**NATIONAL ACADEMY OF SCIENCES**
**OF THE REPUBLIC OF ARMENIA**

# R E P O R T
# ON MAJOR RESEARCH OUTCOMES
# FOR 2016

## DIVISION OF MATHEMATICAL AND TECHNICAL SCIENCES

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

The Division of Mathematics 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 14 academicians, 9 corresponding members, 28 foreign members as well as 5 honorary doctors.

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

At the annual general meeting held on 12 April N.Arakelyan's report "On the main scientific and scientific-and-organizational results of the Division for the 2015 year" was approved. Scientific reports of foreign members of NAS RA S.Adian (RF), A.Manzhirov (RF), as well as DSc(phys.-math.) V.Hakobyan (Institute of Mechanics), DSc(phys.-math.) S.Pogosyan (Institute of Mathematics), cand. (tech.) H.Ascatryan (Institute for Informatics and Automation Problems) were presented at the meeting.

At the annual general meeting held on 28 June the elections of the academician- secretary of the Division were held. Academician L.Aghalovyan was elected as the academician-secretary of the Division.

At the annual general meeting held on 8 July the new staff of Bureau and the scientific secretary of the Division were elected.

In 2016 9 meetings of the Bureau of the Division were held. The following was considered and approved: the reports of the institutions of the Division for the year 2016, including the programs of basic funding; the working plan of the Division for 2016 year; the number of the postgraduate vacancies and their distribution among the institutes for 2016-2017 academic year; the results of admission to the postgraduate school, research advisers and scientific topics of the postgraduate students; the decision project of the general meeting for the reporting year; applications on maintaining of scientific objects of national value for 2017 as well as on state target programs. The main results of the scientific organization of the Division, the results of the international and local conferences, organized by the Division institutes, issues on provision and on the results of the scientific trips, anticipated applied development of the institutions of the Division for the 2016-2020 years, the rating process of the productivity of the institutions of the Division as well as some other scientific-and-organizational issues were discussed.

The following scientific journals are published on the Division specialties: "Proceedings of NAS RA. Mathematics" (6 numbers ), "Proceedings of NAS RA. Mechanics" (4 numbers), "Proceedings of NAS RA. Technical Sciences" (4 numbers), as well as the electronic "Armenian mathematical journal" (2 numbers).

196 scientific articles ( including 96 abroad) and 70 conference abstracts ( including 10 abroad) were published in 2016 by the researchers of the institutes of the Division, as well as 11 monographs (including 7 abroad), 2 collections of scientific articles and 2 tutorials (including 1 abroad).

The institutes of the Division have organized 9 scientific conferences .

1 Doctoral and 9 Candidate's dissertations were defended by the researchers of the institutes. 9 Candidate`s dissertations were defended at the Scientific Councils of the institutes of the Division.

A number of projects on international grants have been implemented in the institutes of the Division.

In December of the reporting year annual report meetings of the institutes were held, the reports of the institutes for 2016 year were discussed and approved.

### Institute of Mathematics

#### *Major achievements*

Necessary and sufficient conditions under which the conditional distribution of the random field is Gibbsian have been obtained. A definition of the potential energy (without using the concept of the interaction potential) has been offered which gives a possibility to justify the Gibbs formula. These results

are an important part of the currently developing general theory of Gibbs random fields (Sup: acad. R.Ambartsumian).

## Institute of Mechanics

### *Major achievements*

By the method of pseudofunctions for stresses under antiplane deformations for non-linear creep theory the closed (exact) solution of mixed boundary value problem for half-space in case when the coupling between the intensities of the velocity of stresses and strains has a power form has been constructed. At the same time the component of deformation rate has been given on an endless strip, located on the boundary plane of the half-space, and shear stresses are zero outside the strip. Based on a comparative analysis of the exact solution and the generalized principle of N.Harutyunyan for imposing deformation rates, the boundaries of the application of this principle have been detected (Sup: corr. member S.Mkhitaryan).

In the monograph "Applied theory for micropolar, multimodulus shells and plates", on the basis of Cosserat pseudo-continuum and expanded hypothesis the applied theory of thin shells, membranes and plates has been constructed. The simplest model for calculation of thin structural elements, exploring a wide class of problems, has been offered. A substantial influence of the micropolar and multimodulus materials on strength characteristics and frequency of different types of vibrations of structural elements has been stated (Sup: acad. S.Hambartsumyan).

### *Outcomes of applied developments*

A device designed for the study of strength and deformation behavior of soils under the influence of a controlled cyclically varying the frequency of forced torque of various levels has been constructed.

Main parameters of the device: frequency cyclic torque of oscillation – 1-20 Hz; maximum value of torsional deformation – up to 20mm ( corresponding to standard); maximum torque value – 16,1 kilogram-force x m. The device is run safely (Sup.: DSc(tech.) K.Karapetyan).

## Institute for Informatics and Automation Problems

### *Major achievments*

The rotor-router model on infinite square lattice and semi-infinite cylinder representing the process of quasi-random walk of a particle (information) has been investigated. Set of labeled vertices which generated closed loops by rotors have been taken into consideration. The sequence of labels in the rotor-router walk was conjectured to form a spiral structure obeying asymptotically an Archimedean property. We have shown that the spirals are directly related to tree-like structures which represent the evolution of the cluster of vertices visited by the walk. We have shown that in case of square lattices, the average number of visits to the origin $\langle n_0(t)\rangle$ by the moment $t \gg 1$ is $\langle n_0(t)\rangle = 4\langle n(t)\rangle + O(1)$, where $\langle n(t)\rangle$ is the average number of rotations of the spiral (Sup: cand.(phys.-math.) V.Pogossyan).

### *Outcomes of applied developments*

Methods and software have been developed for calculating heart rate based on the analysis of the human face video (Sup.: DSc(phys.-math.) H.Sarukhanyan).

The software system of “Test Quality Analysis” has been developed which implements test quality analysis and evaluation in two languages, runs on the server, has a web-based simple and accessible user interface. The module which calculates the statistical and mathematical indicators can be considered as a separate component of the system and can also be used as a computer desktop application. The developed system can be applied in various operating system environments (Sup.: DSc(phys.-math.) M.Haroutunian).

### Department of Hydromechanics and Vibrotechnics

#### *Major achievments*

Opportunities to use the wind power as a renewable source of energy and an alternative to the hydrocarbon energy comprise a topical issue. To achieve this goal a wind power plant comprised of a wind turbine, an alternating current generator, automatics and auxiliary components that transforms the wind power into electric energy has been proposed (Sup.: cand(tech.) G.Avetisyan).

#### *Outcomes of applied developments*

Based on the results of theoretical and experimental research a wind power plant using a wind turbine with a vertical axis of rotation and an output of 20 kW has been designed, manufactured and installed per order of the "Energotechnics" CJSC. The wind power plant has been patented in the Republic of Armenia (patent № 3029A).

Development of different modules of a wind turbine of this type to create a wind farm that would work in parallel to the general electric network is planned. (Sup.: cand(tech.) G.Avetisyan).

## DIVISION OF PHYSICS AND ASTROPHYSICS

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

The Division of Physics and Astrophysics includes the Byurakan Observatory after V.Ambartsumian, the Institute for Physical Research, the Institute of Applied Problems of Physics, the Institute of Radiophysics and Electronics, the International Center for Relativistic Astrophysics Network - Armenia and "Galaktika" CJSC.

The Division includes 10 academicians, 13 corresponding members and 30 foreign members.

During the reporting year 2 general meetings were held.

At the annual general meeting held on April 12 the academician-secretary of the Division Ju. Chilingaryan presented the main results of the scientific and organizational activities of the Division for 2015. Scientific reports were made by NAS RA foreign members P.Sukiasyan (France) "Nanochemistry at epitaxial graphene and Silicon Carbide surfaces and interfaces", A.Sedrakyan (Germany) "Searching for invisible dark matter with stars", V.Saryan (RF) "Ways of increasing the potential of the existing systems of global natural and anthropogenic processes monitoring and the possibility of creating an accessible network between biological and inert objects of the Earth", A.Baghdasaryan (RF) "Acoustoelectronic devices in the communication, radiolocation and telecommunication systems. Russian and Armenian priorities", academician A.Mkrtchyan "Elementary particle optics", DSc(phys.-math.) Zh.Gevorgyan "Bloch states of porous metal passage of light", DSc(phys.-math.) A.Manukyan "Preparation of metal nanoparticles in carbon structures and their application fields", DSc(phys.-math.) T.Movsisyan "The first scientific results from the updated class Byurakan Schmidt telescope".

At the general meeting held on 28 June academician R.Kostanyan was elected as the academician-secretary of the Division. A new Bureau staff was elected.

During the reporting year a number of national and international scientific events have been held, international cooperation in the scientific organizations of the Division has expanded, new agreements have been signed, cooperation between scientific and educational institutions has continued.

The work on the control system of 2.6 m telescope of Byurakan observatory carried out by "Galactica" CJSC has been fully completed. The modernization of Schmidt class telescope has been substantially completed.

The president of NAN RA academician R.Martirosyan was elected as a foreign member of the Russian Academy of Sciences. Academician A.Mkrtchyan was awarded with Special Gold Prize of the Eurasian Creative Union "Science". Academician E.Ghazaryan won the Annual International Scientific Prize of the

Joint Institute for Nuclear Research (Dubna, Russian Federation). Correspondent member A.Ishkhanyan and T.Ishkhanyan won the President's Award in the field of Physics.

During the reporting year the Division held 9 meetings of the Bureau and 3 meetings of the Directors of the institutes. The discussed topics in particular were related to the increase of efficiency of scientific works, the expansion of the research that has applicable significance, the development of regulations and standards of attestations and the issues related to the assessment of the works of organizations. Attestation of scientific personnel has been conducted.

6 Candidate's dissertations were defended by the researchers of the institutes.

The institutions of the Division have received 6 licenses, 273 articles (including 177 abroad), 99 theses (68), 2 monographs and 2 manuals have been published.

In December of the reporting year annual reporting meetings were held in the scientific organizations of the Division, the reports on scientific and organizational activity in 2016 were discussed and approved. The Publishing Board of the journal "Proceedings of NAS RA. Physics" was discussed and approved.

The following scientific journals are published on Division specialties: "Proceedings of NAS RA. Physics", "Astrophysics" as well as the electronic "Armenian Journal of Physics".

## Byurakan Astrophysical Observatory after V.Ambartsumyan

### *Major achievements*

A new method of "linear packages" (LP) to solve the classic "passing-reflection" nonlinear problems of radiative transfer for an absorbing-radiant one-dimensional anisotropic medium with a geometric thickness has been designed. Due to this, with the help of new elementary linear combinations of the LP an explicit solution for the study of the nonlinear problems has been determined. For the calculation of the new LP, providing the solution of the mentioned above nonlinear problems three methods of known invariant approximations have been developed: the sum of layers, invariant summation, and Ambartsumyan's functional equations (Sup.: cand. (phys.-math.) H.Pikichyan).

On the basis of spectral data of SDSS DR7-DR8-DR9 the uniform spectral classification of galaxies Markarian 779 has been first accomplished, which makes it possible to clarify the spectral classes and subclasses of numerous galaxies, as well as to carry out their statistical study. By using the SDSS DR12 specters the physical parameters to about 300 Markaryan galaxies have been determined, namely, the electron density, metallicity, the column density, the excitation and the dust content (Sup.: cand. (phys.-math.) A.Mickaelian).

In the galactic halo more than 4500 new carbon and long-periodic M-type stellar objects have been discovered. On the plates of FBS survey R Coronae Borealis (RCrB) star has been detected, which has a variability in an optical range of more than 10 magnitudes (FBS 2213 + 421). In two-color WISE diagram the carbon stars of different subclasses have been first separated. The second revised version of the "FBS Late-Type Stars" catalog has been compiled (Sup.: cand. (phys.-math.) K.Gigoyan).

In the stellar association Cyg OB7 26 new emission stars have been identified. It has been shown that most of them on two-color diagram (J-H / H-K) are located in the area of the classic and weak T Tau objects. One of these stars shows a variability (Sup.: cand. (phys.-math.) N.Melikian).

It has been observed that a young star EXor V1118 Ori has increased in brightness in 2014-2016 period. The brightness of the object increased from V=17.1 and reached up to V=13.8 on 13.11.2015 (Sup.: corr. member E.Parsamyan).

