematical journal".

5 monographs (3 abroad), 2 tutorials, 135 in the peer-reviewed journals (108 Scopus/ WoS) and 35 in the conference proceedings (32 abroad), 47 theses (27 abroad) were published in 2024 by the researchers of the Institutes of the Division.

The Institutes of the Division have organized 3 international scientific conferences. Projects on international 4 grants have been implemented in the Institute for Informatics and Automation Problems.

3 candidate dissertations were defended at the Scientific Councils of the Institutes of the Division.

In December annual report meetings of the Institutes were held, the reports of the Institutes for 2024 were discussed and approved.

Institute of Mathematics

Major Achievements

It is known that the hyperplane is a set of not injectivity for the Radon spherical transform (RST), so a natural question arises: to find an additional condition that will allow recovering the unknown function using the RST data. The latter is equivalent to finding conditions that will allow recovering an odd function with respect to a given hyperplane. A new transform has been defined, a so-called weighted RST. The two-data RST has been considered and its inversion formula has been found. The inversion formula, in this case, also uses local data to recover the unknown function. It is enough to have the data of these two transform on some region to recover the unknown function. The work has been published in two Q1 journals (Sup.: DSc.(phys.-math.) R.Aramyan).

A monograph named “Functions of Omega-Bounded Type, Basic Theory” is brought to the final form and published by Birkhauser, Frontiers of Science, in Switzerland. The theories, constructed in the monograph affirm the indisputable priority of the Armenian mathematical school in a very actual topic of complex analysis, since their background are the old, original results of Armenian mathematical school, they are absolutely new or contain all basic, contemporary results in the considered topic as particular cases (Sup.: DSc(phys.-math.) A.Jerbashyan) .

A uniqueness result for an implicit discrete system defined on connected graphs has been proven. The discrete system has been motivated by a certain class of spatial segregation of reaction-diffusion equations (Sup.: cand.(phys.-math.) A.Arakelyan).

Methods of combining Lebesgue and Riemann integrals in questions of the theory and solution of Integral convolution equations have been considered. The concept of improper direct Riemann integrability has been introduced. The results allow to expand the role of the Riemann integral in the theory of integral equations (Sup.: DSc(phys.-math.) N.Engibaryan).

Outcomes of applied developments

The inversion of the Radon spherical transform (RST) is the mathematical basis of thermoacoustic tomography. Using the consistency method (proposed by R.Aramyan) a fundamentally new inversion formula for the RST in 3D has been found, which has an advantage over existing solutions in that it uses local data to recover the unknown function. Also, the formula has the advantage that it can recover functions with non-compact support (the compactness of the support is an important condition for the previous solutions). Theoretically, this means that it is possible to create a handheld, safe tomographic device. The work is published in IPI (Sup.: DSc(phys.-math.) R.Aramyan).

Works have been carried out on identifying and resolving issues in cloud applications and infrastructures. To this end, monitor environments, collecting log data, application traces, and other data have been monitored. A recommender system designed to match customer support requests with previously resolved support tickets or relevant knowledge base articles has been developed. This system helps customers and support teams quickly access problem-resolution tips or identify trending issues to warn vulnerable users proactively. The system's capabilities and potential improvements by leveraging large language models and fine-tuning them for enhanced performance have been discussed. Typically, identifying and resolving issues can take days or even weeks, but with targeted recommendations, this process can be reduced to a few hours or, in simpler cases, enable self-service solutions. In another study, we have addressed the challenge of reducing the volume of application-distributed traces through sampling and its impact on troubleshooting cloud applications. Approach has been focused on detecting critical traces and storing them for detailed analysis. Using explainable

AI solutions, malfunctioning microservices have been identified and transparent insights into their root causes have been provided. In the third project, we have tackled discovering applications in cloud environments. Method leverages application log data containing rich contextual information to differentiate applications. Related entities by analyzing log types and their distributions have been grouped. This approach not only differentiates diverse types of applications but also identifies their specific deployments, offering a hierarchical representation of applications in terms of time and topology. The rule-induction methods have been applied to learn and explain alert resolution patterns. This approach has been validated against historical resolution data, which previously required extensive manual efforts (Sup.: cand. (phys.-math.) A.Poghosyan).

Institute of Mechanics

Major Achievements

New methods of mathematical modeling of non-stationary problems of magnetoelasticity have been proposed, the physics of interaction of electromagnetic and mechanical phenomena in magnetoactive elastic thin-walled bodies has been revealed. The new results regarding the flutter phenomenon have been obtained (Sup: cand.(phys.-math.) M.Mikilyan).

The new approach to solving the problem of contact between a rigid stamp and an elastic half-plane has been proposed, taking into account friction forces. In contrast to the well-known Galin problem, where the contact zone is divided into sections of adhesion and sliding, here it has been proposed to adopt the law of dry friction in the entire contact zone, but with a linearly changing friction coefficient. The proposed approach allows a closed solution of the problem, little different from Galin's solution (Sup.: DSc(phys.-math.) V.Hakobyan).

In the monograph “Motion of the deformed rigid body”, within the framework of the theory of elasticity, the kinematics of the motion of a deformable solid body has been investigated using methods of theoretical mechanics and asymptotic methods of separation of motions. In different coordinate systems, kinematic quantities are presented within the framework of the kinematics of the motion of an absolutely rigid body, adding additional terms that depend on the elastic properties of the body. The characteristic quantities of the motions of such systems differ significantly from the characteristics of the motion of an absolutely solid body or a mechanical system that does not contain elastic elements (Sup.: DSc(phys.-math.) A.Ghukasyan).

Outcomes of applied developments

It has been established that the load-bearing capacity under axial tension of thin-walled tubular elements made of fiberglass based on plain-weave glass fabric with a primary overlap, as determined by direct measurements, can be significantly higher compared to the values calculated using the material strength typically determined by standard testing methods (Sup: DSc(tech.) K.Karapetyan).

Institute for Informatics and Automation Problems

Major Achievements

The following theorem has been proved: let D be a 2-strong digraph of order $n \geq 9$ such that its $n - 1$ vertices have degrees at least $n + k$ and the remaining vertex z has degree at least $n - k - 4$, where $k \geq 0$ is an integer. Then D is Hamiltonian (Sup.: cand.(phys.- math.) S.Darbinyan).

Unmanned aerial vehicle (UAV) swarms have gained significant attention for their potential applications in various fields. The effective coordination and control of UAV swarms require the development of robust mathematical models that can capture their complex dynamics. The paper introduces mathematical models and relevant paradigms based on the design and analysis of self-organizing swarms of UAVs. The logical and technological construction of the model relies on the theorems developed by authors for obtaining full information exchange during the swarm quasi-random walk. The suggested rotor-router model interprets the discrete-time walk accompanied by the deterministic evolution of configurations of rotors randomly placed on the vertices of the swarm graph. The recommended optimal and fault-tolerant gossip/broadcast schemes support the resilience of swarm to internal failures and external attacks, and cryptographic protocols approve the security.

The proposed cloud network topology serves as the implementation framework for the model, encompassing various connectivity options to ensure the expected behavior of the UAV swarms (Sup. cand. (tech.) S.Poghosyan).

The work introduces an advanced simulation platform for terrain monitoring and task optimization, leveraging collective artificial intelligence embedded within self-organizing swarm of UAVs. The developed cloud-based, multi-user platform offers interactive features for seamless collaboration and real-time video viewing, enabling users to explore collectively dynamic landscape imagery and submit requests via an intuitive, QT-based interface. The interface enables the assignment of specific tasks to peers for use cases such as area reconnaissance, information gathering, transferring, as well as enemy position attacks in military applications. The UAV navigation maps are generated and adapted by the swarm map configurator. The road graph is built using the rotor-router model, while the complete information exchange graph is based on the gossip/broadcast model. The platform supports dynamic task reconfiguration, enabling new task allocations and UAV role distribution, while ensuring data and communication security throughout swarm mission operations (Sup.: cand.(phys.-math.) V.Poghosyan).

The Weibull distribution is widely used as a mathematical model in many applied problems. Numerous examples of its application in the field of image processing are known at the IIAP. As a result of the study, the possibilities of improving the accuracy of several widely used empirical formulas have been investigated and new empirical formulas have been developed (Sup.: DSc(phys.-math.) D.Asatryan).

Outcomes of applied developments

An optimized multi-modular Earth Observation (EO) data processing service has been developed, consisting of data compression, execution time, resource cost estimation, and cluster configuration modules. The Decision-making module, based on machine learning methods and simulators, evaluates storage and processing layers to make informed decisions regarding data compression and cluster configuration, considering cost, performance, and computing complexity (Sup.: DSc (tech.) H.Astsatryan)

Solutions have been designed to support autonomous management of cloud infrastructures, facilitating the diagnosis of undesirable system behaviors using machine learning methods. One of these solutions has been implemented in production. Additionally, a project proposal has been developed for a platform to enable smart agriculture, leveraging modern AI tools and showcasing potential for commercialization (Sup.: DSc(phys.-math.) A.Harutyunyan).

New capabilities for eduroam, video conferencing, SSL certificates and ACME2 protocol systems in the ASNET-AM network have been researched and implemented. Options for expanding the capabilities of the existing centralized automated system have been studied (Sup.: cand.(tech.) A.Petrosyan).

A system for converting Internet call bills into a database and creating personalized reports has been developed (Sup.: cand. (tech.) G.Petrosyan).

Department of Hydromechanics and Vibrotechnichs

Major achievements

Resonant stabilizers of wave processes have been developed in pipeline systems (Sup.: cand. (tech.) G.Avetisyan).

Outcomes of applied developments

The cooling tower has been developed at the invention level (patent of RA № 1063). For increasing the air flow, entering the cooling tower through its windows, a new part has been introduced, which is an extension to the lower part of the cooling tower along its perimeter of canopy, which in section in relation to the horizon, can have a straight, inclined, exponential, catenoidal and other curve shapes depending on the given cooling level (Sup.: A.Simonyan).

DIVISION OF PHYSICS AND ASTROPHYSICS

Academician-Secretary – academician R.Kostanyan
Scientific Secretary – N.Davidyan

The Division includes the Byurakan Astrophysical Observatory after V. Ambartsumian (BAO), the Institute of Physical Research (IPR), the Institute of Radiophysics and Electronics (IRPE), the Institute of Applied Problems of Physics (IAPP) and the International Center for Relativistic Astrophysics Network - Armenia (ICRANET).

The Division includes 5 academicians, 10 corresponding members and 22 foreign members.

During the reporting year 4 general meetings and 21 bureau sessions were held. Constant communication has been established with the Division organizations to discuss and solve numerous current issues.

At the annual general meeting of the Division, held on April 22, the report "On the main results of scientific and organizational activities of the Division for 2023" by the Academician-Secretary of the Division, academician R.Kostanyan was presented and approved. It was decided to hold hearings with the participation of the institutes of the Division, with the purpose of implementing and developing projects of national importance, taking into account scientific cooperation between scientific organizations. Scientific reports of corr. memb. S.Petrosyan (IPR), DSc(phys.-math.) N.Sahakyan (ICRANET-Armenia Network), cand.(phys.-math.) V.Kocharyan (IAPP), DSc(phys.-math.) A.Egikyan (BAO), as well as cand.(phys.-math.) M.Khanbekyan (IPR) were presented at the meeting.

At the meetings of the Bureau the applications for basic financing of scientific and technical activities "Preservation and development of infrastructures" for 2024, admission to postgraduate studies, business trips (11 applications) were discussed and approved. An expert assessment to the letters from governmental authorities and appropriate answers were provided to the applicants. The program "Re-equipment of the organizations of the NAS RA system" was discussed and approved, within the frames of the applications for the purchase equipment for IPR and IAPP.

At the general meeting of the Division, held on June 3 the candidacy for the position of the director of the IAPP was discussed, approved and presented for discussion to the Presidium of the NAS RA. The re-elected Scientific Council of the Institute was approved.

The issues of increasing the efficiency of scientific works, expansion of applied research, assessment of the activity of the scientific organizations were continually discussed.

13 local seminars and 16 international conferences were organized, new agreements were signed, collaboration with other branches in science and education was in progress. Basic applications for 2024 developmental strategy of the Institutes for the upcoming years were discussed and approved. In order to promote cooperation between the organizations of the Division and with foreign countries, the directors of the institutes made reports at seminars organized on the research directions of the institutes (5 seminars), and within the framework of scientific cooperation with foreign countries reports were made by the foreign leaders of jointly implemented works (4 seminars).

Specialized councils for solving special-purpose problems and investment problems have been organized, in which NAS RA members, specialists from scientific organizations of RA and other departments were included. The following was discussed: the program of the wind energy development in Armenia, the project for the comprehensive study of radon in RA, the topic of using "innovative" sensor technology, which was developed by "PSI" and other issues of organizational character.

In December, annual general meetings were held in the scientific organizations of the Division, where the reports on scientific and organizational activities for 2024 were discussed and approved, later they were approved by Bureau sessions of the Division.

4 candidate's dissertations were defended by the researchers of the Division institutes.

The Institutes of the Division have received 3 author licenses (1 international). 4 monographs (2 abroad), 3 tutorials, 208 in the pre-reviewed journals (161 Scopus/WoS), 23 in conference proceedings (9 abroad), and 151 theses (54 abroad) have been published.

The following scientific journals are published on the Division specialties:“Proceedings of NAS RA. Physics” (imp.f. 0.5, 4 issues), “Astrophysics” (imp.f. 0.6, 4 issues) and the electronic “Armenian Journal of Physics” (4 issues).

Byurakan Astrophysical Observatory after V. Ambartsumyan

Major achievements

Homogeneous classification of Blazars by activity types has been carried out based on the medium resolution spectra. In total, 1170 objects have been classified (552 BZB + 618 BZQ). 447 objects (293 BZB + 154 BZQ) have changed their types, i. e. types have been revised for 38% of the classified objects (Sup.: cand.(phys.-math.) A.Mickaelian).

The physical parameters of 837 M dwarfs: masses, luminosities, radii, temperatures, distances from the Sun, etc. have been revealed. Flares have been detected for some of them. Many of them have been found to form binary systems (M dwarf + M dwarf, M dwarf + white dwarf, etc.). In high Galactic latitudes, more than 10 kps above the Galactic plane, about 300 new stars of class M AGB (Asymptotic Giant Branch) and Post-AGB have been discovered, having very dense circumstellar shells (Sup.: cand.(phys.-math.) A.Mickaelian).

During accretion of ionized material onto the nuclei of active galaxies, the Birman mechanism has been triggered, due to which magnetic fields can be generated from zero in these objects. The efficiency of the Birman mechanism in accretion disks located in the nuclei of galaxies has been studied. In order to take into account accurately the interaction of newly formed magnetic fields on the motion of charged particles in this process, it is necessary to solve second-order integral equations. It has been shown that the fields generated in accretion disks are quite significant and can play an important role in the further evolution of magnetic fields in active galaxies (Sup.: cand.(phys.-math.) R.Andreasyan).

The greatest achievement in studying FUors is the observational evidence that the previously well-known object RNO 54 is an exceptionally old FUor. This object has almost completely lost traces of eruptive activity but still exhibits high luminosity and retains an accretion disk. This success, which was almost immediately confirmed by an international research group, is crucial for understanding the post-outburst evolutionary path of FUors (Sup.: DSc(phys.-math.) T.Magakian).

A study of the α Crucis system has been conducted. Surrounding this system, which includes three massive stars, a shock wave has been observed. Initially, the system was hypothesized to belong to the so-called "runaway" objects. However, the research has shown that α Crucis is part of an entire star cluster. It has not been ejected from its parent cluster but moves together with the other cluster members, while the shock wave formation is due to large-scale motions of the ISM (Sup.: cand.(phys.-math.) H.Harutyunian).

The fundamentals of the standard Lorentz code (SLC) of particle uniform motion and the Special Theory of Relativity (SRT) have been studied. To this aim, the theory of, so-called, Master space induced supersymmetry (MSp-SUSY) has been developed. The standard Lorentz code (SLC) is derived in a new perspective of global double MSp-SUSY transformations. In such a way, the two fundamental postulates of SRT have been derived (Sup.: DSc(phys.-math.) G.Ter-Kazarian).

The influence of various physical factors on the evolution of spectral lines formed both at reflection from the medium and at passage through it (inhomogeneity of the medium, localisation of primary energy sources, influence of turbulent flows, etc.) has been revealed and studied. The specifics of the influence of micro- and macro-turbulent motions on temporal changes of the formed spectra in comparison with the case of absence of gas-dynamic flows have been studied in detail (Sup.: DSc(phys.-math.) A.Nikoghossian).

The conductivity coefficients of the neutron star crust have been studied. The bulk viscosity of the superconducting quark matter in the core of a neutron star has been computed. It has been shown that in a certain range of density and temperature, the bulk viscous damping time scale of density oscillations can fall below 10 ms, thus affecting the evolution of the merger of quark stars. New equations of second-order hydrodynamics have been obtained from the Zubarev (Sup.: DSc(phys.-math.) A.Sedrakyan).