## Institute for Physical Research

### *Major achievements*

Faraday effect has been studied in Rb and Cs nanocells for the region of atomic vapor thickness $L$ = 40 - 900 nm. A red shift of the signal peak in the Faraday rotation spectrum has been observed in Rb cell for $L$ = 45 nm, caused by Van der Waals interaction between the Rb atoms and sapphire windows. From the measured peak shift value of −180 MHz, the interaction coefficient $C_3 \approx -1 \pm 0.1$ kHz×mcm$^3$ has been determined for $6S_{1/2} \rightarrow 6P_{1/2}$ transition (Sup.: DSc (phys.-math.) D.Sarkisyan).

The third independent potential exactly solvable by hypergeometric functions has been introduced after the Eckart and Pöschl-Teller potentials. The potential is an asymmetric step-barrier with variable height and steepness. For the problem of transmission above such a barrier a compact formula for the reflection coefficient has been derived (Sup.: corr. member A.Ishkhanyan).

A new approach for obtaining a variety of non-diffracting light beams has been proposed and realized based on coherent superposition of two Bessel beams with controllable separation. A non-diffracting $\lambda$ = 532 nm light pattern of 4-th order rotational symmetry has been formed by this method which has induced a quadrupole photonic structure in $Sr_xBa_{1-x}Nb_2O_6$ crystal. Formation and control of the solitons in such structures has been demonstrated (Sup.: DSc (phys.-math.) R.Drampyan).

Carbon-encapsulated superparamagnetic and single-domain ferromagnetic $Ni_2C$ nanocomposites have been synthesized by solid-phase pyrolysis technique. The dependence of morphology, structural and magnetic characteristics of the nanocomposites on the size and concentration of Ni nanoparticles in the carbon matrix has been studied (Sup.: cand.(phys.-math.) A.Manukyan).

### *Outcomes of applied developments*

A principally new method to obtain silicon-containing coating on aluminum surface has been developed and patented. A current of 0.0015 - 0.003 A/cm$^2$ density is applied between the aluminum sample plunged in water (cathode) and non-solvable and chemically water-immune conducting material (anode) for the period of 2 to 8 hours, depending on required coating layer thickness (Sup.: acad. R.Kostanyan).

A multilayer sensor for thermoelectric detector consisting of photon absorber, heat conducting and thermoelectric films has been suggested and patented. The photon absorber and heat conductor are superconductors, serving as electric contacts as well. Application of the invention in thermoelectric detectors can increase the photon registration speed (Sup.: cand.(phys.-math.) A.Kuzanyan).

A unipolar 1D1R-type memristive memory element (ReRAM) consisting of ZnO:Ga/ZnO:Li/ZnO heterostructure Schottky diode (1D) and Pt/ZnO/ZnO:Li/Al heterostructure memristor (1R) has been developed and fabricated by electron beam vacuum deposition technique. The characteristics of the laboratory samples of developed memory element have been studied (Sup.: cand.(phys.-math.) R.Hovsepyan).

A laboratory model sample of a new “tremorograph” device has been developed in collaboration with PSI company for neurological diagnostics. Features located in 3 - 16 Hz frquency region have been recorded while testing the device, consistent with the known literature data. Simultaneous usage of tremorograph with previously developed stabilograph allows to measure the complex characteristics of human neuro-muscular activity which is important in medical and sport domains (Sup.: DSc(phys.-math.) S.Gevorgyan).

## Institute of Applied problems of Physics

### *Major achievements*

The transition radiation from relativistic electrons has been investigated on a periodically deformed interface between two dielectric media. The most general case has been studied when the deformation depends on the time. It has been shown that instead of a single peak in the backward transition radiation on a flat interface for periodic interface one has a set of peaks (Sup.: acad. A.Mkrtchyan).

The phenomenon of ions and charged particles acceleration in specific systems at the presence of acoustic waves has been detected (Sup.: corr. member A.Mkrtchyan).

It has been experimentally shown that in the X-ray shortwave range at white beam spectrum it is possible to identify the beam with a wide angular and spectral distribution by using a temperature gradient and acoustic field applied to the single quartz crystal, pump it in the direction of the reflection and control the operating parameters of the beam in a large range (Sup.: cand.(phys.-math.) V.Kocharyan).

### *Outcomes of applied developments*

The acousto-plasma diode of different "Bell" forms has been developed for cleaning and creating metal shells (Sup.: acad. A. Mkrtchyan).

A new non- invasive method and appropriate device to determine the presence of cancer in biological objects have been developed. A new acousto-plasma vacuum evaporation method has been developed to synthesize composed media of different relative densities (Sup.: corr. member A.Mkrtchyan).

New composed ordered media based on silicon and aluminum oxides, with a certain percentage of noble and alkali metals have been synthesized. On the basis of synthesized new refractory materials detection-converters devices of visible and invisible ranges of electromagnetic wave have been developed (Sup.: cand.(phys.-math.) V.Nalbandyan).

In the framework of Mossbauer spectroscopy a unique signal analyzing system proceeding in amplitude and temporal mode has been developed (Sup.: cand.(phys.-math.) V.Margaryan).

Experimental studies devoted to the controlling of space-time characteristics of the reflected X-rays up to energies 100 keV under the influence of a temperature gradient in the quartz crystal have been continued.

Band-pass filters of the hard X-ray radiation with a large aperture and a space-time controlled features have been designed and created (Sup.: acad. A. Mkrtchyan).

## Institute of Radiophysics and Electronics

### *Major achievements*

Electrodynamics properties of 2D photonic crystals formed by rectangular holes with 0.7 mm x 0.7 mm cross section with lattice constant p = 1,15 mm in the Corderit ceramics having a bulk dielectric constant ε=5.2 have been investigated in 10÷75 GHz frequency range. It has been found that despite the small lattice constant($p \ll \lambda$) and the band gap absence in this frequency range, the 2D periodic structures are not described by the model of effective uniform dielectric permittivity.There is polarization rotation for normal incident waves to the direction of the air ducts in these media. The conditions for maximum rotation of polarization vector in a specified frequency range have been obtained. Compact rotators of polarization plane, combining the properties of dielectric antennas have been developed. Linear to circular polarization converter based on 2D structures has been developed. Thus, for the first time the ability to perform multi-function polarization-selective 2D microwave devices on ceramic materials has been demonstrated (Sup.: corr.member A.Hakhoumian).

Higher order statistics (HOS) has been used to differ moving object from the noise in CW radars. Finding coherent components in spectrum gives the opportunity for identification of moving targets from the clutter as well (Sup.: cand.(phys.-math.) T.Zakaryan).

The formation of indirect excitons on the border CH_3NH_3PbI_3/TiO2 semiconductors has been considered. Propagation of light in the dilute perforated metal has been considered. Role of Bloch states in the focusing in these systems has been considered. Faraday and Kerr effects in metamaterials have been discussed. Finite sizes of the system have been taken into account. Time dependent Faraday rotation has been considered. Slowly varying external magnetic field and spin relaxation cases have been discussed (Sup.: DSc(phys.-math.) Zh.Gevorkyan).

Optimal growth regimes and properties of separate layers in CIG (CIGS ) solar cells grown on glass-ceramic thin films substrate have been investigated. The studies of nanocrystalline structure of perlite glass-ceramic substrates have been continued depending on technological regimes of syntez and composition of output raw compounds. Measurements performed with the help of atomic-force microscope indicate that the average size of nanocrystals actually depends on the concentration of crystalline centers and can reach 150-200nm. X-ray studies prove that the great hardness of material depends on crystals of valostonite and

aluminium oxides resulting from crystallization process which occupy more than 90% of the volume (Sup.: corr.member S.Petrosyan).

The theory of picowatt power solar element based on the single nanowire with radial *p-n* transition has been developed. The influence of nanowire radius and surface velocity of recombination on the efficiency coefficient has been investigated (Sup.: cand.(phys.-math.) A.Yesayan).

### *Outcomes of applied developments*

Modern problems concerning monitoring and control of RF plasma have been analyzed from the viewpoint of improvement of the methods in use as well as development of new methods which lead to the increase of efficiency and reliability of such systems (Sup.: cand.(phys.-math.) T.Zakaryan).

The conical beam planar ring-slot antenna on radial transmission line has been designed and investigated. Resonance conditions for shorted and open radial line have been evaluated. Using of resonance-type radial line for feeding the ring-slot antenna increases the antenna emission efficiency. The radius of ring slot is chosen from the maximum condition of first kind Bessel function $J_1(kr)$. The directivity pattern has been measured for emission to free space, after diffraction on metallic disk, and after transmission through dielectric thick layer (Sup.: N.Pogosyan).

The sequential two-step: vacuum and combined (vacuum with the *gas transport*), deposition technology has been developed to fabricate perovskite $CH_3NH_3PbCl_{3-x}I_x$thin films widely used in solar cells nowadays. Organic metilamonium chloride ($CH_3NH_3Cl$) and inorganic lead iodide ($PbI_2$) have been used as a precursor for fabrication of films. The synthesized films have dark reddish-brown color and effectively absorb solar radiation even at thicknesses of 350-400 nm. Studies have shown that the films optical absorption edge corresponds to 1.6 eV (Sup.: cand.(phys.-math.) A.Yesayan).

The formation of nanoparticles in fluids produced by laser ablation has been investigated. Their dimension range is from 20 nm up to 500 nm and depends on the power of the laser radiation and the exposure time. By changing these values a liquid enriched with different densities of nanoparticles can be obtained. The generation of the ensembles of nanoparticles depends on the depth of the immersion of the metal target in a liquid. The increase of the pressure changes around the laser plasma hinders the propagation of nanoparticles and leads to the formation of larger ensembles (Sup.: cand.(phys.-math.) R.Khachatryan).

Portable devices for diagnostics and treatment of various diseases have been developed and manufactured: 1) "hot needle" – for the influence on the biologically active points of the body with possibility of temperature and time control; 2) a device for measuring the conductivity of hypodermic tissues (Sup.: acad.A.Ghulyan).

The data of field measurements of clear air and clouds microwave emissive characteristics have been processed. Field measurements have been carried out by a radiometric system at Ka (37GHz) band of frequencies (Sup.: DSc (phys.-math.) A.Arakelyan).

## ICRANet Armenia

### *Major achievements*

Analysis of Fermi LAT data accumulated during 2008-2015 from the observations of 30 radio galaxies which allows to understand high energy emission processes in FR I/FR II sources has been carried out. The code, which optimizes the parameter space for the modelling of emission from blazars using Markov Chain Monte Carlo method has been developed (Sup.: cand.(phys.-math.) N.Sahakyan).

## DIVISION OF NATURAL SCIENCES

### *Academician-Secretary - corresponding member R.Aroutiounian*
### *Scientific Secretary – S.Atshemyan*

The Division includes the Scientific and Production Centre (SPC) "Armbiotechnology", the Scientific Centre of Zoology and Hydroecology, the Institute of Botany, 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, the Institute of Physiology after L.Orbeli.

The Division includes 8 academicians, 11 corresponding members, 27 foreign members as well as 12 honorary doctors.

2 general meetings, 28 Bureau meetings of the Division were held during the reporting year.

At the annual meeting of the Division held on 19 April the report of the academician-secretary V.Hakobyan on the scientific and scientific-organizational activities of the Division in 2015 was heard. The issues obstructing the activities of the institutes of the Division were discussed and the following proposals were made: to provide funding to buy new devices and for scientific expeditions, to appeal to RA Government to increase the age limit of the directors of the Institutes to 70 years and to review the law of purchases, to specify the funding of the Botanical Garden as a separate line, enable scientists to the list of employees eligible for the extra work, and to include a premium for scientific degree in retirement.

It was proposed to support the Institute of Molecular Biology in the organization of the immune serum "Immunomodulator" production, to conduct the elections of academicians and corresponding members in the Division with the concept of 2/3, and conduct the elections at the general meeting with the concept of 50% + 1, as in this case the risk factor dicreases.

Scientific reports of the leading scientists of NAS RA were heard: corr.member A.Trchounian "Biohydrogen: Phenomenon, mechanisms and application", DSc(biol.) G.Sargisov "Typology of rodents in the setting of research behavioral models", cand.(biol.) A.Arakelyan "Integration of telomere biology into functional genomics research", cand.(biol.) N.Hovhannisyan "The investigation of multidrug resistant *Pseudomonas aeruginosa* strains isolated from soil and how to overcome microbial resistance", cand.(geogr.) L.Sahakyan "Mercury as a risk factor in Armenia".

At the general meeting held on 28 June the report of the academician V.Hakobyan on the activities of the Division for the period of 2010-2015 was heard and the elections of the new academician-secretary were held. As a result of the secret ballot the corresponding member R.Aroutiounian was elected as the academician-secretary of the Division and the new structure of Burreau was approved.

At the 28 meetings of Bureau the following reports were discussed and approved: the working plan of the Division for 2016; the reports of the institutions of the Division on 2015 and 2016 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; the applications of the institutes for new appliances; the reports of the institutes on the scientific-organizational activity in 2016; the project on methodology and criterias of the functional effectiveness evaluation of the institutes; the innovation projects represented by the institutes; the retention of the territories in New Artamet by the Scientific Centre of Zoology and Hydroecology; the plans of naming the Institute of Botany after A.Takhtajian; the possible participation to the fundamental scientific projects with CIS countries; the program of fundamental scientific studies for 2015-2020.

The reports of the directors of the institutes of the Division on the scientific and organizational activities in 2016 were discussed at the on-site meetings of Bureau.

The travel expenses for scientific visits of researchers from the Division institutes were discussed and 23 travel grants were provided from the NAS RA funds preappointed for the scientific visits.

8 local and international events were organized by the institutes of the Division including seminars, conferences, scientific expeditions, a total of 400 participants, 47 of which were from abroad.

347 articles (154 – in local and 193 – in foreign journals) and 121 abstracts (38 – in the materials of local and 83 – in the materials of foreign conferences), 16 monographs, 3 educational tutorials and 3 patents were published by the institutes of the Division.

17 Candidate's dissertations were defended by the researchers of the Institutes at 5 specialized councils of the Division.

## Institute of Botany

### *Major achievements*

During the reporting period in the field of geo-botanical investigations the study of changes of plant communities, ecosystems and habitats of Armenia has been continued. A new classification scheme of habitats of the republic has been developed. The EUNIS Habitats classification scheme has been reworked and adapted to our conditions; a new classification scheme of habitats of Armenia has been developed and as a result of this investigation a monograph was published. Currently in Armenia about 750 habitats of different ranks are allocated and described. Of the 10 categories of the first rank existing in Europe, 8 are met in Armenia. 228 categories of habitats of different ranks are absent in Europe and their description is provided for the first time. Besides for the first time in Armenia the determination keys for habitats up to the third level have been developed. The work is of interest to botanists, biologists, geographers, environmentalists, employees of conservation organizations, nature lovers as well as for teachers and students of biological, geographical and agricultural specialties of universities. Special attention is given to the Armenian rare ecosystems and habitats, a study which is ongoing (Sup.: DSc( biol.) G.Fayvush).

## Centre for Ecological-Noosphere Studies

### *Major achievements*

Atmospheric dust researches in city of Yerevan done by different methods have indicated that priority pollutants from a standpoint of geochemical and sanitary and hygienic risks and health risk to the population are Mo and Cd. In different functional zones of the city (streets with heavy traffic, green spaces and kindergartens) significant differences in quality and quantity characteristics of dust have been detected that supported a necessity of conducting target researches. Studies of Yerevan dust by a scanning electronic microscope have indicated that irrespective of functional zones of the city (heavily loaded streets or a green zone) dust composition is dominated by small-diameter particles (0.3-0.6mkm), the most hazardous for human health (Sup.: cand.(geogr.) L.Sahakyan).

### *Outcomes of applied developments*

In the frames of an agreement conculded with the Zangezoor copper molybdenum plants monthly monitoring has been provided of concentrations of heavy metals, xantogenate, oil products and some physico-chemical parameters of waters of rivers spatially located close to towns of Kajaran and Kapan and a rural community of Syunik, and effluents from the Artsvanik tailing repository.

Cooperatively with the State Service for Food Safety of the Ministry of Agriculture RA the centre is involved in testing the food imported to the Republic of Armenia. Through the accounting year over 345 tests have been done. As a result no cases of exceeding of maximum allowable concentrations have been revealed (Sup.: DSc(geol-min.) A.Saghatelyan).

By order of the Armenian NPP water sampling from two runoffs has been done and oil products and biological and chemical oxygen consumption have been determined in order to produce quarterly nature protection and management reports to be passed afterwards to the Ministry of Nature Protection RA (Sup.: cand. (biol.) G.Tepanosyan).

In the frames of a complex program on development of fish farming and restoration of the Sevan trout populations under financial support of Sevan Trout CJSC a scope of work has been implemented aimed at creating a system of remote monitoring of Lake Sevan water quality. Through interpretation of LANDSAT 8 OLI and Sentinel satellite images of medium- and high-resolution spectral signatures of water temperature, chlorophyll- α and total suspended solids have been developed and lake water temperature, turbidity and bloom in period April-November 2016 have been assessed. A time series of evaluation maps of Lake Sevan water temperature, turbidity and blooming has been produced (Sup.: cand. (geogr.) Sh.Asmaryan).

In the Informational-Analytical Center for Food Chain Risk Assessment a scope of works has been done aimed at risk assessment of quality and informational adulterations of ice-cream available to the consumer market. It has been found out that actual content of the product does not correspond to that provided on the consumer package, in particular some kinds of ice-cream do not contain any butterfat. Besides, data

on dry matter and dry fat-free milk residue in the ice cream samples point to the use of butterfat surrogates and fat-free milk in the process of production.

A sanitary and hygienic safety at the markets offering products of animal origin and namely Yerevan market N1 (known as GUM) has been assessed. It has been found out that 80% of meat pavilions are at high-zone risk. The identified risk level does not assure consumers' health.

With a view of assessing health risk induced by mycotoxins and in particular by aflotoxin B1 contained in plant-origin food, cereals samples have been collected from Yerevan markets and aflotoxin B1 has been determined. As it has been found out, some rice, wheat and buckwheat samples are high in aflotoxin B1. Based on public inquiries about consumption of grain legumes in Yerevan a database on quantity consumed has been produced to be used in a quantitative risk assessment in the future (Sup.: cand. (vet.) D. Pipoyan).

In the frames of a project "Learning for the Future" the UNESCO Chair on " Education for sustainable development" has conveyed a number of events including series of scientific seminars on a topic "Modern problems of ecological environment". For the students of Yerevan primary and high schools the Chair has organized a workshop course "Ecological footprint" (Sup.: cand.(biol.) G.Poghosyan).

A popular science newspaper "Most" has been issued with the partial financial help from the Centre (Sup.: DSc(geol-min.) A.Saghatelyan).

## Scientific Centre of Zoology and Hydroecology

### *Major achievements*

The studies have included outskirts of Small Sevan (Gegharkunik province), the beginning and the upper parts of Hrazdan river and the adjacent areas of Akhpara water reservoir. The study area is a unique territory of Central Armenia, where, on one hand, a high mountain lake Sevan with non-stable water level is situated and, on the other hand, there are highly exploited agricultural lands of two provinces. Research has revealed species composition of current fauna of invertebrates and vertebrates (including sinanthrop), trophic links of some species, ration, daily and seasonal activity, fertility, parasitic fauna of fish, wild and domestic animals, parasitic diseases prevalence among different animal species, as well as circulation of biohelminths in pasture ecosystem. Osteological study from the new arrivals of archaeological excavations of Sotq historical monument (VI-I B.C.) has been conducted. Cytogenetic researches, as well as studies of the physiological mechanisms of animals' behavior have been carried out.

It has been discovered that due to the stabilization of the water level in the lake and its increase during the spring and summer seasons new shallow water areas have been formed. It has maintained a stable food supply for a variety of water birds and created an opportunity for recovery of breeding bird fauna and attraction of migratory birds' species. After a long period two pairs of Pigmy Cormorant have been registered in the lake. The increase of the water level has led to some negative impact as well: some of the habitats occupied by vertebrates have been destroyed.

As a result of the study and assessment of insects' diversity 4 new species have been discovered, 9 species have been recorded for the Armenian fauna, 1 species for Gegharkunik province has been reported for the first time and karyotypes for 5 species of beetles have been described for the first time. The prospective species of ticks and insects as a biological tool in pests control have been defined (Sup.: acad. S.Movsessyan).

During the studies of Sevan-Hrazdan hydroecosystem serious changes in temperature regime from sources of Hrazdan river to Akhpara reservoir compared with previous years have not been revealed, thereby peculiarities of biocenoses' development has been dependent on the anthropogenic impact due to the river contamination with agricultural wastewater and sewages, pollution of the river bed with coarse household wastes, water consumption etc.

The influence of the lacustrine ecosystem is obvious on the composition of hydrobionts in the source of Hrazdan river. As a result of hydrological regime changes the substitution of species more common for lacustrine ecosystems to species more common for riverine ecosystems has been done. Calculated by different saprobic indices (microbiological, hydrobiological) water quality on different studied parts of Sevan-Hrazdan hydroecosystems has been assessed as β′-mesosaprob.

The studies implemented on Arpa river as well as its tributaries Eghegis and Herher aiming to reveal the influence of small HPP's have shown that main changes in water quality and structure of biocenoses were the result of water consumption for the operation of those HPP's. As a result of water consumption wetted

perimeter of studied parts is shrinking as well as velocity is decreasing and temperature regime is changing. Due to these changes the role of pollution from adjacent settlements is increasing.

In conditions of HPP's presence as well as their technical problems the bioconditions and natural reproduction possibilities of fish species in mentioned rivers have been devastated. Diversity and number of fish in the parts of the rivers above HPP's is relatively small (Sup.: (biol.) B.Gabrielyan).

### *Outcomes of applied developments*

Parasites' species composition of mammals, domestic and wild birds, fish, the circulation of biohelminths in the pasture ecosystem as well as the parasitic diseases prevalence among different animal species have been studied. Eight species of ticks (ectoparasites) have been recorded and their infection rates have been identified. Medium and high prevalence rates of endoparasites (lung and gastrointestinal helminths belonging to 14 genera) have been reported for small ruminants. The species composition of snails which serve as intermediate hosts of biohelminths have been defined. Their infection with larval stage of Dicrocoelium and Protostrongylyus has been identified, also host-parasite relationship in course of life-threatening zoonotic disease -Trichinellosis has been studied. The prevalence of echinococccosis among livestock has been studied. Five species of parasitic protozoa have been identified.

Two species of nematods (cyst nematode *Globodera* and stem nematode *Ditylenchus*) with different intensity of potato infection have been revealed from the farms of Gegharkunik and Kotayk provinces. It has been proved that during one vegetation period of plants potato-cyst nematodes produce one generation, while the reproduction of stem nematode in favourable temperature conditions (above $0^{o}$C) could continue also in the storage.

The data obtained in 2016 on animals' and plants' parasites can be used for the assessment of parasitological status of the environment, treatment and prevention of animals' parasitic diseases, as well as for the development of most effective means of pest control.

The species of Ixodidae ticks and bloodsucking insects which can serve as potential vectors of human and animal dangerous diseases have been observed. Obtained results can be used for the assessment of epidemiological and sanitary-hygienic situation of the province.

As a result of the long-term research previously conducted in the Russian-Armenian joint experimental centre, recommendations on sheep and goat Protostrongylus control in the context of Armenia have been developed.

The bioecological features and trophic links of 9 species of phytoseiidae ticks and 10 species of gall midges herbiphagus have been studied. The possible application of mentioned ticks and insects in biological pest control has been assessed.

During selection works on cold hardiness line of Phitoseiidae ticks it has revealed that breaks in the large-scale selection works would lead to a significant decrease of selection process efficiency. The methodologies of applied selection can be used for the breeding of useful tick species in biological control (Sup.: acad. S.Movsessyan).

For public needs the resources of fish and crayfish in Lake Sevan have been estimated. Some rise in the total biomass of the whitefish has been registered which is mainly the result of the presence of fecund generation in previous 2-3 years. The commercial resources of the whitefish in 2016 were 450 t, the resources of the crucian carp were 97-100 t and the resources of the Sevan trout were 1-1.5 t. Significant resources of other fish species (barbel, khramulya, stone moroko, armenian spirilin) have not been revealed. The resources of valuable fish species of Lake Sevan – khramulya and barbel are continuing to decrease.