Outcomes of applied developments

Work has continued on the creation of a new software package and new methods of processing observational material. The automatic processing package (pipe line) is also being improved, which allows processing the scientific images obtained during the whole night, using many additional images (bias, flat-field, dark etc.) (Sup.: DSc(phys.-math.) T.Magakian).

Over 483,200 measurements have been taken at the Armenian-Russian station during 212 observing nights and the orbits have been restored for 410 artificial Earth satellites (Sup.: cand.(phys.-math.) H.Harutyunian).

Institute for Physical Research

Major achievements

Using an optical nanocell containing cesium atomic vapor, different behavior of magnetically induced (MI) transitions in the hyperfine structure of the D_2 line of Cs atoms in strong magnetic fields (> 5000 G) has been revealed for groups excited by σ^+ circularly polarized radiation at $F_g = 3 \rightarrow F_e = 5$ ($\Delta F = +2$) and excited by σ^- circularly polarized radiation at $F_g = 2 \rightarrow F_e = 4$ ($\Delta F = -2$). The developed theoretical model describes clearly the experimental results (Sup.: DSc(phys.-math.) D.Sarkisyan).

A technique for optical transmission imaging of strongly scattering objects has been developed, based on selective digital registration of ballistic photons that have passed through a sample when irradiated with modulated (pulsed) laser radiation. Depending on the modulation mode, it is possible to register either an "analog" image or contours of image features, without the need for software processing. The system's operation has been tested on model (a stack of papers) and biological (a human palm) objects. By means of automatic control of the signal level, achieved by selecting the appropriate modulation mode, it is possible to obtain images where the internal structure of the object under study is uniformly manifested throughout the entire scanning area, even with strong changes in the background transmission level (Sup.: corr. member A.Papoyan).

A reverse engineering scheme for precise control of population transfer dynamics in nonlinear quantum systems characterized by 1:2 resonance is presented. It involves the use of two resonant laser pulses exciting transitions from the initial and final levels to an intermediate level subject to irreversible losses. Compared with other known techniques, this approach has a significant computational advantage. The pump pulse shape is given analytically, allowing the development of an approach for controlling decoherence reduction. The obtained results can be used to develop advanced technologies in the field of quantum computing and quantum communication (Sup.: corr. member A.Ishkhanyan).

Outcomes of applied developments

An optical interference method for measuring the thermal physical characteristics of dielectric materials, in particular, the temperature dependence of the refractive index ($\partial n/\partial T$), has been developed and implemented. Measurements carried out on a K8 glass sample determined a previously unknown value of $\partial n/\partial T$ in the wavelength region of 780 nm, which was 1.06×10^{-6} K^{-1}. The method fundamentally allows determining other characteristics of the material - the refractive index, the coefficient of thermal expansion, the thermo-optical constant (Sup.: corr. member A.Papoyan).

A device for creating a vortex electric field has been developed, manufactured and tested. Preliminary measurements of the effect of the vortex field on liquid crystals with different orientations have been carried out (Sup.: acad. R.Kostanyan).

The dielectric characteristics and charge transport mechanisms in ZnO films doped with Li or Ga impurities have been investigated. The results have been explained within the framework of the Mott hopping conductivity theory. A floating-gate field-effect transistor has been developed in which the n-type waveguide channel is made of ZnO:Li semiconductor, and the source and drain are made of ZnO:Ga films. The static and dynamic characteristics of the transistor have been measured, and the possibility of controlling the static characteristics of the transistor by changing the gate charge has been shown. The obtained results are used to create single-transistor memory elements (1T1C).

Due to the high read speed and large ratio of the currents of the "1" and "0" states (about 10^5), the proposed DRAM is promising for use as a memory element. The developed technology is patented (Sup.: cand.(phys.-math.) R.Hovsepyan).

Electrode systems for supercapacitors have been manufactured based on Co_2O_3-C (cobalt oxide - carbon) nanocomposites. Their volt-ampere characteristics have been studied using the three-electrode method, and the specific capacity has been estimated depending on the concentration of cobalt oxide in the carbon matrix. The highest value achieved was 100 F/g (Sup.: cand.(phys.-math.) A.Manukyan).

Institute of Applied problems of Physics

Major achievements

The characteristics of coherent diffraction radiation beam of ultrarelativistic electrons from a semi-parabolic target in the terahertz range have been investigated. It has been shown that in the case of the proposed geometry, the intensity of the diffraction radiation on the aperture plane is maximum along the beam axes, in contrast to the transition radiation, which is characterized by a "funnel-shaped" structure with the minimum intensity along the beam axis (Sup.: cand. (phys.-math.) V.Kocharyan).

The spectral and angular distributions of coherent radiation of a bunch of electrons with an energy of 3.6 MeV moving along the axes of hollow cylindrical targets made of fused quartz and Teflon have been studied experimentally at the linear accelerator of the AREAL laboratory of CANDLE scientific center, in the frequency range of 10–100 GHz. It has been shown that the obtained data mainly coincide with theoretical estimates, in particular, the positions of the observed peaks in the spectral distribution with high accuracy coincide with the positions of modes of an infinite waveguide, with the same parameters (Sup.: DSc(phys.-math.) L.Grigoryan).

The thermodynamic characteristics of the pair-interacting hole gas localized in the lens-shape Ge/Si quantum dot have been discussed. In the scope of the exact solvable Moshinsky model the pair interaction potential is modeled via oscillator function. It has been shown that in the considered system the first order phase transition takes place caused by specific geometry of the quantum dot (Sup.: DSc (phys.-math.) H.Sarkisyan).

Outcomes of applied developments

The difference image of reconstructed from the tomographic (CT) slices of ideal and 3D digital models with certain deviations has been studied and it has been shown that this image can be identified with these deviations, that can be used to analyze the inaccuracies of a real 3D printed sample by comparing the CT experimental results and the digital model of the printed sample (Sup.: cand.(phys.-math.) V.Kocharyan).

Using glass-ceramic technology at a reduced temperature, a material in the SrO-TiO_2-B_2O_3 system, first discovered by our team, has been synthesized, and its crystal structure has been studied. Additionally, materials with high dielectric permittivity ($>10^3$) have been synthesized via the solid-phase reaction method, and resonance phenomena have been investigated in them within the frequency range up to 20 MHz (Sup.: cand.(phys.-math.) V.Harutyunyan).

A laboratory aerosol spectrometer has been developed and constructed to determine the size and concentration of particles per unit volume (Sup.: cand.(phys.-math.) T.Muradyan).

A new type of high-voltage (10-50 kV) optocouplers operating in linear mode have been developed, manufactured and tested (Sup.: cand.(phys.-math.) A.Abrahamyan).

Sets of test samples made of standard and admixtured polymer materials have been prepared and their HU (Hounsfield units) values have been measured, resulting in a proposed method for bone tissue imitation (Sup.: cand.(tech.) Yu.Cherepennikov).

A source of acoustic waves in the frequency range of 0.01-1000 Hz with adjustable characteristics has been developed and created. (Sup.: corr. member A.Mkrtchyan).

A new approach to the synthesis of peroxides using acoustophysics methods has been developed (Sup.: cand.(chemical.) S.Barseghyan).

A source of electromagnetic waves with tunable IR range characteristics has been developed (Sup.: cand.(phys.-math.) V.Nalbandyan).

As a research-result of agrophysical properties of bentonite, a technology for processing, obtaining and utilizing an organic mixture with high CUA has been developed (Sup.: G.Asatryan).

Institute of Radiophysics and Electronics

Major achievements

The method to investigate the ripple on the water surface by radar remote sensing has been proposed. It has been estabilished that this is possible due to the selection of ripple's signal in the vector receiver (Sup.: cand.(phys.-math.) T.Zakaryan).

A compact proof of Fermat's Last Theorem, using classical algebraic methods (Newton's binomial, theory of algebraic equations, etc.), has been proposed (Sup.: cand.(phys.-math.) E.Asmaryan).

A new type of solar $CsPbBr_3$ perovskite films have been obtained on glass substrates under vacuum conditions of 10^{-5} Torr, their structural and optical properties have been investigated in case of proton irradiation. The applicability of the membranes under the conditions of high-energy radiations has been demonstrated (Sup.: L.Matevosyan**).**

The features of the double Fourier integral describing the screened Coulomb interaction in disordered semiconductor thin films and a method for accurate calculation of the interaction have been developed (Sup.: cand.(phys.-math.) L.Hovakimyan).

Outcomes of applied developments

It has been confirmed that the ratio of longitudinal and transverse photo-EMF excited by a focused light beam in a p-InSb-n-CdTe heterojunction depends significantly on the properties of the CdTe window layer. It has been shown that, based on the longitudinal photoeffect, it is possible to create sectorial, four-element photocells with the highest photosensitivity, in the range 3-5 μm and it can be used to determine the position of various radiating heat sources in the atmosphere. In particular, the fabricated photocells have a high coordinate (of up to 750 mV/μm) and a photoelectric of (1000 V/W) sensitivities (Sup.: corr. member S.Petrosyan).

A glass-ceramic material containing nanosized wollastonite and gehlenite crystals has been synthesized based on a local natural rock, Aragats perlite. The effect of the fluorine group catalyst Na_2SiF_6 on the crystallization properties of glass has been studied using differential thermal analysis. It has been shown that a decrease in the catalyst content leads to an increase of glass transition temperature, crystallization pick temperature and activation energy (Sup.: corr. member S.Petrosyan).

The functional electrical stimulator of bodies bioactive points has been developed and laboratory tests have been performed. The technical characteristics of the device have been determined (Sup.: acad. A.Ghulyan).

Amplifiers have been developed and RF modules with direct amplification of radiometers in the 7.5 GHz and 16 GHz frequency ranges have been manufactured with a low-frequency output signal. L-band helical antennas have been manufactured and tested in a frequency-modulated radar. Prototypes of various functional blocks in the 2.4 GHz and 5.8 GHz frequency ranges have been manufactured and tested, and methods for heating liquids using RF signals have been studied (Sup.: K.Dadalyan).

Research has been carried out in the direction of obtaining nanoparticles of various materials and determining their sizes by the laser ablation method. In particular, the sizes of graphite nanoparticles depending on the hardness of graphite have been obtained. The dependence of the size of silver nanoparticles in distilled water in case of laser pulse of different wavelength and duration has been studied (Sup.: cand.(phys.-math.) R.Khachatryan).

The method of measurement of electric specifications (gain, polarization imbalance) of parabolic antennas for anti-craft missile systems has been developed. High voltage I-V system for measuring the breakdown voltage of 3D printed dielectric materials has been proposed and

manufactured. Additionally, the method of measuring the dielectric permittivity and loss in such dielectric materials has been proposed as well (Sup.: N.Poghosyan).

ICRANet Armenia

Major achievements

A novel machine-learning-based method for modelling the broadband spectral energy distributions (SEDs) of blazars has been developed. Convolutional neural networks, trained on a comprehensive dataset of simulated blazar SEDs spanning a wide range of parameters, have been designed to accurately reproduce the radiative signatures of these objects. This method provides a powerful and efficient tool for modelling and interpreting multiwavelength observational data (Sup.: DSc (phys.-math.) N.Sahakyan).

DIVISION OF NATURAL SCIENCES

Academician-Secretary – corresponding member R.Aroutiounian
Scientific Secretary – A.Minasyan

The Division includes the Scientific and Production Centre (SPC) “Armbiotechnology”, the Scientific Centre of Zoology and Hydroecology, the Institute of Botany after A.Takhtajyan, the Centre for Ecological-Noosphere Studies, the Institute of Biochemistry after H. Buniatyan, the Institute of Hydroponics after G.Davtyan, the Institute of Molecular Biology and the Institute of Physiology after L.Orbeli.

The Division includes 6 academicians, 8 corresponding members, 27 foreign members as well as 12 honorary doctors.

1 general meeting, 26 Bureau meetings of the Division, 8 reporting meetings of the scientific institutes were held during the reporting year.

At the annual meeting of the Division the main fundamental and applied results of the Institutes were discussed.

At the 26 meetings of Bureau the following issues were discussed and approved: the 2024 working plan of the Division; the reports of the institutions of the Division on 2023 base funding, on the maintenance and development of the infrastructure, on the maintenance of the scientific objects of national importance and scientific and scientific-technical state projects of target programs; the applications for the positions of postgraduate studies and doctoral candidacy for 2024-2025; the applications of the Institutes for new appliances, applications on funding the scientific business trips. At the meeting of Bureau of the Division, a candidate for the vacant position of the director of the A.Takhtajyan Institute of Botany was also discussed and submitted for approval to the Presidium of NAS RA. Zh.Hovakimyan, cand.(biol.) was appointed the director of the A.Takhtajyan Institute of Botany of the NAS RA.

The Division held 5 meetings of the “Problem Council on Biodiversity and Biosafety”. The program of tree replacement in the city of Yerevan, problems related to the ecosystem of Lake Sevan, current problems of protecting plant genetic resources and current problems of viral infections in Armenia were discussed.

As a result of discussions at the meetings of the tender commission of the NAS RA, the institutes of the Division were provided with financing for the purchase of necessary equipment.

Bureau has approved 32 funding applications for scientific business trips.

In order to popularize science among young people, the Division initiated a series of seminars called “Science Today”. The seminars covered the following topics: “Unbroken Code: Armenians”, “Decoding the Genome”, “Assembling a Snowflake: from Atoms to Molecules and Crystals”, “Nutrition and Health”, “Drugs and Their Effects”, “The First study of the Whole Genome in the Armenian Population”.

35 local and international events were organized by the institutes of the Division including seminars, conferences, scientific expeditions, a total of 1396 participants, 142 of which were from abroad.

The institutions of the Division presented their results in the pavilions of the scientific festival "Science Week", young scientists took part in the exhibition organized by the NAS RA on the occasion of "Science Day", individual scientists gave lectures.

2 employees of the organizations of the Division were awarded state awards: the medal “Gratitude” of the Republic of Armenia and the “Order of Friendship” of the Russian Federation.

318 in peer-reviewed journals (277 Scopus/WoS) and 19 conference proceedings (17 abroad), 172 theses (154 abroad), 3 monographs (abroad), 7 educational tutorials were published by the Institutes of the Division, 4 patents of RA were obtained.

The Division's institutions have implemented 41 grant programs with international funding.

3 candidate dissertations were defended by the researchers from the Institutes at 3 specialized councils of the Division.

Institute of Botany after A.Takhtajyan

Major achievements

Three new species, *Alcea kurdica* (Schltdl.) Alef., *A. hohenackeri* (Boiss. & A. Huet) Boiss., *A. transcaucasica* Iljin have been discovered from the family *Malvaceae* of the flora of Armenia (Sup.: DSc(biol.) G.Oganezova).

The collection of the local department of ERE Herbarium has been enriched with more than 480 specimens from 30 families, including 2 new species: *Lycium ruthenicum* Murrayle (the first collection from Armenia) and *Solanum elaeagnifolium* Cav. The general department of ERE has been enriched with 405 specimens from more than 60 families, including 15 new genera, 76 new species and 5 subspecies (Sup.: DSc(biol.) M.Oganesyan).

A significant similarity of pollen morphological features in representatives of the subgenera *Cuscuta, Pachystigma and Grammica* of the genus *Cuscuta L.* (Cuscutaceae) has been revealed, with the exception of the species *C.compacta*. It has been detected that as diagnostic, pollen characteristics can be used only for the allocation of the subgenus *Monoginella*, which reflects its certain isolation within the entire *Cuscuta* genus (Sup.: DSc(biol.) A.Hayrapetyan).

A new species of *Ferula huber-morathii Peşmen (Apiaceae*) has been discovered for the flora of Armenia. The Seed Bank of Armenian Flora (SBAF) currently contains about 2900 specimens from 120 families, 636 genera, and 1630 species, incl. 91 species listed in the Red Data Book of Armenia. The treatments and replenishment of taxonomic and nomenclature data to the international website CARYOPHYLLACEAE CHECKLIST have continued in frames of cooperation with the Berlin Botanical Garden (Germany) (Sup.: cand.(biol.) A.Nersesyan).

As a result of the taxonomic study of the genus *Rubus L. (Rosaceae)*, it has been confirmed that it is represented in the flora of Armenia by 14 species: *R. saxatilis* (subgenus *Cylactis*), *R. idaeus* (subgenus *Idaeobatus*), *R. sanctus, R. armeniacus, R. peruncinatus, R. takhtadjanii, R. zangezurus, R. caucasicus, R. caesius, R. ibericus* (subgenus Rubus). In addition, as a result of the study of herbarium material, the occurrence of *R. ibericus* is confirmed in the flora of Armenia for the first time. A rare local late-flowering and cold-resistant variety of Prunus × dasycarpa "Shlor-Tsiran" has been studied, in the study the phenotyping method has been applied for the first time in accordance with the Guidelines of the International Union for the Protection of New Varieties of Plants (UPOV, 2016 and 2021) (Sup.: DSc(biol.) J.Akopian).

A new Pliocene locality has been discovered in Arevik National Park. A new fossil genus *Pseudosasa* of the *Bambusoideae* subfamily of the *Poaceae* family has been discovered in the early Pleistocene flora of Sisian. A new invasive weed species, *Solanum elaeagnifolium* Cav., dangerous for Armenia, has been discovered in the Syunik region, near the village of Artsvanik (Sup.: DSc(biol.) I.Gabrielyan).

Centre of Ecological-Noosphere Studies

Major achievements

In the frames of an interdisciplinary study, an assessment of a public health risk determined by a number of safety indices of drinking tap water in 12 administrative districts of the city of Yerevan: water-dissolved radon and some of potentially toxic elements (PTE), has been made. The annual effective dose of radon dissolved in tap water has been assessed by collating between the radon activity monitoring results and data on water consumption by the population. Finally, it has been detected that water in administrative districts of Davtashen, Achapnyak and Malatia-Sebastia located in the north and west of the city, is characterized by a relatively high activity of radon. No excesses of activity against international and national MAC have been recorded. The annual effective dose (per oral, inhalation routes of exposure as well as through radon dissolved in blood) does not exceed the WHO individual referent dose 0.1 mSv/yr. The probabilistic risk assessment has revealed that under the worse-case scenario (maximal consumption and maximal activity) the exceeding of the referent dose is possible. Pilot studies into some of potentially toxic elements have identified potential risks, and this justifies the necessity of monitoring (Sup.: cand.(biol.) O.Belyaeva, DSc(food sci.) D.Pipoyan).

Outcomes of applied developments

The activity of naturally occurring ^{226}Ra, ^{232}Th, ^{40}K and referent activity of manmade ^{137}Cs in soils developed on different geological formations across Armenia's territory have been assessed. The major factors of naturally occurring radionuclides distribution are the geologic structure of a locality and soil type, whereas the activity of manmade ^{137}Cs is strongly impacted by the absolute height of the locality (Sup.: cand.(biol.) O.Belyaeva).

The works regarding the exposure and risk assessment by collation between food consumption data and the contents of chemical hazards, have continued. For the first time in Armenia an assessment of possible dietary exposure to chloramphenicol, an antibiotic drug forbidden for use in veterinary, and associated health risks has been made. It has been found that consumption of broiler chicken meat by the adult population is not associated with a potential health risk determined by chronic exposure to chloramphenicol. For the first time the sources of calcium in the diet of the adult population in Yerevan have also been studied. As indicated by lab examinations, dairy products, pizza, fish meat, and eggs are relatively high in calcium. It has also been found that the basic share in daily intake of calcium is made from dairy products, drinking water and flour-based foods. It is noteworthy that daily intake of calcium by Yerevan's adult population is 46.6% less against the norm set up by EAEU Technical Regulations (1000 mg/day). A pilot assessment of risk associated with toxic and potentially toxic elements in drinking tap water in 12 administrative districts of Yerevan has been made. The detected concentrations of four studied elements (As, Pb, Cd, Ni) do not exceed permissible levels. However, using tap water may be associated with a probable health risk due to chronic exposure to arsenic (As) (Sup.: DSc (food sci.) D.Pipoyan).

Pursuing the creation of a remote system of ecological monitoring of Armenia's landscapes, in partnership with the Institute of Informatics and Automation Problems NAS RA and University of Geneva in Switzerland, works regarding creation of a multi-dimensional information system (a data cube) (http://datacube.sci.am) for satellite data compilation and processing, have continued. The system's repository contains Landsat and Sentinel satellite data and is upgraded periodically. The works regarding API development to provide the LANDSAT satellite imagery-based assessment and mapping of air temperature in Yerevan, are underway (Sup.: cand.(geol.) Sh.Asmaryan).

Scientific Centre of Zoology and Hydroecology

Major achievements

4 beetle (*Coleoptera*, family *Glaphyridae*) and a spider (*Aranei*) species new to science have been described; 67 species of invertebrates new to the fauna of Armenia have been identified - 4 species of beetles, 17 species of dipterans (*Diptera*), 37 species of spiders and 9 species of ticks. For the first time in the fauna of Armenia and the Caucasus as a whole, 14 species of tardigrades (*Tardigrada*) have been identified (Sup.: cand.(biol.) M.Kalashian, cand.(biol.) N.Zarikian).

In Syunik Marz, in the root soil of fruit trees, a species of ectoparasitic nematode *Longidorus iranicus* new to the fauna of Armenia has been found in Armenia. For the first time, nematodes of the genus *Trichostrongylus* have been found in rabbits in Tashir and Masis regions, and dicrocoelium eggs have also been found in Masis region (Sup.: cand.(biol.) M.Vardanyan).

For the first time in Armenia, the parasite fauna of bears and stone martens has been studied, 11 species of parasites have been noted, 5 of which are of zoonotic significance. For the first time in Armenia, the monogenean *Gyrodactylus* spp. has been identified in rainbow trout and Kura barbel (Sup.: cand.(biol.) O.Scherbakov).

The karyotypes of the germ cells of 3 species of birds of the genus *Phylloscopus* have been studied. GRC chromosomes localized only in the germ cells have been found in all three species. A first-order spermatocyte with tetravalent chromosomes has been found in the meiotic karyotype of the brown bear (Sup.: cand.(biol.) V.Spangenberg).

A new species for science, *Nannopus* sp., has been registered in the benthic meiofauna of Lake Sevan. According to calculation, it has been assumed that by the end of the century, the average air temperature in the Lake Sevan basin will increase by 2.2–5.8°C, which will affect the thermal and oxygen regimes of the lake, creating more favorable conditions for harmful algal blooms and a number of ecologically unfavorable processes in the lake. A fractal generalization of the reserve-

niche model of distribution of the relative abundance of species in ecological communities has been developed, where the indicator of dependence of species diversity on the degree of area coincides with the Hausdorff metric of the generalized Cantor set (Sup.: cand.(biol.) G.Gevorgyan).

Inconsistency between the flow of ecosystem services in the lowland rivers of Armenia and their perception by local stakeholders has been noted and estimated as one of the important constraints to improve water resource management (Sup.: cand.(biol.) V.Asatryan).

Outcomes of applied developments

Within the framework of the contract with the Ministry of the Environment, the following works on assessing bioresources have continued:

- total and industrial stocks of whitefish in Lake Sevan, permissible catch quantities have been determined (Sup.: DSc(biol.) B. Gabrielyan),
- studies of the state of the lake's crayfish population has shown that, as before, sick individuals have been found in the catches, the proportion of which, compared to previous years, has increased and in 2024 has amounted to 7.8% (Sup.: cand.(biol.) E.Ghukasyan),
- the state of the populations of animal species, that are the main objects of hunting, has been assessed. The Ministry of Environment of the Republic of Armenia has been provided with the list of species of hunting animals, quantities, permitted areas and dates allowed for hunting during 2024–2025 (Sup.: cand.(biol.) M.Ghasabyan),
- the spatial and temporal distribution of the quantitative and qualitative parameters of phytoplankton and zooplankton communities, as well as the species composition and distribution of benthic macroinvertebrates and macrophytes have been assessed (Sup.: cand.(biol.) G.Gevorgyan).

A collection of microalgae cultures, consisted of 333 strains, has been created, including representatives of 54 genera of algae. From the studied habitats, new algae species for Armenia have been registered and introduced into the collection: *Pleurastrum* sp., *Microthamnion* sp. (Lake Sevan), *Bacillaria paxillifera* (wetlands of the Ararat Plain) (Sup.: cand.(biol.)A.Mamyan).

An Armenian patent (No. 891Y G01N 33/00) for the invention of a new method entitled “Manometric method and device for determining the biochemical oxygen demand (BOD) in natural waters” has been registered (Sup.: cand.(biol.) S.Sargsyan).

A novel vaccine structure incorporating three Toxoplasma genes has been designed *in silico*, based on relevant characteristics. Extracts from 5 native Armenian plants have been prepared. MTT assays and in vitro tests have been conducted using the Toxoplasma Rh strain to determine IC50 and CC50 and assess their potential therapeutic effects (Sup.: cand.(biol.) S.Aghayan, cand.(biol.) A.Daryani).

Institute of Biochemistry after H.Buniatyan

Major achievements

The anti-diabetic impact of GABA-supporting mixture (GSM) containing asparagine, glutamine, β-alanine and ethanolamine-O-sulfate has been studied in streptozotocin (STZ)-induced diabetes model in rats. The injected mixture has demonstrated a normalizing effect on glycemic status, glutaminase and glutamate decarboxylase activity, confirming the applicability of GSM in diabetes treatment. The impact of piperazine, pyridine, imidazole and more than 100 newly synthesized derivatives has been studied on the activity of ADA purified from bovine lung. Some of the compounds have demonstrated ability to inhibit ADA by about 40%. In addition, compounds D011 180, D011 181 and D011 182 have demonstrated antioxidant activity. Based on the results obtained, it may be recommended to chemists to synthesize derivatives of more effective compounds that will potentially improve ADA inhibitory and antioxidant abilities suitable for future medical applications. With the purpose of identifying biochemical targets responsible for Dupuytren’s contracture (DC) and searching for applicable medication, the activities of ADA, DPPIV and DPPII in the aponeurosis of DC and healthy people have been compared. ADA activity was 11 times higher

in DC samples in comparison to healthy ones. DC samples had significant DPPIV and DPPII activity in contrast to undetectable levels in healthy samples. These results may contribute to understanding the role of the studied enzymes in etiology of DC (Sup.: cand.(biol.) A.Antonyan).

The impact of widely spread, highly toxic heavy metal cadmium (Cd) on the blood coagulation system, and the impact of amino acid complex (AAc) on that system have been studied. The changes in the blood coagulation system caused by AAc injection after cadmium poisoning have been assessed by parameters characterizing plasma hemostasis. As a result of poisoning, there is a significant increase in blood coagulability, which is regulated by the injection of AAc. Obtained results have been confirmed by morphological studies (Sup.: cand.(biol.) Z.Paronyan).

Targeted photodynamic therapy (PDT) of tumors destroys only the cancer cells, while healthy ones are not affected. To apply this in therapy, a technology for obtaining and purifying a non-covalent complex of cationic porphyrin with hyaluronic acid has been developed, as there are significantly more receptors on the surface of cancer cells than on healthy cells. Due to aluminum oxide loaded column, it is possible to obtain a sufficiently pure complex, which is fully free from unbound components (Sup.: cand.(biol.) G.Gyulkhandanyan).

Outcomes of applied developments

Blood plasma contains different antibodies against sugars. Cancer cells are characterized by aberrant glycosylation of plasma membranes; therefore, these antibodies prevent cancer. Their number decreases with age. In this regard, isolation of such antibodies from donor plasma and their use as prophylactic agents is promising. Two types of guardian resins have been prepared to isolate such antibodies from donor plasma. In one case, glycoproteins isolated from milk have been used as ligand, in the other case – previously desialated α1-acid glycoprotein, isolated from human plasma. These proteins have been bound with sepharose resin using glutaraldehyde and sodium metaperiodate. Proteins have been isolated from the immunoglobulin fraction of blood plasma and they are still being studied (Sup.: cand.(biol.) V.Gasparyan).

Lactic acid strains *Lactobacillus acidophilus, L.rhamnosus, L.bulgaricus, Streptococcus thermophiles, Bifidobacterium bifidum,* grown on MRS nutrient medium, have been selected. Obtained filtrates contain exometabolites, low-molecular peptides, bacteriocins, which have been separated into different fractions by the HPLC method and their antimicrobial properties have been determined. The fractions showing antimicrobial properties against pathogenic bacteria *E.coli, Staph aureus and Candida albicans* have been selected. Bacteriocins with such antimicrobial properties can be proposed as organic preservatives for use in the food industry.

The antimicrobial properties of 25 pyrazoline and pyrimidine compounds synthesized by the employees of the NAS RA Scientific Technological Centre of Organic and Pharmaceutical Chemistry have been studied. Compounds with relatively high antimicrobial properties against pathogenic microbes have been selected. Particularly good results have been obtained against fungi of the genus *Candida*. Some compounds have demonstrated antimicrobial activity against pathogenic bacteria *E.coli* and *Staph.aureus.* The studied compounds can be used in pharmaceutical industry for production of antimicrobial medication (Sup.: cand.(biol.) R.Madoyan).

Scientific and Production Centre "Armbiotechnology"

Major achievements

Technical conditions (TC) for the production of the food additive "Bifinarin" based on strains of bifido- (*Bifidobacterium longum, B. bifidum, B. adolensis*) and lactic acid (*Lactobacillus acidophilus* MDC 9602) bacteria have been developed and approved. The possibility of cultivating lactic acid bacteria (LAB) *L. casei, L. bulgaricus, L. lactis, Lacticaseibacillus rhamnosus* and *Lactiplantibacillus plantarum* as part of a consortium of a new probiotic fermented milk product has been determined (Sup.: cand.(biol.) V.Bagiyan).

PCR amplification of the α-amylase gene has been carried out from the genomic DNA of the *Bacillus amyloliquefaciens* strain using a pair of primers, which was cloned in the shuttle vector pBE-S using the Gibson assembly method. The obtained recombinant plasmid pBE-S_amy2156 has been used to transform the host strain *B. subtilis* Rik 1285 and a strain-producer of α-amylase TS5

has been obtained, providing a yield of the recombinant enzyme with a volume activity of 1200 units/ml. The temperature, pH optima, thermal stability and substrate specificity of the obtained α-amylase preparation have been characterized (Sup.: cand.(biol.) A.Hambartzumyan).

By chemical mutagenesis of *Phaffia rhodozyma* yeast strains producing the valuable carotenoid astaxanthin growing at 28°C and pH 4.5 have been obtained. The conditions for its biosynthesis have been optimized, resulting in the synthesis of up to 10 mg/g of astaxanthin (based on the dry weight of the biomass) (Sup.: cand.(biol.) A.Hovsepyan).

A new inhibitor of extracellular proteases ((S)-3-([1,1':4',1"-terphenyl]-4-yl)-alanine) has been identified. 2.5 mM of it, depending on the substrate and pH of the medium, inhibits the extracellular proteolytic activity of the *Pseudomonas aeruginosa* strain by 70% and the proteolytic activity of the *Stenotrophomonas maltophilia* strain by 90% regardless of the substrate and pH of the medium. The approach used allows to distinguish extracellular bacterial proteases by assessing their activity and inhibition under various conditions (Sup.: cand.(biol.) N.Hovhannisyan).

Researches for obtaining perspective L-tryptophan producers based on selectively selected strains of *Brevibacterium flavum* G27 (m-FP-r, 5-FT-r) and *B. flavum* 59C (m-FP-r, 5-FT-r) have been continued. Mutants with additional resistance to 5-methyltryptophan have been obtained using genetics and selection methods. As a result of deep fermentation, the mutant (G8′) of the *B. flavum* G27 strain has synthesized 8-10 g/l of the target amino acid, the mutant (18′C) of the *B. flavum* 59C strain – up to 12 g/l, and the latter is characterized by a minimum amount of accompanying amino acids (Sup.: cand.(biol.) G.Avetisova).

A method for obtaining protein hydrolysate of food yeast by enzymatic hydrolysis has been proposed. It has been shown that the isolated products of hydrolytic cleavage in the fermentation medium provide a yield of the amino acid L-histidine 22 g/l during cultivation of the strain *Corynebacterium glutamicum* LGS8 (Sup.: cand.(biol.) S.Keleshyan).

Methods for quantitative and qualitative identification of important organic acids (oxalic, malic, citric, succinic, lactic, tartaric, pyruvic), alcohols (methanol, isopropanol, propanol-1, isobutanol, butanol-1, isoamyl alcohol) and esters (ethyl acetate) by GC and HPLC have been developed and validated (Sup.: cand.(chem.) A.Tsaturyan).

The fatty acid composition has been studied and a comparative analysis of the yields of natural cosmetic oil from the seeds of wild and genetically modified blackberries has been carried out. It has been shown that the oil content of the seeds of genetically modified blackberries is almost 3 times higher than that of wild plant samples (Sup.: DSc(chem.) S.Dadayan).

The absence of antagonism, qualitative and quantitative changes in the synthesis of metabiotics during the joint cultivation of probiotic strains of *Lactobacillus* and *Enterococcus* genera have been shown. It has been found that the total amount of amino acids, stimulation or suppression of arginine synthesis, changes in the activity of bile acid salt hydrolase, leading to a change in the content of taurine and glycine depend on the combinations of different bacterial strains in consortia (Sup.: cand.(biol.) F.Tkhruni).