For the replenishment of the whitefish resources it has been proposed to continue to ban the commercial catching of this fish specimen in 2017. At the same time it is necessary to preserve the fingerlings and ensure natural reproduction of the whitefish in the lake. For the preservation of Sevan trout it has been suggested to strengthen the control in the lake and in the river estuaries during the spawning season. Also it has been proposed immediately to take measures on the replenishment of the populations of endangered endemic fish species of Lake Sevan – khramulya and barbel.

Commercial resources of crayfish in Lake Sevan were assessed 4580 t in 2016 and allowed catching for 2017 will be 1100 t.

The demands to the commercial areas of hydrobionts exploitation and their management principles have been developed and presented to the Ministry of Nature Protection (Sup.: DSc(biol.) B.Gabrielyan).

## Institute of Biochemistry after H.Buniatyan

### *Major achievements*

The study of peptide isolated from pigs' heart and ears has been continued with application of HPLC and mass spectrometry. The opportunity of differentiation of *Bacillus anthracis* from related strains has been studied. Chromosomal and plasmid DNA mixtures isolated from *B. anthracis* virulent E7 and non-virulent S55 forms, as well as from *Bacillus thuringiensis* 69-6 , *B. thuringiensis* Z52 and *Bacillus cereus* strains have been used in work. For the purposes of PCR amplification the TAQ-DNA polimerase has been applied. The results suggest, that *cap*A gene is amplified from the DNA obtained from *B. anthracis* E7 (V) virulent strain, whereas it is not amplified from DNA obtained from other strains. The results indicate that *pag* gene is amplified only from DNA isolated from *B. anthracis*, whereas *cap*A gene is amplified from the DNA obtained from *B. anthracis* E7 (V) virulent strain. The developed methodology may be applied for revealing the *B. anthracis* for diagnostic purposes, and for the study of proline-rich cytokine *in vivo* impact during infection with this bacteria (Sup.: DSc(biol.) S.Chailyan).

The activity of adenosine deaminase and dipeptidyl-peptidase, which are targeted at during certain pathologies has been studied, and the low/high-molecular ratio of ADA1in synovial fluids of patients with rheumatoid and reactive arthritis, Bechterew's disease and ankylosing spondylitis have been determined. In the cases of gout and osteoarthritis the level of low-molecular form was negligible. To compare the citrullination state as diagnostic indexes, the ADA1 isoforms have been purified from synovial fluids of patients with different arthritis using gel filtration and ion exchange chromatography (Sup.: DSc(biol.) S.Mardanyan).

The system for screening of bacteria based on their interaction with lectins has been developed. The lectins are bound with bacterial walls that contain various carbohydrate compounds, allowing to reveal the bacteria existing in the environment. For the measurement of this interaction anisotropic silver nanoparticles and quantum dots sensitized with various lectins have been applied. As a result of the interaction, the resonance energy transfer from quantum dots to silver nanoparticles takes place and therefore fluorescence of quantum dots is decreased. Rate of these changes in fluorescence correlates with the concentration of bacteria in media. In these experiments four types of lectins have been applied and their efficacy for detection of Gram positive and Gram negative bacteria has been estimated (Sup.: cand.(biol.) V.Gasparyan).

### *Outcomes of applied developments*

By two independent methods: experimental (by absorption spectroscopy method) and computer modeling (molecular docking method) the effect of fatty acids on the process of complexation of porphyrins with blood proteins has been examined. It has been shown that long chain fatty acids (palmitic and stearic) significantly reduce the binding of porphyrins to serum albumin, in competition with binding sites on the protein with porphyrins. It has been also shown that these fatty acids have practically no influence on the binding of porphyrins to hemoglobin. Since the main carrier of porphyrins in the blood is the serum albumin, it has been concluded, that in photodynamic therapy of tumor it is necessary to monitor the level of fatty acids in the blood (Sup.: cand.(biol.) G.Gyulkhandanyan).

The low/high-molecular ratio of adenosine deaminase1 in synovial fluids of patients with rheumatoid and reactive arthritis, Bechterew's disease and ankylosing spondylitis has been evaluated. In the cases of gout and osteoarthritis the level of low-molecular form was negligible. To compare the citrullination state as diagnostic indexes, the ADA1 isoforms have been purified from synovial fluids of patients with different arthritis using gel filtration and ion exchange chromatography. From eggs of chicken, tolerant to immunoglobulin G, hindering adenosine deaminase2 purification, its antibodies have been purified for investigation of features of this little-studied enzyme (Sup.: DSc(biol.) S.Mardanyan).

The system for screening of bacteria based on their interaction with lectins has been developed. Various lectins (carbohydrate binding proteins) are bound with bacterial walls that contain various carbohydrate compounds. With study of this interaction it is possible to detect bacteria in media, for measurement of which anisotropic silver nanoparticles and quantum dots sensitized with various lectins have been applied. In case of anisotropic silver nanoparticles the detection of bacteria is based on changes of plasmon resonance of nanoparticles as a result of their interaction with bacteria. Rate of the changes correlates with the concentration of bacteria. In other experiments the anisotropic silver nanoparticles and quantum dots

sensitized by various lectins have been applied. In presence of bacteria the interaction of nanoparticles takes place. As a result the resonance energy transfer from quantum dots to silver nanoparticles takes place and therefore fluorescence of quantum dots is decreased. Rate of these changes in fluorescence correlates with concentration of bacteria in media. In these experiments four types of lectins have been applied and their efficacy for detection of Gram positive and Gram negative bacteria has been estimated (Sup.: cand.(biol.)V.Gasparyan).

## Scientific and Production Centre "Armbiotechnology"

### *Major achievements*

For the first time an efficient method for preparing enantiomerically enriched (ee > 98%) important non-protein amino acids (*R*)- and (*S*)-Alyl-Gly, (*R*)- and (*S*)-OH-Val which are of great demand in the commercial market, has been developed by the chemical-enzymatic method (Sup.: cand.(chem.) S.Dadayan).

Six new peptides containing non-protein amino acid (*S*)-allylglycine have been synthesized and their possible biological activity has been revealed using the PASS-online program (Sup.: cand.(chem.) Yu.Danghyan).

New HPLC methods have been developed and improved for biological active substances. Enantiomeric yield and C, H, N, S elemental composition of non-protein amino acids and their analogs synthesized in our Centre and not described in the literature have been investigated. Quantitative and qualitative analyses of protein amino acid of liquid cultures and plant extracts have been performed (Sup.: cand.(chem.) A.Tsaturyan).

The study of strains belonging to the culture collection of SPC "Armbiotechnology" has revealed *Escherichia coli, P.aeruginosa* and *K.pneumoniae* strains resistant to a number of antibiotics. According to antibiotic resistance, these strains have been isolated to separate groups. It has been demonstrated that a number of peptides synthesized in the Centre inhibit the growth of *P.aeruginosa* 9290 ($Ap^r$, $PANSEF^r$, $Amox^r$, $Augm^r$, $Sm^r$) strain and the growth of *K.pneumoniae* 5244 ($Ap^r$, $PANSEF^r$, $Amox^r$, $Augm^r$, $Sm^r$) strain, but have no influence on the growth of *E. coli DH5α*/pUC18 strain (Sup.: cand.(biol.) N.Hovhannisyan).

The antimicrobial properties of a number of new non-protein compounds synthesized in the Centre, having structural similarity to L-valine, have been examined. 2 Previously unknown analogues of L-valine, which can be used for the selection of highly producing strains, have been identified (Sup.: cand.(biol.) A.Chakhalyan).

The technology for biosynthesis of L-alanine in the "Biostat-S" reactor based on the *Brevibacterium flavum GL18* producing strain, earlier obtained in the Centre, has been developed. As a result of optimization of technological parameters it has become possible to reduce the process period, exclude chalk from the fermentation medium, reduce the amount of side amino acids and increase the yield of the target amino acid by 24 g/l (Sup.: cand.(biol.) G.Avetisova).

As a result of combining *Geobacillus stearothermophilus* heterologous gene *arg*B and *Corynebacterium glutamicum* homologous gene *arg*G in cells of *Brevibacterium flavum*, a new recombinant L-arginine producing strain has been constructed, the activity of which is by 2 g higher compared to the original strain and equals to 33 g/l (Sup.: cand.(biol.) A.Hovsepyan).

For recombinant enzymes characterization and technologizing of the most promising enzymes, from the complete genome sequence of *Pectobacterium carotovorum* a pair of primers for cloning the genes of enterobacterial aspartate aminotransferase with a broad substrate specificity has been created. Using the latter, out of 10 DNA samples isolated from bacteria, derived from the Centre 5 recombinant strains have been obtained. Aspartate aminotransferase of one of these strains has been characterized by temperature and pH optima (Sup.: cand.(biol.) A.Hambardzumyan).

The technology for L-histidine production has been improved in experimental-industrial conditions, using new highly active strain-producer – *Br. flavum* LGS2 (Sup.: cand.(tech.) A.Vardanyan).

An improved combined method for preparing the product with high bioinhibiting property (up to 26000 Au/ml) from culture liquids of lactic acid bacteria and yeast has been developed. Some of its physicochemical and bioinhibiting properties have been determined (Sup.: DSc(chem.) A.Aghajanyan).

The technology for co-cultivation of LAB *L.rhamnosus* 2012 and *Kluyveromyces marxianus* 86 yeast strains (from the culture collection of SPC "Armbiotechnology") which in contrast to the separate cultivation allows to increase the yield of antimicrobial substances (complex) with a broad spectrum of antimicrobial activity has been developed. The results of double photon laser fluorescent microscopy have revealed the presence of interaction between the bacteria and yeast cells in culture liquid which may be caused by interaction between cell receptors. This phenomenon depends on the used strains of LAB and yeast (Sup.: cand.(biol.) F.Tkhruni).

Alkalophilic microorganisms producing Glycosyltransferase (*Bacillus alkalophillus* A-12 and *B. alkalophillus* A-19) have been isolated and identified. Some physiological and biochemical properties of the isolated microorganisms and enzymes they produce have been studied. Transglycosylation of glycosides of the Stevia plant has been carried out by the studied enzymes (Sup.: cand.(biol.) V.Ghochikyan).

While carrying out envisaged scientific and research work within the framework of the project methods for the asymmetric synthesis of unsaturated α-substituted (*S*)-α-amino acids and bis-(*S*)-α-amino acids by using Glaser reaction have been developed. The structures and absolute configurations of obtained enantiomerically enriched novel non-protein α-amino acids have been studied (Sup.: cand.(chem.) A.Mkrtchyan).

Studies have shown that nodule bacteria significantly differ in species composition and diversity in Artsakh soils. In soils of Martakert and Martuni regions, nodule bacteria of lentils, cumin, chickpeas and beans dominate. Nodule bacteria of peanuts and soybeans are found only in the regions of Askeran and Kashatagh. Nodule bacteria of alfalfa and sainfoin are found mainly in the Askeran and Martuni regions (Sup.: cand.(biol.) V.Hakobyan).

Pretreatment of chalcopyrite by biogenic iron obtained by immobilized on shungite and activated carbon cells of *Acidithiobacillus* sp. 13Zn allows to increase the efficiency of bioleaching of iron and copper about 1.5-2.0 times with the association consisted of *Acidithiobacillus* sp. 13Zn and *L.ferriphilum* CC (Sup.: DSc(biol.) N.Vardanyan).

By moleculare-genetic methods taxonomic belonging of the following green microalgae *Chlorella vulgaris* Pa-001, *C. pyrenoidosa* Pa-002, *Scenedesmus acutus* Pa-004, *S. obliquus* Pa-005, *S. quadricauda* Pa-008, *Chlorococcum* sp. Pa-011, *Pandorina* sp. Pa-006 has been specified. The mentioned strains have been shown to be identical to *Parachlorella kessleri*, *P. kessleri*, *Acutodesmus obliquus*, *Scenedesmus* sp., *Desmodesmus* sp., *Coelastrella terrestris*, *Chlorococcum ellipsoideum,* by 99.0-99.9%, respectively (Sup.: cand.(vet.) V.Goginyan).

For the first time research of the chemical-physical properties of extracellular colloidal exopolysaccharide of the newly isolated iron oxidizing chemolithotrophic bacteria *Leptospirillium ferrifillium CC* has been carried out. A method for isolation of homogeneous extracellular colloidal polysaccharide has been developed. Its chemical composition has been found out. As a result of research by means of an optical polarizing microscope and computer programs the sizes, and variation forms of colloidal particles, hydration and peculiarities of crystallization have been found out. The research for screening of microorganisms-producers of cyclofructans by means of dyes and spectrophotometric studies has been carried out (Sup.: cand.(biol.) L.Markosyan).

The innate resistance of lactic acid bacteria *Lactobacillus acidophilus* GH 201 and *Lactobacillus delbrueckii* MH 10 to UV radiation has been revealed and conditions for UV-induced mutagenesis have been optimized for them. With the use of UV-mutagenesis cold-sensitive mutants with high probiotic, adaptive and antimicrobial properties have been obtained, out of which the most productive 4 strains were deposited at the Microbial Depository Centre (Sup.: DSc(biol.) H.Hovhannisyan).

90 new entomopathogenic strains have been isolated, out of which 6 strains of *B. thuringiensis* sp. with insecticide activity against Coleoptera and 1 active strain of *L. sphaericus* against mosquitoes have been selected (Sup.: N.Ghazanchyan).

Inulinase activity of 23 lactic acid bacteria and 5 types of yeast has been studied. 6 Strains with strong inulinase activity have been selected. Preservation of 400 strains of lactic acid bacteria has been carried out using culture liquid and glycerin at 4:6 ratio (Sup.: cand.(biol.) K.Chitchyan).

Molecular genotyping of 180 strains of entomopathogenic bacilli has been carried out and 2 prospective strains have been selected (Sup.: cand.(biol.) K.Darbinyan).

A wide spectrum of antimicrobial activity of some strains of *Brevibacillus laterosperus* sp. has been proved (Sup.: M.Kinosyan).

### *Outcomes of applied developments*

The production of optically active non-protein amino acids has been continued. In the European market ("Iris Biotech", "Acros Organics") more than 15 non-protein amino acids names have been realized.

The production of acido-lactic product "Narine" on the basis of lactic acid bacteria *Lactobacillus acidophilus* ИНМИА B-9602 (Er.317/402) has been continued. The product is made in accordance with AST 173-98 N17 and implemented in pharmacy chains "Esculap", "Natali-Pharm", "Alfa-Pharm" and delivered to a number of maternity homes and kindergartens.

The production of new fertilizers "Ecobiofeed" and "Ecobiofeed+" for agriculture purposes has been established. During the reporting period 15t biofertilizers realized in the farms of RA have been made.

A small-scale production line has been established in the pilot plant of the Centre and serial production of various types of the simplest medicines (3% hydrogen peroxide, 30% hydrogen peroxide, boric acid, magnesium sulphate, potassium permanganate, ammonia, castor oil, glycerin), having a certain demand in the RA market, has been launched (Sup.: acad. A.Saghyan).

## Institute of Molecular Biology

### *Major achievements*

Using GWAS data from 169 healthy subjects the distribution of common single nucleotide polymorphisms associated with predisposition to mono- and polygenic diseases in Armenian population has been characterized using bioinformatics and statistics analyses. The results have indicated the high prevalence of polymorphisms associated with metabolic, cardiovascular diseases and cancers (Sup.: cand.(biol.) A.Arakelyan).

The aggregate analysis of genetic, ethnographic, anthropological, historical and linguistic data have revealed that Turkic-speaking ethnic groups living in Iran have kept Iranian identity and cultural heritage. In addition, it has been shown that the patrilineal gene pool of the Turkic-speaking groups consists of only 10-12% of Turkic element, while the matrilineal genetic structure retains the Iranian substrate.

The genetic diversity of whole genome mitochondrial DNA has been studied in geographically different groups of Armenians. On the basis of a simulation modeling the age of the Armenian matrilineal gene pool has been determined, which is revealed to be more than four thousand years (Sup.: DSc(biol.) L.Yepiskoposyan).

### *Outcomes of applied developments*

Phenotypic characteristic for 10 Armenian grape cultivars has been created according to the OIV 455-1 descriptor. Based on these metrics Armenian grape cultivars resistant or susceptible to downy mildew have been identified.

Optimal combination of growth factors that allows to increase *in vitro* tuberization of potato variety "Kuraj" has been developed (Sup.: cand.(biol.) H. Devejyan).

## Institute of Hydroponics Problems after G.Davtyan

### *Major achievements*

As a result of perennial researches new, organic hydroponic system of the raw material production has been developed (RA Patent, N 3044 A, 2016), according to which the seeds of the plants are sown in the mixture of substrates and organic fertilizers (manure, guano and biohumus) which are widespread filled on the insulator polyethylene film unrolled on the soil by 25-30cm layer. The water from the pool passing through cleaning filter with the help of pump is given to the main pipe, which is connected to the distribution pipes. They have holes with tips by means of which plant watering is done. Water is pushed under the 0,01-0,015MPa pressure in the form of a jet (0,1-0,15kgsecond/cm$^2$) which is spread in the root-bearing zone of the plant meeting the hard fraction of the substrate. Organic fertilizers quantities and their combinations

(manure, guano and biohumus and so on) are regulated depending on the biological peculiarities of cultivating plant species and the type of substrate. One-time watering duration is 10-20 seconds; frequency is 8-10 times during the day, as well as one-time given water amount is 20-70ml.

For getting saplings by in vitro method callus culture has been obtained from different explants (hypocotyls, sprout, root sprouts) of Picea pungens L. and their growth intensity has been determined. It has turned out that Murashige and Skoog nutrient media with the content of 0,5mg/L α-NAA and 2.4 D is optimal for sprout callus, in case of which the highest growth index 3.45 has been registered. Meanwhile, in case of hypocotyls and root explants, growth high index (1.06 and 2.53 accordingly) has been registered in the conditions of BAP and 2.4D 0.5mg/L.

For the first time standardization of *Teucrium polium* L. hydroponics and wild plant species has been implemented. It turned out that phenylpropanoid glycosides verbascoside, poliumoside and teupolioside content in the hydroponic row material was 1,2; 1,2 and 4,2% and in the wild raw material was 2,5; 1,5 and 6,6% accordingly.

It turned out that radioecologically safer raw material of *Melissa officinalis* L. and valuable crop *Brassica oleracea var. Sabellica* L. provided water stream hydroponics (cylindrical, gully, continuous). Meanwhile, the share of artificial radionuclides ($^{137}$Cs, $^{90}$Sr) amounted to 2,0-5,0% of total β-activity of *Brassica oleracea var. Sabellica* L. and 1,4-3,0% of *Melissa officinalis* L. Regardless of the conditions of plant growing, controlled artificial RN ($^{137}$Cs, $^{90}$Sr) content in row material was within MACL (Sup.: corr.member S.Mayrapetyan).

### *Outcomes of applied developments*

Proposals on realization of decorative tree-shrub and fruit tree saplings, obtained as a result of developing hydroponics cultivation biotechnology (nearly 3000), were sent to Municipality of Yerevan and other interested organizations with the aim of signing contracts (Sup.: cand.(biol.) A.Hovsepyan).

Practical radio protective proposals have been developed which application in the hydroponics and agrocenosis will give an opportunity simultaneously to decrease artificial radionuclides biological accumulation in the plants and obtain radioecologically safer raw material (Sup.: cand.(agric.) L.Ghalachyan).

Patents on “Hydroponic organic system” (author: corr.member S.Mayrapetyan), “Growing method of *Lycium barbarum* L.” (author: DSc(agric.) M.Babakhanyan) and “Polymer-Inorganic Sorbent for Radioactive Cesium Removal and Method of Preparation” (author: cand.(biol.)A.Tadevosyan) are of applied importance.

## Institute of Physiology after L.Orbeli

### *Major achievements*

The results have revealed electrophysiological indices of neuroprotective effectiveness of Lycium barbarum in the motoneurons of the spinal cord; functional parameters induced by Lycium barbarum in motor and sensory recovery of hind limbs after sciatic nerve crush in type 2 diabetes; adaptogenic effects of Lycium barbarum in cardiovascular and thermoregulatory systems, as well as in NADPH-dependent antioxidant system in the spinal cord, on oxidative stress caused by type 2 diabetes (Sup.: DSc (biol.) V.Chavushyan-Papyan).

The electrophysiological study of hippocampal neurons in the model of Alzheimer’s disease and neuroprotective impact of viper venoms has been carried out, as well as the study of morphological and functional alteration of erythrocyte ghosts and giant unilamelliar vesicles caused by Vipera latifi venom and the comparative investigation of the effect of 3 vipere venoms (MLO, MR and VL) on human erythrocytes ghost membranes using fluorescent microscopy and changes in ATPase activity under snake venom influence in vitro. The ion pumps [Na+,K+]-ATPase and (Ca2+ + Mg2+)-ATPase play a pivotal role in the active transport of certain cations and maintenance of intracellular electrolyte homeostasis (Sup.: DSc (biol.) N.Ayvazyan).

The effect of MLO venom on cardiomyocytes, cardiac fibroblasts and epithelial cells has been studied. The tested venom strongly affects adhesive properties of all tested cell types. The methods mastered in the

ITE laboratory have allowed to identify lethal and non-lethal doses of MLO crude venom, and demonstrate morphological and physiological changes in aforementioned cells (Sup.: cand.(biol.) Z.Karabekian).

### *Outcomes of applied developments*

Scientific and technical work led to the development and fabrication of industrial prototypes of 3-channel Holter electrocardiograph and Holter modification of "Bioscope" with saving the recorded signals in the built-in memory card. Subsequent clinical studies using this equipment will allow to develop the methods for early diagnosis of the beginning of the most popular in Armenia cardiovascular diseases and cancer (Sup.: DSc(biol.) R.Sargsyan).

Jointly with the company "PSI" Ltd. (Precision Science and Instruments, Armenia) laboratory work has been carried out to detect possible scopes of application of highly sensitive SFCO sensors developed by the company in medicine and biology. It has been shown that on the basis of SFCO sensors the study of the tremor in norm and pathology is possible. At present work is being carried out to create hardware-software complex meant for using in neurological and neurosurgical clinics, sports physiology and medicine, testing of pharmaceuticals (Sup.: cand.(biol.) A.Khachunts).

## DIVISION OF CHEMISTRY AND EARTH SCIENCE

***Academician-Secretary – academician L.Tavadyan***
***Scientific Secretary – cand.(chem.) A.Avetisyan***

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

The Division includes 9 academicians, 6 corresponding members and 21 foreign members of NAS RA.

4 general meetings of the Division were held during the reporting year.

At the annual meeting held on 19 April the reports of the academician-secretary, academician L.Tavadyan, directors of the research institutes, as well as foreign members of NAS RA, related to their scientific and organizational activities in 2015 were discussed.

As a result of a secret ballot academician L.Tavadyan was elected as the academician-secretary of the Division at the general meeting held on 28 June.

At the general meeting held on 20 July the elections of the new stuff of Bureau were held. The innovation proposal on "Radioactive waste neutralization by MNR method", presented by the Prime Minister's advisor G.Hovsepyan and executive director of LLC "AT Metals" G.Mezhlumyan was discussed at the same meeting.

At the general meeting held on 28 November the issue on the term extension of the director of the Institute of Geophysics and Engineering Seismology J. Karapetyan for two years was discussed and approved. The annual reports on the activities in 2016 of the editorial boards of the "Chemical Journal of Armenia" and the journal of "Proceedings of NAS RA. Earth Sciences" were discussed and approved at the same meeting.

12 meetings of the Division were held where scientific and organization problems were systematically discussed.

At the meetings of Bureau the following was discussed and approved: the working plan of the Division and the positions of postgraduate studies for 2016, the applications of base funding of scientific and technical activity, the applications of target programs of the institutes of the Division for 2017, integration of the Laboratories of regional geology and lithology of the Institute of Geological Sciences and creation of a new structural unit – Laboratory of lithology and regional geology, the approval of the nomination of the head of the newly established laboratory, creation of a group of the Geological museum of the Institute of Geological Sciences for studying the history of geological science, as well as the approval of the nomination of the head of the newly established group, the annual reports of the Division and the institutes, as well as the reports on base fundings of scientific and technical activities of the institutes for 2016.