The effect of extracts of a number of medicinal plants on the growth of probiotic LAB strains has been studied. It has been shown that lemon balm extract at a concentration of 0.25% promotes milk fermentation, improves the taste and texture properties of dairy products, increases viscosity, antioxidant activity, lactic acid bacteria titer and extends shelf life (Sup.: cand.(biol.) L.Danielyan).

The morpho-physiological and biochemical properties of the green microalgae *Haematococcus pluvialis*, which synthesizes the natural carotenoid astaxanthin have been studied. The strain cultivation conditions have been optimized, which ensures a pigment yield of 85 mg per 1 g of dry microalgae biomass. Based on symbiotic nitrogen-fixing, phosphate-solubilizing and photosynthetic cyanobacteria *Arthrospira platensis* and *Nostoc* a new complex biofertilizer preparation has been developed and field-tested to improve the productivity of humus-poor soils (Sup.: cand.(vet.) V.Goginyan).

A metal-resistant bacterium with high iron oxidation activity identified as *Leptospirillum ferrodiazotropum* Ksh-L has been isolated from the heap leaching system of the Kashen copper-molybdenum mine. It has been found that the isolated *L. ferrodiazotropum* culture compared to the control is almost 4 times more effective in stimulating copper and iron bioleaching from chalcopyrite

and in association with the sulfur-oxidizing bacterium *Acidithiobacillus thiooxidans* it increases the efficiency of copper extraction from chalcopyrite by 1.7 times (Sup.: DSc(biol.) N.Vardanyan).

Laboratory methods for obtaining aqueous-alcoholic tinctures of the medicinal plants marsh cinquefoil and round-leaved wintergreen have been developed, which allow maceration of the original raw materials to ensure the highest content of biologically active compounds in the ready-to-use preparations (Sup.: cand.(chem.) G.Hovsepyan).

A flat-square complex of the Ni^{II} ion has been synthesized and studied in the Mannich reaction. Within the framework of the reaction, various amines have been tested, 5 new α-amino acids have been isolated and subjected to molecular docking (Sup.: cand.(chem.) A.Mkrtchyan).

Based on the obtained amino acids, 4 protected amino acids have been synthesized: 9-fluorenylmethoxycarbonyl-(S)-valine, N-9-fluorenylmethoxycarbonyl-(S)-β-[4-allyl-3-(2`-chlorophenyl)-5-thioxo-1,2,4-triazol-1-yl]-α-alanine, 9-fluorenylmethoxycarbonyl-(S)-3-(3-methylindol-1-yl)-α-alanine, N-9-fluorenylmethoxycarbonyl-(S)-allylglycine. Three dipeptides containing protein amino acid have been obtained by ester activation method: 3-9-fluorenylmethoxycarbonyl-(S)-valyl-(S)-5-methyl-2-thioxo-1,3,4-thiadiazole-alanine, N-9-fluorenylmethoxycarbonyl-(S)-β-[4-allyl-3-2-chlorophenyl-5-thioxo-1,2,4-triazol-1-yl]-α-alanyl-glycine, 9-fluorenylmethoxycarbonyl-(S)-3-(3-methylindol-1-yl)-α-alanylglycine. The structure of the obtained amino acids and dipeptides has been confirmed by NMR analysis. These compounds are endowed with potentially high antifungal and antimicrobial activities (Sup.: cand.(chem.) T. Sargsyan).

Click-coupling reactions have been used to synthesize non-protein amino acids, which have been introduced into the peptide chain to obtain new biologically and pharmacologically active peptides (Sup.: cand.(chem.) Z.Mardiyan).

Outcomes of applied developments

The biological fertilizers "NitroPro" and "PhosActive+" based on strains of nitrogen-fixing and phosphate-mobilizing bacteria have been developed and introduced into production. An agreement on the start of production of biopreparations has been signed jointly with the company "GROWWELL" LLC (Armenia) (Sup.: cand.(chem.) A.Tsaturyan).

Technical Conditions (TC) for the production of the food additive "Bifinarin" based on strains of bifido- (*Bifidobacterium longum, B. bifidum, B. adolensis*) and lactic acid (*Lactobacillus acidophilus* MDC 9602) bacteria have been developed and approved (Sup.: cand.(biol.) V.Bagiyan).

Institute of Molecular Biology

Major achievements

The first study of whole-genome sequences of modern and ancient DNA samples from the population of the Armenian highlands has refuted the theory of the Balkan origin of Armenians. The results obtained exclude the Assyrian origin of the Sassun people and show that the population of this mountainous region underwent a recent contraction in size, setting them apart from other territorial groups of Armenians. While checking for genetic continuity in the Armenian highlands, we have found a genetic input into the region from a source linked to Neolithic Levantine farmers. It has been established that the populations from the eastern, western, and central parts of the Armenian highlands show a relatively high level of similarity, which indicates the general demographic history of geographically different groups of Armenians (Sup.: DSc(biol.) L.Yepiskoposyan).

Outcomes of applied developments

Models have been developed for the *in silico* prediction of the ADMET parameters of chemical compounds. All models have been developed following regulatory guidelines, including ICH M7, REACH, ECHA-16-B-09, and OECD 37849783. The models have been built using both conventional and advanced machine learning algorithms and have been validated. These models are applicable to research groups and laboratories focused on the development of new pharmaceuticals, environmental pollution studies, agrochemicals, or cosmetic compounds. These models are freely

available and serve as an alternative to expensive commercial software, limited access to which can hinder the quality of research efforts (Sup.: cand.(biol.) N.Babayan).

Institute of Hydroponics Problems after G.Davtyan

Major achievements

The plants of *Moringa oleifera* Lam., nourished with the optimal $N_{43}:P_{35}:K_{22}$ calculated by mathematical modeling, have exceeded the control (Davtyan's 1N nutrient solution - $N_{55}:P_{11}:K_{34}$ atom%) by 2.6 times in dry plant material weight, and by 1.3 times in protein content. A relatively high accumulation of tannins (1.6 times), flavonoids (1.1 times) and vitamin C (by 10-30%) has been observed in the control variant. Different ratios of macroelements in the nutrient solution do not have a significant effect on the content of extractive substances, phenolic acids and carotenoids.

The leaves of two-year-old hydroponic ashwagandha (*Withania somnifera* L.) have been distinguished by a high content of total flavonoids (1.5 times) compared to one-year-old ones. The total content of phenolic acids in the leaves of one- and two-year-old hydroponic plants has exceeded those of soil plants by 1.3 and 1.2 times, respectively. Several phenolic acids have been found in the leaves of two-year-old hydroponic and soil plants, which has formed the following decreasing order: rutin > chlorogenic acid > ferulic acid > coumaric acid. Hydroponic plants have exceeded soil plants by 1.3, 1.1 and 1.1 times in the content of chlorogenic acid, ferulic acid and coumaric acid, while in soil ashwagandha leaves, the biosynthesis of rutin has proceeded 1.2 times more intensively, compared to hydroponic plants.

Saffron (*Crocus sativus* L.) has been introduced into hydroponic culture, for the formation and growth of its corms the concentrations of BAP-2.0 mg/L and NAA-0.5 mg/L in a nutrient medium of 0.5 MS are optimal (Sup.: corr. member S.Mairapetyan).

Planting density has a significant influence on the content of monounsaturated and polyunsaturated fatty acids in the seeds of soybean (*Glycine max* (L.) Merr.). Under hydroponic conditions the lowest content of monounsaturated fatty acids and the highest content of polyunsaturated fatty acids have been observed at the lowest planting density (30 plants/m^2). At the same time in this variant the lowest ratio of ω-6 and ω-3 fatty acids (10:1) has been registered (Sup.: cand.(biol.) A.Tadevosyan).

Outcomes of applied developments

New crops have been introduced into hydroponic culture for the first time: the wild edible plant *Polygonatum orientale* Desf., the medicinal plants *Aloysia citrodora* Paláu and *Vitex agnus-castus* L. (Sup.: cand.(biol.) A.Tadevosyan).

Large-scale experiments on moringa and soybean in water stream hydroponics have been carried out. “Hydroponic soybean cultivation” and “Hydroponic moringa production” proposals for implementation in production have been submitted to the HESC of MESCS RA (Sup.: cand.(biol.) A.Tadevosyan).

Syrian hibiscus velvet type (*Hibíscus syríacus* L. - White Chiffon), which can be used in landscaping as a decorative plant, has been introduced into hydroponic culture (Sup.: cand.(biol.) L.Hovhannisyan).

Norway maple (*Acer platanoides* L.) and silver birch (*Betulaceae varrcosa Ehrh*), which are widely used in urban landscaping, have been introduced into the hydroponic environment (Sup.: cand.(biol.) Kh.Mayrapetyan).

About 520 saplings of different tree-shrubs (thuja, sycamore, catalpa, juniper, oak, sophora, judea tree, silk tree, privet) and plants raw materials produced as a result of scientific experiments have been sold for about 1mln drams (Sup.: A.Ghahramanyan).

A practical proposal for the investment of hydroponic cultivation of Eleutherococcus has been developed (Sup.: cand.(biol.) A.Vardanyan).

An investment proposal for the hydroponic production of pyramidal thuja (*Thuja occidentalis pyramidalis*) saplings has been developed (Sup.: cand.(biol.) A.Hakobjanyan).

The aquaponic system has been improved with filtration and passive heat transfer systems (Sup.: A.Ghahramanyan).

Institute of Physiology after L.Orbeli

Major achievements

The possible neurotoxic properties of the venom of the Macrovipera lebetina obtusa snake have been studied using electrophysiological measurements and confocal immunostaining. The specifics of the effect of this hemolytic venom on different human blood groups have been studied as well. Lyophilization of a significant dose of the antivenom obtained against the gyurza venom has been carried out and its comparative assessment of the antivenom efficacy has been carried out in relation to the liquid preparation (testing of proteolytic activity, neutralization of lethality, neutralization of local hemorrhage) and the NORAF product of the largest Indian antivenom manufacturer (Premium Serum). The experimental immunoglobulin serum has been concentrated using caprylic acid. Its purification has been performed using the purchased Sartoflow® Smart Small-Scale Benchtop TFF System tangential filtration system, and the determination of immunoglobulin titer has been performed using an electrophoretic analyzer separately for each blood collection(Sup.: DSc(biol.) N.Ayvazyan).

The informativeness of the method for estimating simple visual-motor reaction time for studying the human functional state depending on various factors (age and mental load) has been demonstrated. The study and comparative analysis of the frequency properties of individual spike-wave complexes (SWCs) have been conducted in different animal models of epilepsy. It has been found that the fast three-phasic spike component is similar in all animal models both in time and frequency domains. The amplitude spectra of this component has shown a single expressed peak at 18-20 Hz. The slow component has shown a much larger variability across the rat models. A novel algorithm for segregation of seizures and spike-wave discharges (SWDs) from artifacts has been developed and tested. The algorithm has been tested on long-term EEG recordings in four different animal models of epilepsy. The algorithms for detecting seizures and separating them from artifacts have also been evaluated on EEG recordings of children with absence epilepsy (Sup.: cand.(biol.) A.Khachunts).

Outcomes of applied developments

"Development of Hyperimmunoglobulin products for Passive Immunotherapy against infections caused by Methicilin-Resistant Staphylococcus aureus bacteria". Within the framework of the grant, an agreement has been signed and cooperation has been started with the National Research Center for Epidemiology and Microbiology of Moscow named after Academician N.F. Gamaley. Together with the Moscow State Research Center for Epidemiology and Microbiology, staphylococcal anatoxins were obtained, with which rabbits were immunized. (Sup.: cand.(biol.) G.Kirakosyan).

"Hyperspectral imaging and chemometrics for revealing ablated heart tissue". The work was focused on the general set-up of the conditions for acquiring hyperspectral images of heart tissue. Specifically, the activities consisted in the collection of heart from bovine individuals, and the corresponding cardiac tissue dissection and preparation for Hyperspectral Imaging. The imaging setup (light source, filters, hyperspectral camera) has been optimized after evaluating each sample results, and several preprocessing methods are being evaluated on the produced data (Sup.: F.Villarruel).

"Discovery of new drug targets and first-in-class chemical modulators. From Diverse Data to Leaders in 3D AI." Through computational modeling and docking conducted by partners, several compounds have been identified that exhibit high affinity for the PDL-1 protein in silico. The effect of these compounds on the metabolic activity of cells has been tested, followed by evaluating their impact on PDL-1 synthesis (Sup.:R.Abagyan(USA), cand.(biol.)Z.Karabekyan).

"Assessment of Effects of Sutherlandia frutescens in Parkinson's Disease". The findings suggest that Sutherlandia may have a protective and stimulating effect on behavior in rats, as well as a role in modulating hippocampal activity (Sup.: cand.(biol.) L.Darbinyan).

"Characteristics and comparative analysis of the pig intestine as a scaffold and human skin". Decellularization performance of porcine small intestinal submucosa has been investigated to obtain a structurally acceptable substrate that is completely free of decellularization reagents and non-toxic to cells. The results have been evaluated by histological analysis, improvement and adaptation of

washing protocols, and cytotoxicity assessment using the MTT test (Sup.: cand.(biol.) Z.Karabekyan).

"Development of methods for regeneration of peripheral nerves". In the context of this research project, the effects of electrically conductive materials on decellularized nerve tissue scaffolds and cellular components have been tested (Sup.: V.Grigoryan).

"Development, analysis, and database replenishment of required information on substances with nicotine-like effects on nAChR receptors". Interdisciplinary analysis has been conducted and the database of substances with nicotine-like effects on various types of nAChRs with minimization of addiction and side effects has been replenished (Sup.: cand.(biol.) A.Voskanyan).

An experimental system has been designed for a comparative assessment of the efficiency of two methods for registration of motor activity in small animals (the method of shielding the electromagnetic field of SFCO sensors from PSI LLC. and the method of electromagnetic field energy absorption) (Sup.: cand.(biol.) A.Khachunts).

DIVISION OF CHEMISTRY AND EARTH SCIENCE

Academician-Secretary – academician L.Tavadyan
Scientific Secretary – cand.(tech.) L.Gasparyan

The Division includes the Scientific Technological Center of Organic and Pharmaceutical Chemistry, the Institute of Chemical Physics after A.Nalbandyan, the Institute of General and Inorganic Chemistry after A.Manvelyan, the Institute of Geological Sciences, the Institute of Geophysics and Engineering Seismology after A.Nazarov.

The Division includes 5 academicians, 5 corresponding members and 16 foreign members.

4 general meetings, 1 committee meeting, 14 meetings of the Bureau, 5 operational meetings and 2 meetings of the subcommittee of the Problem Council on Seismology, Seismic-Resistant Construction, Natural and Technogenic Disasters were held during the reporting year.

At the annual general meeting of the Division held on April 22 the reports of the Academician-Secretary, acad. L.Tavadyan, directors of the Institutes, as well as leading scientists, related to their scientific activities and achievements in 2023 were discussed.

At the general meeting on February 27 J.Karapetyan was nominated for the vacant position of the director of the Institute of Geophysics and Engineering Seismology after A.Nazarov. Editoral boards of the "Chemical Journal of Armenia" and "Proceedings of NAS RA. Earth Sciences" for 2024 were discussed and approved.

At the committee meeting of the Division the issue of creating a center of scientific and experimental laboratories was heard and discussed.

At the operational meetings of the Division the issue of the assessment of the risk of hazardous chemical waste "Lacquer ethinol" of the "Nairit Plant" and its safe neutralization was discussed.

At the meetings of the subcommittee of the Problem Council the following issues were discussed: the technology of utilization of the chemical waste "Lacquer ethanol" of the "Nairit Plant" CJSC, represented by "Ecoatom" LLC; sensor technology, worked out by PSI and its application, mainly for border control.

At the meetings of the Bureau the following issues were discussed and approved: applications for the programs of basic financing of scientific and scientific-and-technical activity: "Preservation and development of infrastructure" and for state target programs for 2025; working plan for 2024; distribution of full-time and part-time postgraduate free places of the NAS RA for 2025/2026; applications for purchase of the equipment in the scope of the program on "Maintenance, rearmament of scientific equipment, purchase of substances for scientific research, fulfillment of unforeseen urgent expenses of the NAS RA Institutes" for 2024.

New and revised staffs of scientific councils of the Institutes of Geophysics and Engineering Seismology after A.Nazarov, Geological Sciences and Chemical Physics after A.Nalbandyan were discussed and approved. The new structural changes of the Institute of Geological Sciences were discussed.

The issues regarding conceptual proposals, made to the state universities and research organizations of RA, on the process of consolidation of the state universities of RA and their merger with research organizations, support for the establishment of the chemical laboratory at Shushi Technological University, and the issues related to the draft law of the Republic of Armenia "On Higher Education and Science" were discussed.

98 researchers (4 of which were financed by NAS RA) of the institutes of the Division were sent to academic trips to Russia, Kazakhstan, Iran, USA, China, Italy, Belgium and other countries for the purpose of joint research, as well as for participation in international conferences and symposia.

The reports on the scientific and technical activity of the Institutes on the program "Preservation and development of infrastructure" of the basic funding and state target programs for 2024 were discussed and approved.

198 in the peer-reviewed journals (143 Scopus/WoS) and 4 in the conference proceedings (abroad), 84 theses (53 abroad), 5 monographs (2 abroad), 2 manuals were published by the Institutes of the Division, 11 patents (4 international) were obtained.

One candidate dissertation was defended in 2024.

The Division actively took part in the discussion of the scientific results of the Institutes during the annual meetings of these organizations.

Scientific Technological Centre of Organic and Pharmaceutical Chemistry

Major achievements

An effective method has been developed for the interaction of molecular iodine with phenylacetylene, N, C-substituted and unsubstituted pyrazole derivatives in the presence of cadmium (II) acetate to obtain the corresponding mono-, di- and triiodo derivatives. The role of solvents and molar ratios of reagents has been optimized. It has turned out that in acetic acid in the presence of mercury (II) acetate, mercury ionization of the triple bond of the resulting iodophenylacetylene easily occurs to obtain an organomercury intermediate, the subsequent demercurization of which with molecular iodine leads to diiodophenylvinyl acetate. Oxidative dehalodimerization of iodophenylacetylene in the presence of dilithium tetrachlorocuprate has been carried out to obtain 1,4-diphenylbuta-1,3-diyne (Sup.: cand.(chem.) H.Sargsyan).

Outcomes of applied developments

Low molecular weight mono- and diamines (3-aminopropyltriethoxysilane - APTES, hexamethylenediamine-HMDA, 1,4-diaminobutane-DAB) and high molecular weight polydimethylsiloxane with terminal amino groups (PDMS-NH2) have been studied as catalysts in the synthesis of cross-linked composite films based on polydimethylsiloxane with terminal hydroxyl groups (PDMS-OH). Glycerol and 1,2-propylene glycol analogs of tetraethoxysilane (TEOS): tetra(2,3-dihydroxypropoxy)silane and tetra(2-hydroxypropoxy)silane have been used for the first time to cure PDMS-OH. It has been shown that these cross-linking agents have a number of advantages over TEOS. The obtained silicone composite films containing diclofenac can find application as transdermal patches *(*Sup.: corr.member V.Topuzyan).

Institute of Chemical Physics after A. Nalbandyan

Major achievements

The high-entropy $(Ti_{0.4}Ta_{0.4}V_{0.4}Nb_{0.4}Cr_{0.4})AlC$ 211 and $(Mo_{0.25}Ti_{0.25}V_{0.25}Cr_{0.25})_4AlC_3$ 413 MAX phases and their 2D derivatives, which are promising for use in electrochemistry and aggressive environments, have been pioneered by self-propagating high-temperature synthesis (SHS) method. For the first time, in this type of compounds the phenomenon of out-of-plane ordering has been revealed, which allows designing new materials with desired properties for multifunctional applications by modifying the metals in the 4e and 4f Wyckoff positions (Sup.: cand.(chem.) S.Aydinyan).

A theoretical concept has been developed and a software tool has been proposed for numerical modeling of three-particle chemical transformations (Sup.: DSc(phys.-math.) A.Gevorkyan).

Outcomes of applied developments

Within the EU4 grant (ENI/2021/424-550) “Development of a river basin management plan for the northern basin in Armenia”, a river basin management plan for the Northern Basin of the Republic of Armenia for 2025-2030 has been developed and presented (Sup.: cand.(chem.) S.Minasyan).

Colored smoke mixtures have been produced in various packaging for civil and defense purposes, and a scheme for their pilot production has been developed (Sup.: cand.(chem.) D.Davtyan).

High-entropy MAX phases and their two-dimensional derivative MX-enes (20–30 nm in thickness) obtained by the SHS method demonstrate higher oxidation stability in air compared to the corresponding low-entropy materials, which makes them attractive for electrochemical and catalytic applications (Sup.: cand.(chem.) S.Aydinyan).

Biocompatible biodegradable polymer-hydroxyapatite composite implants have been obtained, which do not show toxicity to living cells (Sup.: cand.(tech.) M.Aghayan).

Institute of General and Inorganic Chemistry after M.Manvelyan

Major achievements

The glass formation domains, phase diagrams, and directed crystallization of glasses have been studied in the aluminoborosilicate MeO/MeF_2-Al_2O_3-B_2O_3-SiO_2 (Me = Mg, Ca, Sr, Ba) and barium-bismuth-germanate systems. Optical glasses transparent in the IR range have been developed based on fluorine-containing silicon-germanate compositions for night vision devices. Thermally stable and transparent glass-ceramics with a coefficient of thermal expansion (CTE) of $(15\text{-}30)\cdot10^{-7}$ K^{-1} have been synthesized for electronics applications (Sup.: DSc(tech.) N.Knyazyan).

In order to synthesize challenging silicate compounds such as nickel silicate, barium silicates, and zircon $ZrSiO_4$-based compounds, various techniques including combinations of chemical and thermal approaches have been developed and applied for the precipitation method utilizing silica hydrogel, derived from serpentinites($Mg(Fe)_6[Si_4O_{10}](OH)_8$)), as the silicon dioxide source in the precipitation process. The findings have allowed simplifying syntheses conditions of the above-mentioned compounds thereby creating prerequisites for the development of cost-effective energy-saving technologies. A ceramic glaze composition has been determined using locally available raw materials (Sup.: DSc(chem.) N.Zulumyan)

The production of a binder material from borogypsum using microwave (MW) radiation in the presence of mineralizers has been studied. It has been revealed that MW radiation enhances the effectiveness of mineralizers, improving the physical and mechanical properties of the resulting binder. The use of 0.1% potassium maleinate extends the setting time from 2.5–4 minutes to 7–12 minutes, while the compressive strength nearly doubles to 9 MPa. (Sup.: cand.(tech.) K.Grigoryan).

Outcomes of applied developments

New compositions and technology for fast-setting aluminate cement based on local clay raw materials have been developed. The general regularities of cement synthesis and hydration have been determined, depending on the clinker phase ratio of C12A7/CA and the cooling rate of melts (Sup.: DSc(tech.) N.Knyazyan).

A new microwave (MW) method for producing yttrium aluminates based on natural rocks has been developed in order to reduce energy costs and improve their properties. Yttrium aluminum garnets (YAG) with compositions of $Y_2O_3\cdot Al_2O_3$; $2Y_2O_3\cdot Al_2O_3$ and $3Y_2O_3\cdot 5Al_2O_3$ have been synthesized from soluble salts of aluminum and yttrium via the MW method. These materials are applicable in medicine (surgery, ophthalmology), military industry, lasers, and cosmetology (Sup.: cand.(tech.) V.Baghramyan).

A new glass-ceramic composite material having the composition 31.0 BaO–30.0 B_2O_3–15.0 Al_2O_3–7.0 SiO_2–6.8 MgO–5.9 ZnO–4.3 MgF_2 (mol. %) has been synthesized, based on low-melting glass and Al_2O_3 filler. This material is applicable for using in low-temperature co-fired ceramics (LTCC) technology (Sup.: cand.(tech.) A.Kostanyan).

Institute of Geological Sciences

Major achievements

Within the framework of thematic studies Sr-Nd isotope analyses of ore-hosting rocks and minerals of the Kaputan magnetite-apatite deposit have been carried out. The study has revealed the important role of evaporites in the mineralization mechanism of this type of deposits. A three-dimensional spatial model of the deposit has been created based on about 3000 XRF analyses. According to the obtained new data on the geochemistry of rocks and minerals, the Kaputan deposit has significant REE+Y (majorly, LREE) resources – ~127 thousand tons (Sup.: cand.(geol.) N.Nekrylov, cand.(geol.) S.Hovakimyan).

It has been established that microbialites possess a complex structure characterized by diagenetic changes and biogenic activity. They have been formed over a range from 9060 cal BP (the oldest) to 230 cal BP (the youngest), in some cases reflecting natural fluctuations in water levels. In cold, deep horizons, radially fibrous, abiogenic crystals date to 1510 cal BP. The presence of the mineral rhodochrosite ($MnCO_3$) only on the surface of deep microbialites indicates microbial

influence in a cold environment. Based on oxygen isotope δ^{18}Ocarb values (-2.06 ‰ to 0.77 ‰) and carbon δ^{13}Ccarb values (3.15 ‰ to 5.56 ‰), the main process of carbonate accumulation is attributed to photosynthesis. Deuterium values (-17.65 ‰ to -16.51 ‰) and oxygen isotopes (-1.76 ‰ to -1.09 ‰) point to significant evaporation in Lake Sevan (Sup.: cand.(geol.) L.Saakyan).

As part of the Armenian-German collaboration radon activity concentrations have been detected in groundwater and lake water samples taken from ten wells/sources near the southwestern and southern shores of the lake. High concentrations have been specifically recorded at the mouth of the Argichi River — 200 Bq/m³ (caused by a flooded artesian well in the coastal zone), near Zolakar — 55 Bq/m³ (possibly due to an artesian well in the coastal zone), and north of Artsvanist — 50 Bq/m³. This latter radon anomaly clearly indicates groundwater inflow into the lake, as there are no artesian wells near the shoreline in this area. Thus, the radon method is suitable for assessing groundwater inflow into the lake (Sup.: A.Arakelyan).

New petrological-geochemical data and paleontological age results have been obtained. In particular, analysis of major elements in samples has revealed that most volcanics exhibit normal alkalinity, ranging from basalts to rhyolites, representing a calc-alkaline series. Based on trace elements, they are predominantly of subduction origin, with some MORB-like and rare OIB types. Dating of deposits, found alongside or within the volcanics in the upper reaches of the right bank of the Sevget River, has identified two complexes. In Lower Cretaceous radiolarites, late Valanginian-Hauterivian radiolarians have been determined, while in limestones Cenomanian-early Turonian radiolarian species have been identified. For the first time, a geological map of the entire Bazum Horst area has been prepared and presented, significantly altering previous conceptions (Sup.: cand.(geol.) K.Galoyan).

Outcomes of applied developments

Based on the development of a unified geological, volcanological, and geochemical database for assessing geothermal energy potential, as well as on ambient noise seismic tomography data, five promising sites have been identified in the Republic of Armenia for selecting locations for large-scale geological and geophysical studies and exploratory drilling (Sup.: DSc(geol.) Kh.Meliksetian).

A new mechanical model of the processes leading to and triggering strong earthquakes has been developed. This model enables the determination of the potential energy (earthquake energy) accumulated in the Earth's crust (epicenter) during the long-term preparation of an earthquake, based on the principles of deformable solid body mechanics. The model also allows the estimation of the spatial parameters of the earthquake focus (including its volume, km³), the degree of mechanical stress reduction in the epicentral zone at the Earth's surface perpendicular to the fault, the magnitude of the so-called “released stresses” (Reid's elastic rebound hypothesis), and the size of the aftershock distribution zone and surface area after the earthquake. The model also provides the ability to determine the maximum deformation for a given soil layer using earthquake surface effects (fault length, focus depth, and relative displacement magnitude). In consideration of the high reliability of the new model, a novel method for predicting the main kinematic parameters of an earthquake — displacements, velocities, and accelerations — has been developed, depending on the predicted earthquake magnitude, geological conditions, and distance from the fault line. Earthquake response spectra constructed from the resulting synthetic accelerograms (standard seismic construction curves) for all four soil categories based on seismic characteristics closely match those derived from actual accelerograms (Sup.: acad. E.Khachiyan).

Seismic risks for residential buildings and infrastructure in the Republic of Armenia, as well as the impact of destructive earthquakes on human life and health, have been summarized and analyzed (Sup.: cand.(geol.) R.Arutyunyan).

The sen2r library of the R programming environment, installed and configured on the laboratory's server, continues to download automatically raster layers of the snow cover index (NDSI) for the Kasakh River basin from Sentinel-2 images, updated at five-day intervals. This data is used for ongoing adjustments to the methodology for monitoring seasonal snow cover formation and melting processes, as well as for developing methods to forecast the annual water supply in the Kasakh River basin (Sup.: N.Tarasyan).

As part of the topic “Assessment of the Vulnerability of the Akhuryan Reservoir in the Context of Transboundary Water Resource Management and Climate Change”, the impact of climate change on potential changes in surface runoff within the Akhuryan Reservoir watershed has been assessed. The analysis has been conducted according to mild (SSP1-1.9), moderate, and severe (SSP5-8.5) climate change scenarios. According to the obtained data, the average annual air temperature in the studied area will increase by 0.97–6.05°C by 2100, while precipitation will change insignificantly — by up to 29 mm, and surface inflow into the reservoir will decrease by 14.3% (Sup.: A.Arakelyan).

Institute of Geophysics and Engineering Seismology after A. Nazarov

Major achievements

The intensity field of seismotectonic deformations of the Taurocaucasian region that occurred during the period 2000-2023 has been estimated and mapped based on the analysis of tensor components of the seismic moment and focal mechanisms of strong earthquakes (M≥5.0). It has been revealed that during the specified observation period, the most intense seismic deformation processes, in the form of three destructive East Turkish earthquakes, occurred in the system of multi-segment faults of the East Anatolian deep fault (Sup.: cand.(phys.-math.) E. Geodakyan).

The spatial and temporal features of seismicity have been identified, in particular, the nature and physics of paired (doublet) earthquakes have been studied (Sup.: cand.(geol.) J.Karapetyan).

A scientific and practical methodological approach to assessing the value of response spectra [SR] for specified areas of seismically active territory has been developed. This has made it possible to estimate the average and 84% probability [SR] values for base frequencies expected in three separate zones of the probabilistic seismic hazard map of the territory of the Republic of Armenia at a scale of 1:500000 (Sup.: cand.(phys.-math.) V. Grigoryan).

Outcomes of applied developments

Hardware and software components have been developed, and a highly stable sinusoidal signal generator has been manufactured on a modern element base with an output frequency range from 0.1 to 100 Hz, designed to operate as a master oscillator in a set with vibration stands (Sup.: S.Shakhparonyan).

A 3-channel hardware and software logger with the ability to record both on an internal drive and on an external one via a local network has been developed and manufactured. To visualize the logger's operation, software for a PC has been developed that allows, in addition to real-time tracking of signals from sensors, also recording (logging) of data (Sup.: H.Shakhparonyan).

A velocity sensor has been designed, manufactured and tested, which allows one sensor to record both horizontal and vertical vibrations that may occur in the event of water inflow into a dam during the movement of a mixture of bulk materials (Sup.: A.Gasparyan).

As a result of the analysis of geoecological problems of the territory of the Kaps reservoir and the results of the experimental geophysical studies, natural and man-made factors influencing the stability of the reservoir have been identified, for the assessment of the spatiotemporal changes of which a set of ecogeophysical methods (ecogeophysical monitoring) has been proposed (Sup.: R.Gasparyan).

Two vertical vibration stands have been designed and prepared, one of which is in working condition, and the other is undergoing experimental work (Sup.: M.Mihranyan).

DIVISION OF ARMENOLOGY AND SOCIAL SCIENCES

Academician-Secretary - academician Yu.Suvaryan
Scientific Secretary - A.Melkumyan

The Division includes the Institutes of History, the Institute of Oriental Studies, the Institute of Arts, the Institute of Archaeology and Etnnography, the Institute of Economics after M.Kotanyan, the Institute of Language after H.Acharyan, the Institute of Literature after M.Abeghyan, the Institute of Philosophy, Sociology and Law, Shirak Armenology Research Center, "Armenian Encyclopedia. Publishing House".

The Division includes 5 academicians and 14 corresponding members.

In 2024 3 general meetings of the Division were held.

At the general meeting held on January 17 the nominated candidates for the position of the director of the Institute of Oriental Studies were discussed and submitted to the Presidium of NAS RA.

At the annual general meeting held on April 4 the report of academician Yu.Suvaryan on "The main results of scientific and scientific-organizational activities of the Division for 2023" was discussed and approved. The following scientific reports were presented: "The Image of David of Sasun in Yervand Kochar's Art" (corr. member A.Aghasyan), "Dialects of Nagorno-Karabakh" (DSc(phil.) V.Katvalyan).

At the general meeting held on July 3 the nominated candidates for the position of the director of the Institute of Oriental Studies were discussed and submitted to the Presidium of NAS RA.