7 researchers of the institutes of the Division were on academic trips in Russia (Moscow, Saint-Petersburgh, Novosibirsk, Chernogolovka), Italy and other countries for the purpose of joint research, as well as for participation in international conferences and symposia.

The Division jointly with the Institute of Geological Sciences organized the Workshop "Bridging Europe and Asia: Quaternary stratigraphy and Paleolithic human occupation in Armenia and Southern Georgia" with participation of 42 scientists, including from Russia, USA, Austria, Germany, Estonia, Turkey, Italy, Israel, Poland, the UK, France, Serbia, Ukraine; jointly with the Institute of Geophysics and Engineering Seismology organized the First International Scientific Workshop dedicated to the 55th anniversary of the IGES NAS RA "Problems of improvement of seismic intensity scale" with participation of 90 scientists, including 15 foreign participants.

274 articles (129 in local and 145 in foreign journals), 50 abstracts (4 in local and 46 in foreign conferences), 4 monographs and 4 patents RA were published by the institutes of the Division.

13 Candidate's dissertations were defended in 2016.

The Division organized and assisted the annual reporting back meetings of the Division institutes and discussions of scientific results.

## Institute of Chemical Physics after A.Nalbandyan

### *Major achievements*

Based on the gel-electrophoresis method antiradical and antioxidant activities of bioflavonoids bound with DNA by different ways have been revealed. It has been shown that antiradical activity of bound flavonoids and ability to protect DNA from oxidative injuries depend on the binding type (Sup.: acad. L.Tavadyan).

By the method of microwave radiation rhenium boride has been synthesized relevant to ultra-hard materials, which approximates to diamond by the Vickers microhardness, as well as exhibits sufficient resistance to high-temperature corrosion. By the example of model reactions: decomposition of isopropyl alcohol and hydrazine hydrate it has been shown that the synthesized compound demonstrates high catalytic activity (Sup.: DSc(chem.) S.Arsentiev).

To obtain pseudoalloy W-Cu (used as a material with high thermal and electrical conductivity, mechanical durability, heat-resistance and other important properties) joint magnesiothermic reduction of $WO_3$ and CuO has been studied. Determining influence of heating rate on the mechanism of multi-stage reactions has been revealed (Sup.: corr. member S.Kharatyan).

### *Outcomes of applied developments*

Direct process of technical titanium powder production from titanium (ilmenite) slag (88% $TiO_2$) has been realized under the combustion mode using magnesium-based combined reducers (Sup.: corr. member S.Kharatyan).

Based on hydride cycle method new efficient methods for the synthesis of $TiAl_3$ titanium aluminide and the Ti4V6Al (Ti64) alloy have been developed that provide the basis for new technological processes (Sup.: DSc(tech.) S.Dolukhanyan).

## Scientific Technological Center of Organic and Pharmaceutical Chemistry

### *Major achievements*

Unknown in literature reactions of electrophilic addition of unsaturated quaternary phosphonium salts have been carried out, particularly bromination of tributyl- and tripropy-3-chlorobutane-1,3- dien phosphonium bromides by molecular bromine, and substitution of chlorine atom located in sp2 hybridized carbon of triphenyl-3-chlorphosphonium by alkane thiol group (Sup.: DSc(chem.) M.Hovakimyan).

No mixed-phosphine-nitrosyl complexes have been characterized to date either with simple iron-porphyrins or with mutant hemoproteins with open axial sites. Low-temperature *in-situ* FTIR and UV-visible measurements show that trimethylphosphine reacts with microporous layers of iron *meso*-tetra-*p*-tolylporphyrin nitrosyl to form the previously unknown six-coordinate nitrosyl-phosphine complex of iron-porphyrin. Upon warming this compound to room temperature in the presence of excess phosphine, the NO ligand is completely replaced by phosphine resulting in formation of the bis(trimethylphosphine) complex of iron-porphyrin. Simultaneously, the NO released oxidizes free phosphine to corresponding phosphine oxide with concomitant formation of nitrous oxide (Sup.: DSc(chem.) T.Kurtikyan).

### *Outcomes of applied developments*

The method of separation of the prenilizoflavanoid mixture obtained from the fruits of Maclura pomifera by complexation of osain and pomiferin has been tested, excluding preparative chromatography (Sup.: DSc(chem.) V.Mnatsakanyan).

## Institute of General and Inorganic Chemistry after M.Manvelyan

### *Major achievements*

Hydrothemal microwive method of synthesis of Ca, Mg and charge of pigments by synchronous interaction of soluble salt of Ca, Mg, sodium silicate and solution of chromic elements has been developed. It has been shown that the microwave treatment promotes the quicker penetration of chromophores in diopside's lattice at lower temperature (Sup.: cand.(tech.) V.Baghramyan).

Phase diagram and glass forming region of glasses of $LiF\text{-}Al_2O_3\text{-}B_2O_3$ system, as well the behavior of transparent and segregated glasses under heat treatment, crystallization products have been studied. The influence of met stable liquation on photo chromic properties of glasses and glass-ceramics activated by AgCl and $Cu_2O$ has been revealed. Photosensitive glass-ceramics with TCLE in $15\div28\cdot10^{-7}$ $K^{-1}$ range and high transparency in the visible region of spectrum have been obtained. (Sup.: DSc(tech.) N.Knyazyan).

### *Outcomes of applied developments*

In the frame of the project "The technology of complex chemical processing for serpentinous ultrabasic rocks" the pilot manufacture construction has been realized. A number of required experiments connected with the chemical processing of the rock have been carried out. It has been shown that the interaction of the heated serpentinites taken in kilograms with HCL in the reactor occurs in the same way as in the laboratory environment where the reagents are weighted in grams.The collection of experimental data has been performed: time and energy consumption required for the rock crushing and grinding, output of the constructed kiln coupled with consumed energy (Sup.: DSc(chem.) N.Zulumyan).

The glass-like binding materials with low soldering and sitallization temperature for making grinding tools have been synthesized. In order to reduce the reaction temperature in powder systems of $C(B_4C)$ - glass-like binding materials - and to change the mechanism of interaction at the melt - solid interface, a mixture of low-melting and high-melting sitallized glasses with certain physical and mechanical parameters has been used. Glasses have been synthesized on the basis of boronalumina and borosilicate systems containing bivalent metal fluorides (Sup.: DSc(tech.) N.Knyazyan).

## Institute of Geological Sciences

### *Major achievements*

In collaboration with the Department of Earth Sciences of Taiwan National University Tsav intrusive complex, the largest of Kapan terrane (South Armenia) has been dated with application of U-Pb method. New dates, 131÷129 Ma, show Lower Cretaceous age of intrusive and demonstrate absence of Eocene units dated by K-Ar earlier. According to new U-Pb data, Tsav intrusive in Kapan and Kokhb-Shnokh intrusive in Somkhet-Karabakh terrane (153÷152 Ma) were formed in different ages (Lower Cretaceous and Upper Jurassic accordingly) in the limits of different terranes (Kapan and Somkhet-Karabakh) (Sup.: corr. member R.Melkonyan).

A new method of determining the value of the transverse vibrations of seismic velocities of the particles of soil in fault zone, depending on the magnitude of the earthquake has been developed (Sup.: acad. E.Khachiyan).

New $^{40}Ar/^{39}Ar$ determinations of the following volcanic units have been obtained: Vayotsar volcano, 31 . 8±2.8 Ka; Argavand flow, 221.1±5.0 Ka; Gutansar flow, 314.1±16.2 Ka, Garni columnar joints lava flow of basaltic trachyandesites, 127.7±2.6 Ka; lava flow that covers columnar flow in Garni village - 49.9± 9.2. The mentioned age determinations have been used for estimations of recurrence rate of volcanism in Armenia (Sup.: cand.(geol.) Kh.Meliksetian).

### *Outcomes of applied developments*

Considering the strong earthquake as an aftermath of the earth surface momentary rupture, a certain method of determining the speed magnitude of latitudinal seismic fluctuations of soil particles in the territory of the rupture and in the neighboring territories of certain distance from it has been suggested, depending on the magnitude of the earthquake. Corresponding empirical formulas have been acquired which, in cases of earthquakes of $6.0 \leq M \leq 9.0$ magnitude, allow to find the biggest value of the ground acceleration not only within the area of the surface rupture, but for soil particles at a certain distance from it as well. In case of the expected earthquake of $M \geq 6.0$, the acquired results can be used in the territory of the earth surface rupture and in the building sites at a certain distance from it in order to acquire its estimated synthetic seismograms and accelerograms (Sup.: acad. E.Khachiyan).

New spatial density model of Quaternary and upper Pleistocene volcanic centers of the territory of Armenia and neighboring areas of Georgia and Turkey has been generated. Probability of opening of new monogenetic vents within studied territory has been estimated (Sup.: cand.(geol.) Kh.Meliksetian).

New software package to integrate automated system for monitoring landslides, first established in the territory of Armenia has been developed. This software package allows to take measurements of electronic measuring data-recording devices and transmit the data received in real time over the Internet to a remote central server; analyze the observational data by statistical methods of analysis of time series for determination of dangerous dynamics of the landslide process at each landslide area in accordance with its geological structure. The software package has been developed in collaboration with experts of project "Organization of the automated monitoring system of landslides in Armenia", which has installed the appropriate equipment on the landslide areas at Arapi, Getahovit, Voghjaberd. During September and October of 2016 the software package was successfully tested and verified at the Arapi landslide area. Currently, the software continues to operate in the same area. The system is available for on-line monitoring over the Internet (Sup.: cand.(geol.) A.Avagyan).

In the Akhuryan diatomite basin, in the shelly-argillaceous varieties, where the content of calcium carbonate reaches 50-57%, as a result of some non-chemical processing, mineral raw material of biogenic-aragonite structure (mollusks) of 95% calcium carbonate content has been acquired and the percentage of the insoluble part is 2.5-4%. The mentioned variety, which has a high level of solubility, without effortful chemical processing may be used as mineral forage for farming animals (Sup.: cand.(geol.-min.) T.Avagyan).

### Institute of Geophysics and Engineering Seismology after A.Nazarov

#### *Major achievements*

Fundamentally new schemes for the calculation of buildings and structures on the seismic impact have been proposed (Sup.: corr. member S.Hovhannisyan).

Complex in situ testing for different structural systems of buildings, structures of special architectural significance, foundation soil using a new seismosystem, developed in IGES has been conducted. The dynamic characteristics and their relationship have been determined. The actual technical condition, design defects, damage, vulnerability and reliability for further exploitation have been assessed. Analysis and evaluation have been carried out according to both the regulations in force in the country, and the European methodology for assessing the vulnerability of buildings ((EMS-98) (Sup.: cand.(geol.) J.Karapetyan).

Modern portable, ultra-sensitive, membranous piezoaccelerometers for usage in different sectors of the economy have been designed, constructed and tested in field conditions (Sup.: A.Gasparyan).

#### *Outcomes of applied developments*

A vertical vibration table the vertical oscillations of which are obtained from a horizontal vibration table by appropriate structural transformations has been designed (Sup.: A.Gasparyan).

An instrumentation amplifier for seismic sensors, which are tested in field conditions has been desiged and constructed (Sup.: S.Shahparonyan).

A modern multifunctional instrument for measuring the water level in wells has been developed, manufactured and tested in the field conditions (Sup.: M.Miranyan).

As a result of complex geophysical studies major natural and technological factors forming hydration the walls of Marmashen church buildings complex and threatening the safety of churches have been revealed. Relevant proposals, especially necessary for the implementation of eco-system of geophysical monitoring of the adjacent dangerous landslides of slopes have been presented (Sup.: R.Gasparyan).

## DIVISION OF ARMENOLOGY AND SOCIAL SCIENCES

***Academician –Secretary - academician Yu.Suvaryan***
***Scientific secretary - cand.(philosophy) H. Kocharyan***

The Division consists of the Institute of History, the Institute of Economics after M. Kotanyan, the Institute of Philosophy, Sociology and Law, the Institute of Language after H. Acharyan, the Institute of Literature after M. Abeghyan, the Institute of Oriental Studies, the Institute of Archaeology and Ethnography, the Institute of Arts, the Armenian Genocide Museum-Institute, Shirak Centre for Armenian Studies, "Armenian Encyclopedia. Publishing house". All Armenian foundation for financing of Armenian Studies acts in the frames of the Division as well.

The Division includes 9 academicians and 18 corresponding members.

In 2016 three general meetings of the Division were held.

During the annual general meeting on 19 April the report of academician Yu.Suvaryan on "The main results of scientific and scientific-organizational activities of the Division during 2016" was considered and approved. The following reports were presented: "The earliest stages of habitation in Armenia according to the recent archaeological data" (corr.member P.Avetisyan, B.Gasparyan); "Scientific and educational activities of the Institute for Armenian Studies, YSU" (corr.member A.Simonyan); "Modern problems of investigation of the Armenian language" (cand.(philol.) V.L.Katvalyan).

At the general meeting of the Division held on June 28 the elections of the academician-secretary took place, the academician Y.Suvaryan was elected as the academician-secretary of the Division.

At the general meeting held on July 9 the elections of the Division Bureau staff took place. The scientific report of the academicians R.Safrastyan and A.Melkonyan "The April war and the geopolitical situation in Armenia" was heard.

During the current year 14 Bureau meetings were held. The following points were considered and approved: working plan of the Division, the applications of the projects on keeping and development of infrastructure of based financing of scientific and scientific-technical activities in 2017, on preservation of

scientific objects having national value, on the state special purposed project, as well as current reports on the mentioned procedures during 2016; applications for 2016 post-graduate studies; the 2016 program of the annual general meeting of the Division; the staff of the committee selecting the most important scientific works financed by All-Armenian Foundation for Armenian Studies; the staff of the scientific council of the Institute of Language after H. Acharyan; the theme and the organizing committee of the Second International Conference of Armenian Studies; the problem of participation in the International program "Horizon 2020"; realization of common scientific project with Academy of Social Sciences of China; changes within the scientific council of the Institute of Oriental Studies; problems of organizing attestations and competitions within the scientific organizations of the Division; edition quantities of the scientific journals of the Division, their realization and editorial boards; improvement of the electronic sites of the Division scientific institutions; publication of the volume o f the International conference "Armenian Genocide and the problem of compensation"; nominating for the RA President prize for achievements towards international recognition issues of the Armenian Genocide; organization of scientific events towards 25th anniversaries of the Republic of Armenia and the Republic of Mountainous Karabakh and other scientific and organizational issues.

At the session of the Division Bureau on December 21 the reports on scientific and scientific-organizational activities of the Division Bureau and scientific organizations were considered and approved.

During the current year the Division continued the organization of events dedicated to 100th anniversary of the Armenian Genocide, particularly an international conference "Armenian Genocide and the problem of compensation" was organized. An international conference "The Quarter of Century of the New Armenian statehood" was held as well.

Three volumes of the "Historical-Philological Journal", "Journal of Armenian Studies" and the "Herald" each, as well as two volumes of the English online journal "Fundamental Armenology" were published in the current year.

145 books (included 2 abroad), 14 tutorials, 856 articles (included 209 in foreign journals) were published by the institutes of the Division.

## Institute of History

### *Major achievements*

The second book of the fourth volume of the academic multivolume "The History of Armenia" was published. It covers the period from 1945 up to 1991. The book is introduced on the wide base of new archive materials, already published collections of documents and scientific literature.

The History of the Armenian Culture in X-XIV centuries was examined in the frames of the theme "The Problems of the Armenian Statehood" (Sup.: acad.A.Melkonyan). It is introduced that in the mentioned historical developed Medieval period the Armenian culture reached the highest level. The level of the general development of culture but not the significances and specific development of the separate branches is introduced from the point of veiw of historians and not the art critics. To appraise the place and role of the Armenian culture up to the international criteria the parallels were drawn with the civilizaitional similar phenomena of different countries.

The Soviet Armenian Historiography in 1920-1930 was investigated in the frames of the theme "Historiography and Source Studies" (Sup.: cand.(hist.) A.Shahnazaryan). It was mentioned that the acting political and state system took the corresponding measures for the formation of Soviet Armenian Historiography of 1920-1930. H.Manandyan, Ash. Hovhannisyan, Leo and others made their contribution to the development of the historiography in the course of the first twenty years of the existance of Soviet Armenia.

## Institute of Archaeology and Ethnography

### *Major achievements*

Within the framework of the subproject "Ancient and Old Armenia. Excavations and study of archaeological sources" 22 sites in the regions of RA and Artsakh were excavated and studied during the current year. Due to the data obtained from excavations and laboratory analyses, the source bases of studies for the history and culture of the Near East and Armenia was refreshed, regularities and peculiarities of the

formation and development of historical and cultural environment of the period from the initial phases of the Stone Age to the Late Middle Ages were revealed. Archaeological, architectural, archaeo-botanical, anthropological numerous data and facts towards the anthropogenesis in the regions situated to the north of Araks, towards the conception of civilization as a result of "agricultural revolution", towards the formation and development of complex societies and early state formations, towards the urban culture of the periods since the Van Kingdom to Artashesids were described and analyzed in details by contemporary scientific methods. The considerable part of the results of the mentioned studies have been published in several high ranked impact factor journals (Sup.: corr.member P.Avetisyan).

Within the framework of the subproject "Comparative study of the basic motives and excerpts of Armenian fairy tales" works on systematization and study of the folklore heritage of Armenian fairy tales were continued. In order to correspond to international standards of systematizing of fairy tales, according to the principles of concordance created by Hans Jorg Uther, common and peculiar traits of national and international fairy tales of the same type were elaborated. The next 18th volume of the series of books "Armenian folk fairy tales" dealing with the fairy tales of Parskahayk was composed and published (Sup.: DSc(philol.) T. Hayrapetyan).

### *Outcomes of applied developments*

During the current year, within the framework of the project "My Armenia", which is realized in Armenia together with the Smithsonian Institution of the USA, extensive researches were carried out in the regions Vayots Dzor and Syunik in order to make and realize projects of development of cultural and rural tourism (Sup.: DSc(hist.) H. Marutyan, candidates (hist.) A.Tadevosyan and G.Shagoyan).

Within the project on organization of tourism and preservation of archaeological sites excavated by the Institute, corresponding works were continued in the cave Areni 1. During the current year a passageway to the main halls of the cave was placed made by scaffolding (Sup.: B.Gasparyan).

## Institute of Oriental Studies

### *Major achievement*

The second of the four volumes of "History of the Neighbouring Countries of Armenia" (chief editor – acad. R.Safrastayn, responsible editor - DSc(hist.) P. Chobanyan) which has no precedent in Armenia with its contents, coverage of issues and researches. The volume covers the history of the bordering countries of medieval Armenia, namely Iran, Byzantium, the Arab Chalifate, Georgia, the Ottoman state, as well as the region of Eastern Transcaucasia in the IV-XVIII centuries. Special attention has been paid to the relations of those countries with Armenia and the Armenian nation.

Within the framework of the program "Armenia and the Problems of Political, Social, Cultural and Ethnic History of Turkey, Iran, Caucasia and Arabic Countries of Mashriq" (Sup.: acad. R.Safrastyan) the book by V. Bayburdyan on one of the world religions – Islam was published. The work is the first attempt to present to the Armenian readers the history of Islam, to give a general idea about various issues in regard to different currents, directions, worship, theology, rituals and the legal system of that religion.

Within the framework of the program "Eastern Sources of the Ancient, Medieval and New Period about Armenia and the Armenians" (Sup.: DSc(hist.) P.Chobanyan) H. Jamkochian has addressed the most important issues of the ancient and medieval period of history in his work "The Life of St. Gregory the Illuminator of Armenian Ms. Sin. Ar. 455" (published in cooperation with the Institute of Oriental Studies of the Academy of Sciences of RF). Here the author discusses the Arabic edition of Agathangelos' "History of Armenia" the other, independent version of which has received the name "The Life" in Armenology. The discovery of the new edition of Agathangelos' work opens new perspectives for the study of issues in regard to the origin of the version called "The Life". The emergence of the new editions of Agathangelos' work has also proven the truthfulness of a number of data given by Movses Khorenatsi.

## Institute of Language after R. Acharyan

### *Major achievements*

Within the frames of the theme "Issues of General Comparative and Applied Linguistics" (Sup.: DSc(philol.) V.Hambardzumyan) special importance has been given to the problem of the usage of data from Armenian language in the studies of Indo-European – Semitic relations. A reference has been made to Armenian-Latin, Armenian-Italian linguistic relations, the current state and new achievements of Indo-European linguistics, some key differences of traditional and modern Indo-European approaches. The analytical word formation type of Grabar has been investigated. Typological peculiarities of some tense forms of indicative mood have been investigated in the light of modern Typological Linguistics. Separate semantic groups of Armenian have been examined, etymological studies, experimental studies of Armenian phonetic system have been done, the compilation of concordances is in the process.

Within the frames of the theme "Problems of the Historical development of Armenian Language" (Sup.: cand.(philol.) G.Mkhitaryan) the attempts of word interpretations in the fifth century manuscripts have been examined and interpreted. A study of the vocabulary of handwritten dictionaries, colophons, cure books, as well as linguistic examinations of several Grabar and Middle Armenian manuscripts have been done. The influence of Latin on some Middle Armenian translation works has been viewed, terminological systems in different stages of language development have been studied, the peculiarities of historical development of language and grammar studies have been touched upon. The translation of Gr. Tatevatsi's "Girq Hartsmants" into Modern Armenian has been completed.

Within the frame of the theme "Problems of Study and Classification of Modern Eastern and Western Armenian" (Sup.: cand.(philol.) N.Sargsyan) a range of facts concerning Modern Armenian grammar and vocabulary, various issues of text linguistics and syntax, problems of modern colloquial Armenian structure and functioning as well as problems of vocabulary and grammatical manifestations in literary and colloquial languages have been examined. Structural analyses of terminological systems of different spheres have been done. Medical dictionaries and glossaries have been compiled. References have been made to the relationship between language and society as well as to the problems of language regulation. The second volume of the dictionary of Modern Armenian neologisms has been compiled, which includes about 1500 new words, with relevant grammatical explanations and original examples. A number of phonetic and grammatical, lexical and terminological peculiarities of literary Western Armenian language has been investigated, the examination of rapprochment of Western and Eastern Armenian languages has been done. The process of the Western Armenian investigation has been considered starting from 1860s to the half of the 20$^{th}$ century. A practical dictionary of Western Armenian has been compiled.

Within the frames of the theme "Study of Armenian Dialects" (Sup.: cand.(philol.) V.Katvalyan) a description of a number of still unknown systems of dialectical units has been done. The interrelations of literary Eastern Armenian and four dialects of [k] branch, which are used in RA have been studied according to the phonetic-grammatical and lexical systems. The relationships of a number of dialects have been studied by the isoglossic-statistical and lexical-statistical principles. A number of grammatical, lexical, phonetic facts of Armenian dialects have been examined by using linguistic-geographical as well as historical methods.

## Institute of Literature after M.Abeghyan

### *Major achievements*

In the department of ancient and medieval Armenian literature (Sup.: DSc(philol.) V.Devrikyan) the research of Ani, as an image of mourning city, has been carried out through the light of the medieval Armenian and European literature. Thorough analysis of literary expressive means has shown how Ani, as the symbol of Armenian Renaissance, is connoted with the image of a mournful woman. In the process of the work the circumstance to embrace Ani in the universal heritage of UNESCO has been taken into consideration, in the consequence of which Ani will attract more international attention and interest.

The issue on what role the medieval Christian allegoric images have in the imagery system of Armenian symbolism has been tackled. The research has shown that a great array of medieval religious images acquired new interpretation and meaning in symbolistic literature. With the parallel analysis of

medieval Armenian and European symbolism the conclusion has been drawn that the images and literary means that exist in Armenian symbolism were directly taken from medieval Armenian literature and were adapted to the symbolism of the beginning of the 20th century aesthetic system (Sup.: acad. S.Sarinyan).

In the context of literary connections the literature produced in the Armenian colonial settlements of the 14-18th centuries has been compared with the contents of the contemporary Armenian manuscripts and published books in the same countries. The comparative analysis has shown how the literary movement and perceptions found their equivalent expression in the theme of written manuscripts and published books (Sup.: DSc( philol.) H.Edoyan).

## Institute of Philosophy, Sociology and Law

### *Major achievements*

In the frame of the theme "Historical-philosophical, socio-political and legal studies of the Armenian reality" (Sup.: acad. G.Poghosyan) researches have been conducted in four scientific directions: philosophy, sociology, law and political science.