The following international academic conferences were organized: "The Problems of Social and Economic Development Under the Circumstances of Introduction of Artificial Intelligence Achievements" jointly with NAS RA M.Kotanyan Institute of Economics, the Institute of Economics of the NAS of Belarus and the Saratov Scientific Center of the AS of Russia; "The Issues of Interrelations of Literature Studies and Culturology in the Era of Globalization", "Literary Trends and the Schools in the Context of the World Classic Literature and National Literatures (from Early Classicism until the 20s of the XX Century): Typology, Common Features and Peculiarities"; anniversary academic conferences dedicated to Paruyr Sevak's and Sergey Sarinyan's Centenaries of Birth jointly with NAS RA M.Abeghyan Institute of Literature; "Western Armenian in the XXI Century: Challenges and Opportunities", "Dialectological Readings" jointly with NAS RA H.Acharyan Institute of Language:

14 sessions of the Bureau of the Division were held. The following issues were discussed: the work plans for 2024; the Division scientific institutions' applications for retaining and development of the infrastructure of basic financing of scientific and scientific-technical activities, and for the government target plans; the issues related to the reports of the Division scientific institutions on implementation of the projects of retaining and development of the infrastructure of basic financing of scientific and scientific-technical activities in 2024, as well as the current reports on implementation of the mentioned projects in 2024; the applications for post-graduate admission; the writing process of Volume 1 of Book 1 of the "Armenian History"; the results of the work on the increase of efficiency of the Division scientific institutions and internationalization of the scientific journals; formation of professional councils in the Division; the Division scientific institutions' 2023 budget programs "Maintenance of the Scientific Equipment, Reequipment, Procurement of Materials for Scientific Experiments and Coverage of Unexpected Urgent Expenses" and "Reequipment of the Institutions Included in NAS RA System"; other scientific and organizational issues. On December 11 the Bureau discussed and approved the reports on the scientific and scientific-organizational activity of the Bureau and scientific institutions of the Division for 2023. At the same session, the candidate for the position of the director of the Institute of Oriental Studies was discussed, approved and submitted to the Presidium of NAS RA.

The following periodicals were published: "Historical-Philological Journal" (3 issues), "Journal of Armenian Studies" (3 issues), "Bulletin of Social Sciences" (3 issues), as well as the electronic journal "Fundamental Armenology" (in English, 2 issues). The Institute of Language after H. Acharyan published the periodical "Language and Linguistics" (1 issue), "Jahukyan Readings" (2

issues), the Institute of Literature after M.Abeghyan published the “Journal of Literary Studies” (2 issues), and the Institute of Arts - the “Journal of Art Studies”(2 issues).

134 books (13 abroad), 16 textbooks, 712 in peer-reviewed scientific journals (106 Scopus/WoS) and 364 in conference proceedings (99 abroad), as well as 223 abstracts (69 abroad) were published by the researchers of the scientific organizations of the Division. 111 articles came out within the system of the International Scientometric Database.

36 international and 21 local conferences were held.

Institute of History

Major achievements

The second book of the first volume of the academic “History of Armenia” series has been published, covering the period from the mid-9th century BCE to the 3rd century CE. It includes histories of the Kingdoms of Van and Haykazuni-Yervanduni, Artaxiad rulers, and King Trdat III Arsacid, focusing on international relations, socio-economic, cultural, and ideological issues.

The monograph “The Armenian Question in International Relations (1895–1923)” (“Армянский вопрос в международных отношениях (1895–1923 гг.)”), co-published with the North-Caucasus Federal University, explores the emergence and development of the Armenian Question as an international issue during the late 19th and early 20th centuries. Drawing on archival documents from Russian, Armenian, and Georgian sources, it examines the political, economic, and humanitarian policies of Russia, European powers, and the USA regarding the Armenian population in the Caucasus and Western Armenia. For the first time in Russian historiography, the study presents a comprehensive view of the positions and true policies of all stakeholders concerning reforms in Ottoman Armenian territories. It identifies key phases in the Armenian Question’s evolution, correlating them with World War I and subsequent revolutions in Russia and Turkey. The Lausanne Treaty represents the logical conclusion of the Eastern Question and, by extension, the Armenian Question. It definitively denied the Armenian population in the possibility of establishing their own state.

Outcomes of applied developments

The works published by the Institute, in addition to their scientific and theoretical significance, have considerable practical and applied value as well. They can serve as a base for new historical research, be used in the reworking of other topics, and also be applied in the revision and teaching of textbooks on “Armenian History”, “World History”, “History of Neighboring Countries” and other related subjects. The rich factual material presented in the works is also important for exposing the anti-scientific and fabricated viewpoints in historiography.

Institute of Oriental Studies

Major achievements

The academic initiatives undertaken by the Institute have provided a comprehensive understanding of various aspects of the region's historical, cultural, and social evolution. A notable achievement is the inaugural study of the early history of the Armenian Highlands, which examines the region's development through the lens of environmental interactions and highlights the impact of climate change on the social, economic, and political trajectories of regional societies from the Early Holocene to the decline of Urartu, as presented in the monograph “The Environmental History of the Armenian Highlands: Natural Environment, Climate Changes and Civilizational Processes (X–I Millennia BC)” by A.Kosyan, Y.Grekyan.

Extensive analysis of onomastic and biographical data from royal inscriptions of the Urartian, Neo-Assyrian, Neo-Babylonian, and Achaemenid periods has been carried out. These inscriptions pertain to the inhabitants of Urartu and neighboring regions of the Armenian Highlands. The study, encompassing approximately three hundred personal names, was published in Oxford under the title “The Urartian Onomasticon. A prosopographic study” (Y.Grekyan).

The Institute's researchers have advanced the internationalization of various issues in Armenology and Oriental Studies. A particularly noteworthy study, authored by H. Hmayakyan and published in the journal of History, Archaeology and Ethnography of the Caucasus (Scopus Q1), explores the iconography of the Karashamb Goblet in the context of Hittite cuneiform sources. The study, titled "On the Iconography of Lions and Leopards on the Goblet of Karashamb," examines the symbolic association of lions and leopards with royal authority, reflecting the worldview of the goblet's creators.

A comprehensive study of Turkish-Azerbaijani military cooperation, examining its qualitative stages before and after the 2020 Artsakh war and analyzing the impact of this cooperation on Azerbaijan's identity-ideological transformations within the framework of regional political interactions has been carried out (L. Hovsepyan, A. Tonoyan, “From Alliance to ‘Soft Conquest’: The Anatomy of the Turkish-Azerbaijani Military Alliance Before and After the 2020 Nagorno-Karabakh War” (Scopus Q2)). A study of Azerbaijan's Arab, Middle Eastern, and Islamic foreign policy reveals how the country leverages the Organization of Islamic Cooperation and the concept of Islamic solidarity to oppose Armenia's national interests within the context of broader security policy (A.Pashayan, N.Navasardyan, “Azerbaijani Islamic Diplomacy in the Context of the Nagorno-Karabakh Conflict: The Role of the Islamic Cooperation Organization” (Scopus Q1)).

In the context of economic and social history, researchers have rigorously examined the decree issued by Nadir Shah to the Armenian merchants of Agulis, a previously unexplored historical document (“Nādir Šāh’s Decree Issued at the Request of the Armenian Merchants of Agulis”). The oppressive poll tax, known as “jizya”, levied on Armenian-Christians in Eastern Transcaucasia in the 17-19 centuries has been analyzed. It has been shown that it was one of the main reasons for the conversion of Armenians and Udis to Islam in the region (K.Kostikyan, G.Stepanyan, A.Tovmasyan, “Jizya in Eastern Transcaucasia in the XVII–First Half of the XIX Century” (Scopus Q1)).

Outcomes of applied developments

A significant outcome of applied research is the contribution made by the staff of the Department of Ancient East to the creation of the second book of the first volume of “History of Armenia”, to the development of World History school textbooks for the 8th and 10th grades.

Scholarly works by various researchers have been translated into Arabic, facilitating access through electronic platforms and enabling scientific institutions in 22 Arab countries to engage with the contributions of Armenian orientalists.

Popular science publication, “Christianity as it is”, seeks to present the fundamental principles of Christianity in an accessible and comprehensible manner.

The collective monograph "Resilient Political Systems at the Crossroads of War and Peace," authored by G.Iskandaryan and A.Tonoyan includes an analysis of the stability index of Iran and Azerbaijan within the framework of regional security. This work is particularly pertinent for researchers addressing contemporary issues and for entities involved in foreign affairs. G.Iskandaryan’s “Integration Toolkit for Regional Countries: View from Armenia” published in India, underscores Armenia's role as a transit hub in the North-South transport corridor.

The Institute has maintained its vigorous academic and applied activities, enhancing scientific and diplomatic platforms. Events have been organized with participation of diplomatic representatives from the Middle East, Asia, and other regions, as well as academic experts and governmental institutions, with the objective of analyzing current regional issues and evaluating their implications for the South Caucasus, particularly concerning Armenia’s security challenges.

Throughout the year, a variety of academic events, including conferences, seminars, and book presentations, have been conducted to facilitate the understanding of geopolitical processes and to analyze and assess their causal relationships: international conferences “The Ongoing Gaza-Israel War and its Impact on Regional Developments,” “Perspectives of the Changing Middle East: Dynamics of Change”, “The Combination of Islam and Nationalism in the Neighboring Countries of Armenia: Changes in Identity and Politics”, “Regional Transformations and Armenia: Security Shifts”.

Two conferences were specifically focused on China's modernization and the advancement of Armenian-Chinese relations.

The Institute has hosted numerous international delegations, ambassadors from India, Iran, Syria, Russia, and China to Armenia have participated in joint discussions aimed to strengthen cooperation with the scientific institutions of these countries. The meetings concentrated on exploring new opportunities for scientific collaboration and cultural exchange programs.

The visits of Giorgi Sanikidze, Director of the Institute of Oriental Studies at Ilia University in Georgia and a delegation led by Gholam Ali Haddad-Adeli, President of Iran's Academy of Persian Language and Literature, have resulted in agreements to enhance scientific ties with both Georgia and Iran.

The Institute has formalized three memoranda of cooperation: with the V. Sargsyan Military Academy of the Ministry of Defense, aimed at enhancing collaboration in educational and research initiatives; with the National Defense Research University, also under the Ministry of Defense, with the objective of organizing joint scientific events; with the Caucasus Institute Foundation, committing the involved parties to engage in collaborative scientific research and provide professional consulting services.

Institute of Archaeology and Ethnography

Major achievements

The sub-project "Excavations and Study of Archaeological Sources of Prehistoric and Ancient Armenia" has achieved significant progress across multiple spheres. Notably, substantial results have been achieved in exploring the realities of the second half of the 3rd millennium BC. This period is marked by significant climatic and ethno-cultural changes that shaped the subsequent historical development of the Armenian Highlands. The investigation of several key sites in Armenia and the region (e.g. Karnut, Gegharot, and Karashamb) and the publication of the results in a collective monograph in Belgium, highlight the leading role of Armenian scholarship in this field on an international scale. The foundations of an octagonal building, covering an area of approximately 1000 m^2, have been uncovered on the eastern slope of the 17th hill in the capital city of Artashat. Radiocarbon analysis indicates that this structure dates to the first half of the 4th century, making it the earliest archaeologically documented church in Armenia. This significant discovery provides valuable insights into the mechanisms of the spread of Christianity in Armenia (Sup.: DSc(hist.) A.Bobokhyan).

Significant progress has also been made in the internationalization of the issue of Artsakh's cultural heritage. Notably, the trilingual academic platform https://monumentwatch.org/, available in Armenian, English, and Russian, has been updated. This platform highlights Artsakh's cultural heritage on a global stage and monitors its current state (Sup.: DSc(hist.) H.Petrosyan).

Data from the official monument lists of Soviet Azerbaijan have been retrieved and analyzed from Russian and Georgian archives. This research reveals discrepancies and exposes the inaccuracies in the Azerbaijani authorities' current claims when compared to the lists they themselves compiled during the Soviet era (Sup.: DSc(hist.) H.Kharatyan).

The sphere of memory shaped by the Second Artsakh War has been the focus of in-depth research. In particular, the local practices of commemorating and highlighting the memory of the 44-day war have been observed throughout Armenia, with a pronounced emphasis on border communities. These practices are influenced by the security challenges faced by these communities, local identity narratives, existing symbolic infrastructures, and the agendas of key players involved in memory politics. A recent study explores the profound impact of these factors on the transformation of the modern Armenian identity (Sup.: DSc(hist.) M.Galstyan).

Outcomes of applied developments

The "Applied Anthropology Group" has collected a substantial amount of material on the experiences of violence faced by Azerbaijani-Armenian and Artsakh-Armenian refugees. It includes topics such as forced deportation, massacres, property and belongings left behind in their homeland, difficulties in settling in the Republic of Armenia, the 2020 war, and the exodus of Armenians from Artsakh in 2023 (Sup.: cand.(hist.) G.Kharatyan).

25 students from various universities abroad have participated in training sessions during the excavations of the Vedi Fortress, Masis blur, and Artanish sites.

The Institute participated in the “Science” exhibition organized by the NAS RA, presenting its archaeological findings.

The Institute has provided various professional expertises to the Government of the Republic of Armenia and the Ministry of Education, Science, Culture and Sports.

Institute’s Archive has received and registered a substantial amount of archaeological, ethnographic, and folklore material. It includes complete author archives, field research and excavation reports from various years spanning the 20th and 21st centuries, as well as documents, drawings, photographs, negatives, slides, and collective materials from the ethnographic and folklore departments. A total of 156 units of material have been digitized and processed.

Shirak Centre for Armenian Studies

Major achievements

Within the framework of "Archaeological and Historical-Ethnographic Studies of Shirak-3" (Sup.: cand.(hist.) A.Hayrapetyan) excavations at the Bronze-Iron Age fortress-settlement of Jradzor have continued, centering mainly on the area near the top of the fortress hill. In the 11x11 m excavation area, a 8.20x8.30m building was uncovered, oriented to the north and situated on the hill's bedrock. The entrance was located to the south. Sections of 1-4 rows of walls were preserved in some areas. The walls are made of tuff, and sometimes basalt, and placed on smoothed and processed bedrock. Near the entrance in the southern part, the bedrock served as a plinth. Fragments from the structure were found in the earthwork covering it, including a stone with a cross, a benefactor's stone and other items. The findings show that the structure was reused during the Middle Ages. The excavated rectangular building, with interior dimensions of 5.5x5.5m, draws similarities to the construction techniques of the Urartian cult buildings. Similar structures have been found in other Urartian sites in Armenia (Arin Berd, Karmir Blur, Argishtikhinili) and the Urartian texts mentioned ***susi*** are dedicated to the main God of the Urartian pantheon, Khaldi. The western section of the wall surrounding the top of the conical hill was also cleared of stones displaced during the excavation. A new entrance was created, leading to the summit, with ramparts and towers featuring hemispherical bases. This wall was likely constructed in the Iron Age and was later modified during the Middle Ages.

The term “Lulu tribes”, as mentioned in the inscription of Argishti I on the occasion of the founding of Erebuni, has been the subject of scholarly analysis. The etymological studies of specific names suggest that Argishti used the term “Lulu” to refer to the inhabitants of the regions within present-day Armenia, stretching from the Ararat Valley to the Aghstev Valley. The term “Lulu” appears to be a derogatory label, employed by the king to characterize these groups as “barbarians”. Through this inscription, Argishti mirrors the perceived backwardness of the fish-based economy and the cult of the “fish man”, contrasting it with the more developed agricultural economy and anthropomorphic religious practices of Urartu.

Studies have been conducted to reveal the works of individual ashughs by deeply analyzing their heritage and prominent Armenian ashugh centers. Using the example of Alexandrapol, the historical preconditions for the formation of the Armenian ashugh craft unions have also been studied. Within the context of the coexistence of inherited traditions and transformations, their historical and cultural foundations in medieval ashugh art have also been examined.

Institute of Language after H.Acharyan

Major achievements

The Institute has emphasized the importance of addressing scientific issues that are in one way or another related to the current situation in the world and especially in our region, as well as the challenges faced by the country. Within the framework of the topic “Study of Armenian Dialects” (Sup.: DSc(phil.) V.Katvalyan), the vocabulary related to the national identity in the work of Francesco Rivola, the Italian armenologist of the 16th-17th century, "Dictionarium armeno-latinum"

(1621) has been researched, which, together with the extensive dialectal vocabulary, constitutes the most interesting scientific feature of the first printed Armenian dictionary, as well as the first dialectal dictionary. The dictionary contains an extensive vocabulary related to Armenia, the Armenian people, the Armenian language, as well as other countries, peoples, and languages, the classification and analysis of which and the examination of dialect variants has allowed us to get an idea of the worldview of a part of Armenians in the late Middle Ages, while simultaneously complementing the more or less objective picture of the geopolitical situation of the time, and the history with reliable references to the past of a number of countries and peoples. It has turned out that the dictionary contains information about three neighboring peoples of Armenians: Persians, Turks, and Georgians. In addition, almost all the peoples of the region are mentioned, as a rule, by the names of the nation, country, and language, and sometimes with other information. The dictionary mentions the name Azerbaijan as the name of a province, and it is clear that it refers to one of the provinces of Iran, especially since the nation or language associated with that name is not mentioned. There are also references to European, Asian, and African countries and peoples. The linguistic facts and information contained in Rivola's dictionary reflect the real relationships between the countries and peoples of our region in the 16th-17th centuries and act as a solid scientific counterargument to the current distortions of historical realities.

Within the framework of the topic "Issues of Historical Development of the Armenian Language" (Sup.: cand.(phil.) G.Mkhitaryan), the peculiarities of the use of the subject with oblique cases in the Armenian Bible have been observed. The use of the subject with genitive and dative cases with a transitive verb proves that structures of an ergative nature were not alien to ancient Armenian. Currently, it is generally accepted that about a quarter of the world's languages have ergative structures, including a number of Indo-European languages (Hittite, Luwian, many Iranian languages, Hindi, etc.). Moreover, many languages of our region (including Urartian), regardless of their origin, have had an ergative nature. And the transitions from the ergative structure to the nominative one and vice versa are not only non-unusual phenomena, but quite the opposite. The research proves that such structures had a wide functional application in Old Armenian. This is evidenced by the materials provided by both translation and independent literature; such structures are also very common in modern dialectal Armenian. All this comes to negate the claim of those who deny at least close ties between Armenian and Urartian languages stating that the ergative nature of Urartian excludes the possibility of its etymological relations with Armenian. The materials certainly provide an opportunity for comparisons tracing back thousands of years, revealing the peculiarities and commonalities inherent in ancient languages, the interactions of cultures, which is especially important in the current stage of globalization, when both history and cultural values are often falsified.

Outcomes of applied developments

Affix Dictionary of the Armenian Language, which may be useful for those interested in general and Armenian linguistics as well as for students of philology departments, has been published.

Within the framework of the topic "Problems of the Study and Standardization of Modern Eastern and Western Armenian Languages (Sup.: cand.(phil.) T.Asoyan), two volumes of "New Words" (one volume for each), including material extracted from the functional variants of modern literary Eastern and Western Armenian languages, have been prepared for publication.

Within the framework of the topic "Issues of General, Comparative and Applied Linguistics" (Sup.: DSc(phil.) V.Hambardzumyan), a joint scientific experiment with the Berlin Medical School on bilingualism and the perception of linguistic units has been summarized and disseminated. The goal of the experiment is to identify the linguistic thinking of bilingual individuals at the phonetic and lexical levels, as well as the subconscious impulses of language perception and the response to linguistic units. To carry out the experiment, a combined phonetic and lexical database of Armenian, English and German has been developed. The data base has been put at the basis of the composition of the new version of the well-known *LexTale* tool for testing linguistic skills. For the first time, Armenian has also been included in the test as a term of language proficiency. The link of the experiment: https://www.youtube.com/watch?v=v3va2P61nCs

"Observations around the Native Language: A Collection of Articles", containing the author's observations on some issues and problems of the Armenian language, common mistakes and dual forms, has been published. The book can be useful for both Armenian language specialists, students, teachers, and readers who value the issues of the mother tongue.

The book "Directory of the Institute of Language of the NAS RA – 2023", presenting the bibliographic lists of scientific works issued by the researchers of the Institute in 2023 and the general content of the publications (in Armenian, English, and Russian), has been published.

Institute of Literature after M.Abeghyan

Major achievements

Within the framework of the topic "History and Theory of Armenian Literature" (Sup.: cand.(phil.) H.Vorskanyan), the book by Hakobyan P., Hakobyan A. "Chronicle of Life and Work of Khachatur Abovyan" has been published, in which, as a result of a systematic study of the scientific chronology of the biography of the great Armenian enlightener, the founder of the new national literature and language Khachatur Abovyan (1809-1848), his life and work of the pre-Dorpat (1809-1829) and first Dorpat periods (1830-1833) are presented. The book devotes a special place to the history of the Abovyan family, including all reliable sources about their dynasty up to the birth of Khachatur. The data presented in the book have been carefully studied and clarified, becoming a reliable basis for new historical and cultural studies. In addition to numerous and diverse sources related to Abovyan, data related to the history and culture of Europe and Russia in the first half of the 19th century are presented in parallel. Thus, this work acquires not only philological, but also, in a broad sense, cultural value. The details of the lives of a number of European scientists of the time may be of interest to foreign researchers as a primary source.

The book by E.Mnatsakanyan "Hovhannes Tumanyan in the Evaluation of the Literary Criticism of the Contemporary Time" has been published, where the totality of the assessments given by the literary criticism of the contemporary time is compiled, which later has become a stable guideline for the discovery and interpretation of Tumanyan's creative work. Almost all the responses of literary criticism accompanying H.Tumanyan's work, i.e. articles, reviews, journalistic editorials, monographs, have been studied, the opinions expressed about Tumanyan's creative work have been revealed, their historical and reflective value has been shown anew, the ideological foundations on which the principles of evaluating Tumanyan's art were anchored have been revealed, and the perspectives of the contemporary literary critical thought of the time, understanding the values of the literary-creative process, have been completed.

Outcomes of applied developments

"Literature. Textbook for the 8th form of the general education school" (Nikoghosyan A., Vardanyan A.) has been published.

"The Little Prince" by Antoine Saint-Exupéry has been translated into ancient Armenian /Grabar/ and published (Avetisyan L.). The translation of one of the world's most widely read and beloved books into ancient Armenian /Grabar/, with annotations and a preface, can be used as a textbook, educational and supporting reading material for high schools, educational institutions, universities, as well as for those who study classical Armenian.

The book by Isahakyan A., "Sofia: Avetik's Kind Angel"**,** has been published. It presents the life of Sofia Isahakyan (1884-1966), Av.Isahakyan's wife, for 47 years, which is an integral part of the writer's scientific biography. The book contains numerous unpublished materials, i.e. Isahakyan's letters, postcards, excerpts from the memoirs of the contemporaries and rare, previously unpublished photographs. It provides very valuable information not only about Isahakyan, but also about his entourage, Armenian literary and social life, including Armenian communities in a number of European countries. The book is intended for a wide range of readers and will contribute to the publicization of Isahakyan's life, work, literary, and social and political activities.

Institute of Economics after M.Kotanyan

Major achievements

Within the framework of the theme "Green Economy as a Prerequisite for Sustainable Development of Innovative Agriculture" (Sup.: cand.(econ.) M.Manucharyan):

-the main goal of sustainable development, namely ensuring economic growth, social stability, and ecological balance in the long term, has been substantiated, the harmony of which is ensured through the concept of green economy, which has recently received great attention all over the world.

-the state and features of the green economy formation have been analyzed, and it has been substantiated as one of the factors of sustainable development. The creation of prerequisites for longer preservation of natural resources in the economic cycle, which can solve several complex problems of the modern socio-economic development of the country, has been explored with econometric modeling.

Within the framework of the theme "The Issues of Ensuring Macroeconomic Balance in the Republic of Armenia" (Sup.: cand.(econ.) E.Hakobyan):

-the impact of monetary policy on economic stability, its effectiveness in different countries, as well as the role of digital technologies in transforming the economy and financial markets have been revealed.

-the economic development of Armenia in recent years has been studied and it has been revealed that economic growth is proceeding without a "significant role" from industry and agriculture, whereas the shares of the services, trade, and construction sectors have increased. As a result, the reduction in the shares of the two major sectors that create material goods in the economy and the increase in the share of the services sector in GDP is often accompanied by a decrease in our country's crisis resilience.

Outcomes of applied developments

Within the framework of the theme "Green Economy as a Prerequisite for Sustainable Development of Innovative Agriculture" (Sup.: cand.(econ.) M.Manucharyan) the following priorities have been distinguished, namely:

-considering that about 55-60% of the total volume of water consumption falls on agriculture and water losses during transit make up 28-30% of used water, it is recommended to apply a differentiated approach to irrigation water tariffs according to the volume of water use and season. This will encourage consumers to save on water use costs.

-in Armenia, water resources are mainly polluted by domestic and industrial wastewater, mining activities, agricultural return flows, and household and industrial waste. Although there has been a trend of increasing wastewater discharge volumes in recent years, that discharge is mainly carried out without treatment. Based on the results of many studies, it is proposed to set the amount of payment for wastewater discharges using a cost-based approach. It is to set fairly high rates, compensating for all costs incurred by the system that carries out emissions, to differentiate them according to industrial and domestic wastewater and different sectors of the economy, and to provide tax incentives to those economic entities that reuse wastewater several times after processing. Monitoring the quality indicators of wastewater will enable their multi-purpose use: as fertilizer, biogas, raw material in the production of building materials, the use of dry sludge for soil reclamation, landscaping of landfills, and restoration of the relief of plains.

-biofuels from renewable raw materials are considered promising among alternative energy sources. The Republic of Armenia, as a country highly dependent on imported energy resources, has attached importance to the development of the biomass sector, which will simultaneously solve several social, environmental, and economic problems. In this regard, the RA Government has made amendments to its Resolution No. 48-L dated January 14, 2021, outlining possible sources of biomass in the Republic of Armenia. Since briquetting plants operating in Armenia are mainly specialized in the raw material base of the vegetative mass of grain crops, the environmental and economic benefits of biofuels obtained from the cultivation of winter wheat have been considered.

Environmental benefit: burning every 1000 ha of straw releases 500 kg of nitrogen oxides, 370 kg of hydrocarbons, 3 tons of ash, and 20 tons of carbon dioxide into the atmosphere. Meanwhile, 1000 kg of straw can produce 700 kg of biofuel, which can be used in diesel-powered vehicles, reducing the amount of emissions into the atmosphere during engine operation.

Economic benefit: according to the RA Agricultural Commission data, in 2023, 175.2 thousand tons of winter wheat and 262.8 thousand tons of straw (expressed with a residual yield factor of 1.5) were obtained from 70105 ha of sown area. Considering that about 50% of the resulting straw is used as fodder, the actual amount of biomass will be 131.4 thousand tons. It is estimated that each 1 kg can provide 15 MJ of energy value when converted into briquettes. The additional income from the sale of biomass for 20 AMD/kg to briquetting points will amount to 2.628 billion AMD.

Within the framework of the theme "The Issues of Ensuring Macroeconomic Balance in the Republic of Armenia" (Sup.: cand.(econ.) E.Hakobyan) the following has been proposed:

- the Central Bank of Armenia should develop and implement new methods and technologies for forecasting and analyzing economic data, using machine learning algorithms to optimize monetary policy and make decisions in real-time. Such innovations can significantly improve the effectiveness of monetary policy and contribute to more accurate forecasting of macroeconomic indicators, which will ultimately make the economy more resilient to external shocks and changes.
- the use of monetary policy tools in the Republic of Armenia is visible, which cannot be said in terms of fiscal policy. In particular, it is possible to increase the tax burden on "overheated" sectors, i.e. services, trade, and finance, by amending tax legislation, applying more efficient tax administration, reviewing tax thresholds and privileges, and introducing progressive taxation methods. As a result, the state will receive more tax revenue and the opportunity to distribute resources, which should be directed to the implementation of important measures aimed at developing the potential of the economy: the implementation of large-scale capital projects contributing to the development of infrastructure or the repayment of external state debt.

Institute of Philosophy, Sociology and Law

Major achievements

Within the scope of the topic "Philosophical, socio-political and legal issues of the Armenian society (history and modernity)" (Sup.: cand.(polit.) E.Ordukhanyan) research has been conducted in four scientific directions: philosophy, sociology, law and political science.

The most important results of the Institute include the study of the theory and history of Armenian philosophy, modern legal historical and theoretical problems, key geopolitical processes and civilizational problems occurring in the Republic of Armenia and the South Caucasus region, as well as the study of new social and political realities and challenges in Armenian society. It is important to highlight:

- the study of the historical and philosophical issues of the model of Armenian national education, from the early Middle Ages to the Modern period (DSc (philos.) R.Mirumyan, cand.(philos.) L.Sarvazyan),
- the research of religious and legal concepts in ancient civilizations and problems of the origin and historical development of law (ancient and middle ages), as well as the study of the nature and axiology of law (DSc (law) H.Safaryan, cand.(law) L.Malkhasyan, cand.(law) A.Ikilikyan),
- the comprehensive study of issues of geo-strategy and civilizational identity of Armenia (DSc(polit.) L.Shirinyan).

Outcomes of applied developments

The Director of the Institute E.Ordukhanyan participates as an expert in the work of the Advisory Committee of the Council of Europe Convention for the Protection of National Minorities and the Head of the Research Group D.Hakobyan participates as an expert in the work of the UN Working Group on the Rights of Rural People and Persons Living in Rural Areas.

A number of researchers of the Institute participate in the development of the project "Armenia Transformation Strategy 2050" in relevant areas.

Some scientific results of the Political Studies Department, related to regional security issues and conflict resolution, have been regularly presented to the relevant state bodies of the Republic of Armenia.

Some researchers of the Political Studies Department and the Research Group on Internationalization of Law and Comparative Legal Studies regularly present their analyses and

proposals regarding the organization of the legal and political life of the state in the public expert-analytical platforms.

In order to popularize the Institute and its fundamental scientific directions, the third cycle of scientific lectures has been filmed, which is widely spread on the YouTube channel of the Institute.

Some employees of the Department of State and Legal Studies have periodically provided free legal consultations to forcibly displaced people from Nagorno-Karabakh.

The POLITNOMOS, Journal of Political and Legal Studies, English scientific journal founded by the Institute has been included in the international scientometric databases such as Google Scholar, Semantic Scholar, Crossref, Scispace, Yubetsu Shibata. Work on including the journal in the international scientometric databases Scopus and Web of Science is in process..

Institute of Arts

Major achievements

Within the framework of the basic project "Complex Study of Armenian Art" (Sup.: DSc(arts) A.Asatryan), the work on the study of the prominent Armenian film director Sergey Parajanov's life and creative activity, evaluation of his legacy and determining his role in Armenian and world film art has continued. To arrange the events marking the 100th anniversary of Sergey Parajanov's birth, the international academic conference "Sergey Parajanov – 100" was organized. The coverage of topics and the geography of participants were unprecedented. The collection of conference proceedings, published subsequently, became an important phase both in Armenian art studies and international Parajanov studies.

Within the framework of the basic project "Complex Study of Armenian Art" (Sup.: DSc(arts) A.Asatryan), the work on the study of contemporary art has continued. For the first time, a comprehensive research of the oeuvre of the composer Tigran Mansuryan has been accomplished (Sup.: DSc(arts) A.Arevshatyan). A.Arevshatyan's monograph "Tigran Mansuryan" will be published by NAS RA "Gitutyun" Publishing House.

Outcomes of applied developments

Within the framework of the basic project "Complex Study of Armenian Art" (Sup.: DSc(arts) A.Asatryan) and publication of the spiritual legacy of Armenian classics as part of it, the work on the 2nd edition of Komitas's oeuvre has commenced, and the 1st volume has come out, including Komitas's solo songs with piano accompaniment.

The textbooks for "Music" subject taught in the 6th and 8th grades of secondary schools have been published (Sup.: cand.(arts)T.Shakhkulyan).

4 issues of the illustrated popular-science visual art magazine "Roslin" have come out (editor of the Art section DSc(arts)A.Asatryan), most of the articles are authored by researchers of the Institute.

The radio program series "Identity" of the Ararat Patriarchal Diocese, broadcast on the Public Radio of Armenia with the participation of the Institute specialists, aims to popularize the results of art studies.

International Scientific-Educational Center

Major achievements

The processes aimed at the internationalization of the International Scientific-Educational Center of the National Academy of Sciences (ISEC NAS RA) have continued. Collaborative ties with partner organizations have been expanded, and new international mobility programs have been introduced. Specifically, 10 international and external cooperation agreements, memoranda, and contracts have been signed with various universities, scientific organizations, and other institutions.

ISEC NAS RA has been included for the first time in the *HE Higher Education Ranking*, securing the 233rd position out of 303 participating universities. This accomplishment represents a significant milestone for the institution (https://ranking.heranking.com/2024/isec.am).

Emphasizing the importance of further strengthening the university-scientific organization-employer nexus, the direct involvement of employers in the educational process, and the subsequent development of students' practical skills, ISEC NAS RA has established the Department of "Plant Diversity and Ecosystem Studies" at the NAS RA A. Takhtajyan Institute of Botany. Master's program 051101.02.7 – "Biodiversity Studies and Conservation" has been developed, documented, and patented, with admissions commencing in the 2024-2025 academic year. Notably, other universities in Armenia do not offer this program at any level of education, further highlighting the significance of its implementation. The program will utilize both classroom and material-technical resources of ISEC NAS RA and those of the NAS RA A.Takhtajyan Institute of Botany, including state-of-the-art laboratories and three botanical gardens.