Within the context of the 25th anniversary of the Independence of the Republic of Armenia, a detailed analysis of historical, political, sociological, social, and philosophical developments, as well as achievements of State and society in the years of independence of our country has been made. The analysis of the socio-economic, political and legal problems that should be overcome for the sustainable development of the Armenian state has been made. In this regard, the research of the modern theory of the legitimacy of the authorities, the factors contributing to the political modernization of the country, the legal status of the individual in the context of constitutional reforms, and the relationship of the state to the individual has been carried out.

On the base of conducted researches the scientists of the Institute have presented their findings at three local conferences and published scholarly articles and monographs on the subject. The Institute held an academic conference "Philosophy in the Modern World" dedicated to the World Philosophy Day established by UNESCO. The conference was dedicated to the 25th anniversary of the Independence of the Republic of Armenia.

## Institute of Economics after M. Kotanyan

### *Major achievements*

Within the scope of various research projects carried out in the sphere of Economics (Sup.: corr.member V. Harutyunyan) the need for urgent design and introduction of a new co-funding principle based insurance system has been proposed in order to manage and mitigate the risks associated with the agri-processing business, since intercommunity merging processes could contribute to the effective functioning of the proposed system.

In order to improve the financial performance of agri-processing companies it has been proposed to introduce specific incentives associated with the access to the affordable loans, and purchase of modern equipment and machinery that would initiate and strengthen the cooperation among producers and agri-processing companies, ensuring effective mutual collaboration.

In order to promote and support small and medium-sized entrepreneurship it has been justified and proposed to introduce a lower interest rates funding system by applying post-payment principles within the required time period on received income.

Owing to the strict collateral requirements of the financial institutions an option for uplifting those requirements for farmers has been proposed: good previous credit history of a farmer as a precondition to be qualified for a loan that will ensure higher access to loans and would be an incentive for ensuring higher interests and loan monthly repayments rates, and the creditors would face lower risks associated with non-performing loans.

In order to ensure economic growth, improve the well-being of the population and make the business climate more business-friendly in Armenia it has been proposed to initiate and implement tax system related

reforms with respect to introducing diversified value added tax rates (namely: with respect to first necessity goods and services (of vital importance) based on defining reduced rates), and accelerated depreciation with respect to the corporate tax.

### *Outcomes of applied developments*

Within the scope of the research project "The Issues of Assessment of the Financial and Economic Activities of Economic Agents in the Republic of Armenia and the Approaches to Addressing them" (Sup.: DSc(econom.)A.Bayadyan) on the example of "Yerevan Brandy Factory" CJSC the appropriateness of the newly signed and active contracts between the producers and food-processing companies has been studied, analyzed, and justified; it has been proposed that the Government of the Republic of Armenia needs to subsidize the producers in accordance with the difference between the market price and the defined price floor; and in order to reduce production risks it has been proposed to introduce a new co-funding principle based insurance system since intercommunity merging processes could contribute to the effective functioning of the proposed system.

Within the scope of the research project "The Issues of Integration Processes of the Republic of Armenia" (Sup.: DSc(econom.) A.Tavadyan) the impact of the variables explaining the integration processes on the GDP has been studied; and in order to assess the integration effects of the Republic of Armenia it has been proposed to construct a multivariate regression model. It has been proposed to reduce significantly the difference between the rates of refinancing and the inflation (at least by 2-3 p.p.). It has been justified that in line with current developments in the global energy market, countries like Armenia that heavily depend upon energy import, need to move gradually towards (shift to) the use of the alternative (renewable) energy sources.

## Institute of Art

### *Major achievements*

The work towards studying the activities of prominent representatives of Armenian art has been continued. Among the most conspicuous achievements in this field is the essay, authored by the NAS RA corresponding member Henrik Hovhannisyan, and entitled "The Literary Stage of Suren Kocharyan", which analyzes the art of the outstanding artist of literary stage Suren
Kocharyan. The author characterizes S. Kocharyan as an actor and literary critic, an artist, who had perfected the art of the "theater of one actor". H. Hovhannisyan suggests a fresh approach to the correlation between performing art and literary material – the problem that had been examined in the author's two previous monographs: "The Nature of the Art of the Actor" and "The Stanislavsky System and the Paradox of Acting". The former judgments have been developed further to reveal the correlation between alienation and empathy, or between the bearer of situations and the one representing them on a literary stage, where the so-called public loneliness is excluded. As an example, the art of Suren Kocharyan, the master of literary stage is analyzed. The problem has not been studied to date by theater critics, hence the monograph is the first to address it and thereby supplement H.Hovhnanisyan's former observations and conclusions.

## Armenian Genocide Museum-Institute

### *Major achievements*

Within the program "Armenian Genocide History and Historiography Studies" (Sup.: DSc(hist.) H.Demoyan) a large number of temporary exhibitions were opened not only in the Republic of Armenia, but also in many foreign countries: "Struggling for Life and Dignity: Self-Defense battles during the Armenian Genocide" (Armenia), "Armenian Genocide Front Page Coverage in the World Press, 1853-1925" (France), "The Armenian Genocide: Russian View" (Russia), "The Armenian Genocide" (Latvia), "Armenian Sport and Gymnastics in the Ottoman Empire" (France), "The Road of Aurora: The Odyssey of an Armenian Genocide Survivor" (Armenia), "From Genocide to the Restoration of Independence" (Armenia).

## Shirak Centre for Armenian Studies

### *Major achievements*

In the scope of the program "Shirak's archaeological and historical-ethnographical studies-2" (Sup.: DSc(philol.) S.Hayrapetyan) a hypothesis has been scientifically grounded according to which Aratta country mentioned in the Shumerian records of the second part of III BC millennium was located in the Armenian land. The discovery of old places referring to the old Shumerian culture in the Qeban residence of Western Armenia proves the bond of Shumers with the Armenian land with Euphrates river and likely by that means the name Aratta has been transferred to Shumers.

On the bases of Akkadian and Hittite records a scientific hypothesis has been proposed concerning the old Armenian facts dealing with historical-mythic Sinam king (for example, in the Armenian epic of Tsopq Kharberd is considered to be founded by Sinam king, and it bears the name of the king- Sinamut).

The list of Armenian and Turk ashoughs' names of Kars and Alexandrapol of 19$^{th}$ century has been made and systematized according to ashough musico-poetic metrics, an analysis of sourceological and textological investigation has been done. The exact time period of their activity was fixed for the 40-s of the 19$^{th}$ century.

One new old place was discovered in Shirak region/Ashotsq/. The prospecting excavations carried out in the early bronze age archaeological monument in Mets Sepasar gave us the chance to give the complete picture of the second location with streets and yards. The excavations in Jracor castle were of great importance with their richness and variety: ornamented pottery (pitchers, jugs), different weapons of iron and bronze age.

Research works have been carried out on the number, ethnoconfentional form of refugees-migrants settled down in the province of Alexandrapol in 1914-1918.

## Armenian encyclopedia. Publishing house

### *Major achievements*

Armenian Encyclopaedia. Publishing House has published the first volume of "The Encyclopaedical Dictionary".

## National Bureau of Expertise SNPO

### *Major achievements*

The Director of the National Bureau of Expertises (NBE) took part and made reports at two significant legal international conferences: the VI St. Petersburg International Legal Forum and the 28th ENFSI Annual Meeting held in the Forensic Science Unit of the Basque Country Police in Bilbao, Spain.

The project: "Science for Peace and Security (SPS) Program, Solid State Gas Sensors for Security and Military Threats" has been continued. Within this project "Agilent 7820A GC" Gas-chromatography device, "Drager X-am 7000" model gas analyzer and 6 test sample gases have been obtained. A number of researches of standard and gas samples under examination have been implemented through this devices and already developed methods, the data analyses, derivation of the calibration curves, quantitative calculation have been carried out.

Research works within the frames of the A-2151 project jointly with the Center for Medical Genetics and Primary Health Care have been continued. Within the program skin biopsy in selected patients has been performed and 3 primary seeding for each patient has been done, from which a number of reseeding necessary for obtaining cells have been done. One reseeding from each patient was sent to Denmark for carrying out further functional analysis of a cell. In the framework of the program the following has been also developed: a) a medical directive involving program problems, which was approved by the Ministry of Health, b) a family history form, c) a basic MR standardized questionnaire and d/ an explanatory algorithm of the clinical and scientific activity.

The Scientific Research Center of Applied Problems in Criminology of the NBE in cooperation with the Innocence Project and the Helsinki Committee of Armenia has started to implement the "The American experience of the fatal error correction" program. The aim of the program is to accept a law on maintenance of evidence through relevant legislative amendments. Studies on verdicts of 99 people sentenced to life imprisonment in RA have been carried out, which will help to disclose the evidence base of the verdicts, have the answer, if the mentioned base is enough to deliver a judgment, whether this evidence is maintained for future examination in the conditions of current scientific developments.

Scientific and practical center of two departments (forensic Medicine and Medical Genetics) of Yerevan State Medical University after Mkhitar Heratsi (YSMU) has been opened in the NBE. The main goals of the center are joint implementation of scientific projects, introduction of innovative technologies, consultation regarding expertise and researches, which would enhance the quality of their conduction in these professions.

Within the framework of international cooperation the regular session of Board of European Network of Forensic Science Institutes (ENFSI) was held in Yerevan headed by the Chairman of the Board Jean De Kinder.

NBE has actively participated in the activities of the European Network of Forensic Science Institutes (ENFSI). The employees of the organization took part in European Drugs Summer School on ”Illicit drugs in Europe” (Lisbon, Portugal), as well as at the final meeting of the Expert Working Group “Firearms/GRS”( Dresden, Germany).

At the meeting of the President of the Nagorno Karabagh Republic Bako Sahakyan with the director of NBE issues connected with cooperation of NBE with corresponding organizations in Artsakh have been discussed. The objective of this cooperation is implementation of education and training courses for the specialists with necessary qualification for the field of expertise, provision of continuous professional education, development of programs for forensic field, implementation of research and innovation programs, exchange of scientific, educational, informational and methodological literature.

The cooperation links were continued with forensic centers of Russia, Ukraine, Moldova, Belarus, and Memorandum of Understanding to extend the agreement was signed with National Forensic Bureau in Georgia.

During the accounting period experts and specialists of the organization trained 360 employees of competent bodies who have the responsibilities to get the initial data for expertise and the authorities to nominate expertise.

### *Outcomes of applied developments*

11594 forensic expertises have been conducted, expertise research has been carried out on 28 forensic directions and 129 forensic subtypes and technological directions..

Urgent investigations appointed by the relevant authorities have been continued to be performed and within the law of criminal procedure operating in the RA, the organization has conducted expertises with around Manuals entitled "The discloser of criminological and victimological factors of robberies and banditism" and "The fight against trafficking and forced labor, in armed forces". The economic and accounting expertises department of the organization has carried out studies, examinations and published a manual entitled "Expert's guide (The field of expertise on regulatory framework)".

The organization’s firearm and food products testing laboratories accredited by "National Accreditation Body" SNPO continued their activities as testing laboratories in compliance with the requirements of legislation of the RA about Accreditation system and ISO/IEC 17025-2005 standards.

The food products testing laboratory took part in the international qualification verification test (PT). Corresponding calibration schedules of measuring have been drawn up for taking part in qualification verification tests in the fields of accreditation.

The certification body for twofold purpose and military purpose goods and technologies (products) of the organization accredited by "National Accreditation Body" SNPO also continued its activities corresponding to ISO/ IEC 17065-2013.

A number of activities in 3 areas (drugs, metals and alloys and coatings) directed to international accreditation have been conducted in the Physical Technical Examinations and Chemical Expertises Department in accordance with ISO /IEC 17025:2005 standard requirements. Especially, a set of documents (quality manual, procedures, instructions, forms, etc.) concerning the quality management system operating

in the organization within INL Program and the above-mentioned fields have been translated into English. Besides, a number of procedures have been revised or newly approved by Physical Technical Examinations and Chemical Expertises Department and Quality Assurance Department.

Within INL program supported by the US Embassy staff a process of selecting ILAC appropriate members has begun, which in 2017 will pay a preliminary visit, assessment, and subsequent work related to accreditation process.