ISEC NAS RA has continued the publication of the **"**Katchar" Scientific Periodical, which is included in the list of scientific journals recommended by the Supreme Certifying Committee (SCC) of Armenia, as well as the Popular Science Magazine "In the World of Science". In the reporting year, the faculty of ISEC NAS RA has published 1 educational manual, 4 monographs, one of which was published by a publisher indexed in the "Web of Science" database, and 44 scientific articles, with 7 of them appearing in scientific journals indexed in the "Scopus" and "Web of Science" databases.

Outcomes of applied developments

Auditoriums at ISEC NAS RA have been technically upgraded with computers and projectors. Notably, all auditoriums at the Center are now fully equipped with modern technology. The video conferencing platform linked to the remote learning system at ISEC NAS RA, available at https://conference.isec.am/, has been updated with enhanced security and necessary software packages. Additionally, the remote learning platform itself has been upgraded, and its domain name has been changed to https://online.isec.am/, thereby expanding the tools and capabilities for organizing distance learning.

ISEC NAS RA has participated in the Erasmus+ capacity-building program "Development of Aquaculture and Fisheries Education for Green Deal in Armenia and Ukraine: from Education to Ecology (AFISHE)" program. A new laboratory has been established at ISEC NAS RA, located within the Scientific Center of Zoology and Hydroecology of NAS RA. The activities and achievements of ISEC NAS RA within the program have been presented in Croatia and Portugal. Faculty representatives have participated in two-week professional training sessions at the University of Porto and Dubrovnik. A visit has been organized to the "Sevani Ishkhan" CJSC fish-breeding enterprise located in Karchaghbyur village, RA Gegharkunik region, to explore opportunities for organizing students' research and practical activities. Additionally, a series of training sessions have been conducted at ISEC NAS RA to enhance teaching skills. Course learning materials have been developed and approved as part of the program.

ISEC NAS RA administration and faculty have travelled to the RF, Italy, Poland, Georgia and Turkey, participating in various training programs, conferences, youth forums, and scientific gatherings both in Armenia and abroad. As part of the Erasmus+ program, the Center has carried out student, faculty, and administrative staff exchange programs with 12 European universities.

During the reporting year, lecturers from the University of Prešov (Slovakia), St Cyril and St Methodius University of Veliko Tarnovo (Bulgaria), Federico II University of Naples (Italy), and

National Research University 'Higher School of Economics' (Saint Petersburg) have delivered lectures at ISEC NAS RA.

ISEC NAS RA students, as part of the Erasmus+ International Credit Mobility program, have studied at universities abroad, including the University of the National Education Commission, Krakow (Poland), St Cyril and St Methodius University of Veliko Tarnovo (Bulgaria), University of Tromsø (Norway), University of Lille (France), International Telematic University Uninettuno (Italy), and University of Bologna (Italy).

To enhance and develop the involvement of ISEC NAS RA in the rankings of top universities, the Center successfully facilitated the integration of Armenian-speaking lecturers from abroad into the academic process during the reporting year.

Significant efforts have been made to ensure the alignment of the Vocational Education Programs (VEPs) with the expected learning outcomes and the national qualifications framework (NQF) and state educational standards. As a result, the program curricula have been harmonized with the NQF.

Building on previous years' experience and based on relevant regulations, research has been conducted on the assessment of educational programs by graduates and the evaluation of internships organized by ISEC NAS RA. Surveys have been conducted to assess the satisfaction of graduates regarding the integration of research activities and the academic process. A total of 107 students participated in the research. Training on the topic of "Improvement, monitoring, and quality assessment of vocational education programs" has been organized and conducted (with the trainer being the director of the National Center for Professional Education Quality Assurance (ANQA), R.Topchyan). Regular meetings and discussions have been held with employers, during which feedback has been collected and analyzed. In the reporting year, the opinions of major employers in the fields of "Geology" and "Oriental Studies" VEPs have been studied.

National Bureau of Expertise SNPO

Major achievements

The Organization has continued publishing a scientific periodical entitled "Armenian Journal of Forensic Expertise and Criminalistics". The 11th and 12th editions of the periodical have been published, including 32 peer-reviewed articles.

An international scientific and practical conference was held in Yerevan in September entitled "The Role and Significance of Forensic Expertise in the Legal System, Current Problems, Development Trends and Prospects", dedicated to the 20th anniversary of the establishment of the "National Bureau of Expertises" SNPO of NAS RA. Conference was attended by high-ranking officials from state departments of the Republic of Armenia, heads of law enforcement, scientific and educational institutions from the Republic of Armenia and more than two dozen countries of the world (including the USA, Russia, Switzerland, Germany, Romania, Moldova, Israel, etc.), as well as reputable doctors, judges, scientists, lawyers, international human rights defenders (about 300 participants).

The Organization, together with leading consulting organizations "GTH DNA Consulting Company" (USA) and "Eura DNA, Europe's premier forensic DNA resource" (EU), as well as INTERPOL, held an international regional conference entitled "Advancing Forensic DNA Database Programs in Armenia" in Yerevan, which was dedicated to the formation of a forensic DNA database in Armenia in accordance with the advanced international requirements, and current theoretical and practical issues in this field. Within the framework of the event, internationally recognized leading experts from the US, EU, Georgia and other countries presented international experience and modern approaches to database formation, the prospects for DNA database creation programs in Armenia, including international best practices in legal regulations for the process of DNA data storage.

It is worth noting the replenishment of the atomic absorption spectrometers of the GTA 120 Graphite Tube Atomizer model and the 55 AA Atomic Absorption Spectrometer model of the Agilent Technologies company with a combined microwave multifunctional research station, with its corresponding equipment and the development and implementation of a research method, which allows conducting expert research aimed at determining the atomic composition of various objects of

food, biological, botanical origin and other researchable objects, as well as for fast, accurate, safe and highly efficient sample preparation, with the development and implementation of modern scientifically substantiated methods aimed at providing innovative technical tools and research methods in accordance with modern scientific requirements in forensic practice.

In order to supplement and expand the expert research capabilities, the Organization has carried out work on the installment and introduction of modern scientifically substantiated chromatographic-mass-spectrometric methods, as well as the testing and application of optimal sample preparation methods. The latter gives grounds to state that the Organization is the only expert institution in the Republic of Armenia, where both material science expertise aimed at detecting narcotic drugs and psychotropic substances is carried out with simultaneous full disclosure of the entire chain from producer to consumer, as well as qualitative and quantitative expert research of narcotic drugs, psychotropic substances and medicines in the living environments of the human body - in urine, blood, as well as, for the first time in the Republic of Armenia - in hair, nails, sweat, saliva and internal organs.

New research methods and methodologies have been developed and implemented in the Organization in separate areas, and various research works have been carried out with their application, providing scientifically substantiated results. In this regard, it is especially important to note the methodology used in the field of ecological expertise, developed and published jointly with the Scientific and Practical Center of the State Committee for Forensic Expertise of the Republic of Belarus, which concerns the clarification of the circumstances of anthropogenic impact on the environment or its individual components using calculation and analytical methods.

The Organization has signed memorandums of cooperation with the A.N.Frumkin Institute of Physicochemistry and Electrochemistry of the Russian Academy of Sciences, the leading American consulting organization “GTH DNA”, the Kharkov Research Institute of Forensic Examinations named after Professor N.S.Bokarius of the Ministry of Justice of Ukraine, as well as with the Association of Forensic Experts of Romania, “Titu Maiorescu” University, the Center for Research on Belarusian Culture, Language and Literature of the NAS of the Republic of Belarus, and the National Forensic Institute of India.

Outcomes of applied developments

Within the framework of the state procurement contract for the provision of services for the needs of the state in the accounting period, 14,773 forensic expertise has already been carried out, with a total value of 861,304.5 thousand AMD.

The Organization's units have also conducted 152 expertise / 376 objects examined/ within the framework of civil proceedings, 37 expertise /108 examined objects/ within the framework of administrative proceedings, 2 expertise /3 examined objects/ on the basis of the decisions of the court of bankruptcy, 71 expertise /715 examined objects/ with the RA Prosecutor's Office within the framework of the state procurement contract ’’For the provision of services for the needs of the state ՆՀԳԴ-ՄԱԾՁԲ ’’ (in cases of illegal enrichment), as well as 93 expertise /646 examined objects/ based on contracts concluded with individuals and legal entities within the framework of civil law relations.

STATE TARGET PROGRAMS

Creating Could Computing Environment for the Solution of Scientific and Applied Problems

Coordinator V.Sahakyan, cand. (phys.-math.), Institute for Informatics and Automation Problems

The program aims to address the problems of natural sciences (hydrometeorology, ecology, seismology, biology and medical genetics) and develop a cloud infrastructure using the capabilities of the national research electronic infrastructure.

Leading specialists from the Institute for Informatics and Automation Problems, the Institute of Geophysics and Engineering Seismology after A.Nazarov, the Institute of Physiology after L.Orbeli, the Institute of Molecular Biology, the International Scientific and Educational Centre and the Ministry of Environment of RA have taken part in the program.

In the reporting year, research has been conducted to develop serverless high-performance computing infrastructures. Specifically, efforts have been made to integrate high-performance computing clouds (HPC over cloud) with supercomputing resources, and experiments have been carried out to evaluate and develop containers that can be operated by the Slurm queue system using the Singularity package. Additionally, distributed environments have been created using the Kubernetes package. The efficiency of the Kubernetes agent has been assessed in comparison to the Slurm agent for certain workflows. A pilot Function as a Service (FaaS) environment has been developed, enabling users to create functions using various programming languages. To optimize scientific computing tasks, a multi-modular platform has been developed, which can simultaneously consider multiple attributes, including productivity, costs, CPU and memory usage, scalability, and more. The platform has been tested on satellite image processing tasks with different throughput sizes and infrastructure types. Research on scientific computation optimization has included the storage and processing of large graphs, as well as the parallel solution of linear algebra problems.

Research activities have continued in the field of meteorology, including studies on changes in climate extremes in Armenia and the South Caucasus, improving drought monitoring in Armenia, and short-term forecasting of hazardous weather phenomena using numerical weather prediction models.

In the field of environmental protection, leveraging the experience of creating a unified electronic platform for managing atmospheric emissions, work has been carried out to develop an electronic platform for waste management.

In the field of seismology, efforts have been made to design an operational “smart” earthquake early warning system and to develop programs for calculating the activation time of tectonic faults.

In the field of biology, work has continued on computer modelling of complex systems, in particular, on the modelling the lipid bilayer/transmembrane integrin complex biological system. Resources have been evaluated from the perspective of energy efficiency, and by adjusting several parameters of the software package; attempts have been made to optimize the performance-to-energy consumption ratio. This year, in addition to the previously used computational resources, the computational resources of the "Aznavour" supercomputer have also been utilized.

In the field of medical genetics, research has been carried out on the distribution of genetic variants in the Armenian population.

The results obtained during the implementation of the state target program have been published in 12 articles.

The results obtained during the project have been presented at the conference attended by about 40 specialists in relevant fields.

Factors of the Armenian gene pool stability

Coordinators A.Arakelyan, DSc(biol.), director of the Institute of Molecular Biology, L.Yepiskoposyan, DSc(biol.)

The IMB archive of paleoanthropological material collected on the territory of Eastern Armenia has been updated. Based on the results of sequencing of complete genomes and exomes of

modern DNA samples, the geographical distribution of genetic variants in the Armenian population (draft genome) has been mapped.

Practical (commercial) grade titanium based alloys synthesis by Hydride Cycle method

Coordinator D.Mailyan, cand.(chem.), Institute of Chemical Physics after A.Nalbandyan

The synthesis process of multifunctional, multicomponent titanium-based alloys—Ti-4Al-Nb-1Zr-0.5Sc-0.5Co, Ti-4Al-Nb-1Zr-0.5Sc-0.5Ni, Ti-3Al-1Nb-2Zr-3Co, and Ti-3Al-1Nb-2Zr-3Ni—using the "Hydride Cycle" (HC) method has been investigated. The required quantities of TiH_2, $(Ti+V)H_{1.7}$, ZrH_2, $NbH_{0.99}$, and $ScH_{1.65}$ hydrides have been synthesized by self-propagating high-temperature synthesis (SHS). The influence of alloy formation process parameters on their characteristics, including crystal structure, microstructure, density, and hydrogen absorption, has been studied. Key regularities in alloy production by the HC method have been identified, such as the effects of temperature, heating and cooling rates of the initial mixture, the duration of maintaining the maximum heating temperature, reaction mixture composition (ratios of hydrides or alloying metals to metal hydrides), and the pressing force applied to the initial mixture. Optimal parameters for producing these alloys under laboratory conditions have been determined: a temperature of 1050°C, process duration of 1.5 hours, and a pressing force of 250 kN. X-ray phase analysis (XRD) reveal that, depending on the composition, either single-phase α-alloys (hcp structure, space group: 194: $P6_3/mmc$) or two-phase α + β (bcc structure, space group: 229: Im-3m) alloys are formed. The crystal lattice parameters of the phases have been determined based on XRD data. The process of synthesis of hydrides from the obtained alloys with high hydrogen content by the SHS method has been studied. The maximum hydrogen capacity in the synthesized hydrides is 3.36 wt.%. The synthesized alloys are applicable in the biomedical field due to their enhanced biocorrosion resistance and improved cell adhesion.

Development of radiation-resistant and protective from lazer location glassy and composite materials

Coordinator N.Knyazyan, DSc(tech.), Institute of General and Inorganic Chemistry after M.Manvelyan

The glass formation regions and stability of glasses in the systems ZnO/CdO/PbO-B_2O_3/Bi_2O_3-Al_2O_3-SiO_2, CaO/SrO/BaO-B_2O_3/Bi_2O_3-Al_2O_3-SiO_2 have been studied, as well as the crystallization fields of phases. Improved glass-like materials with radiation resistance and radiation shielding properties, as well as new glass-ceramic and composite materials with high density values of 3.5–4.7 g/cm³, have been developed. Research on γ-ray radiation (0.5–1.25 MeV) and fast neutron radiation (15–50 MeV) for the developed materials has been carried out to study their absorption and interaction with these radiations. Based on the linear attenuation coefficient data, the synthesized materials stand out due to their high ability to attenuate gamma radiation (137Cs with energy of 661.7 keV and 60Co with energies of 661.7, 1173, and 1333 keV have been used as radiation sources). The analysis of the obtained data shows that at energies of 661.7, 1173, and 1333 keV, the samples have a high μ coefficient. A decrease in the μ coefficient is also observed with an increase in photon energy.

Studies have been conducted on the absorption of fast neutron radiation by the developed materials. To study the radiation impact on the presented samples, they have been placed in containers with fast neutron sources and irradiated for 18 days. It has been found that the developed materials are stable under the effect of fast neutron radiation during this period. The reduction in the intensity of the neutron flux has been calculated based on the total effective cross-section values of the nuclei of the elements.

The main directions of the comparative study of the Armenians in their own and other national environment: challenges and prospects of the research

Coordinator R.Karapetyan, cand.(hist.), Institute of Archaeology and Ethnography

Within the framework of the project "The Main Directions of Comparative Research of the Armenians in Their Own and Foreign Environment: Problems and Perspectives of the Study," implemented as part of the state-targeted program funded by the Higher Education and Science Committee of the Republic of Armenia (2021–2025), the Institute's research group has continued its cooperation with scientific centers in 13 countries (Russia, Belarus, Kyrgyzstan, Lebanon, Kuwait, Great Britain, Germany, France, Portugal, Belgium, the Czech Republic, Ukraine, and the USA) on relevant issues. As a result of the research, a theoretical and comparative foundation has been established for interpreting the integration of Armenian communities. Based on the analysis of the obtained materials, expert proposals have been submitted to various departments of the Republic of Armenia. The research results have been published in both international and local journals.

Application of traditional cultural heritage manifestations in policy: opportunities and proposals

Coordinator H.Kharatyan, cand.(hist.), Institute of Archaeology and Ethnography

Within the framework of the project, implemented as part of the state-targeted program funded by the Higher Education and Science Committee of the Republic of Armenia, a group of eight researchers have conducted research primarily on the "governance, public, political, production, and consumer market" component. The amendments to the RA Law "On Commemoration and Holidays" made after 2018 have been studied in detail. Seven amendments have been identified, introducing new commemorative days, including "Armenian Cinema Day", "Taxpayer Day", "National Minorities Day of the Republic of Armenia", and "Day of Remembrance of the Victims of the Sinjar Yezidi Genocide". Additionally, the article of the law stating that "The Day of Commemoration of the Dead following the Feast of Christmas and the Epiphany is celebrated on January 7, a non-working day" was declared invalid.

The project team has visited all regions of the Republic of Armenia, meeting with regional governors, heads of two or three enlarged communities in each region, and cultural organizers in the regions and communities. They have also met with the management of regional museums, school principals, teachers, local public organizations, and regional libraries to discuss their roles in organizing festivities and to explore the applicability of potential scenarios being proposed. In principle, agreements have been reached on cooperation regarding the RA Law on Holidays and festivities not currently included in the law.