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ЕРЕВАНСКИЙ ФИЗИЧЕСКИЙ ИНСТИТУТ

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PHYSICS IN ARMENIA IN THE SECOND HALF OF THE XX CENTURY AND THE MAIN REGULARITIES OF ITS DEVELOPMENT

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ФИЗИКА В АРМЕНИИ ВО ВТОРОЙ ПОЛОВИНЕ XX ВЕКА И ОСНОВНЫЕ ЗАКОНОМЕРНОСТИ ЕЕ РАЗВИТИЯ

В работе дается характеристика физических исследований в Советской Армении. Отмечается, что систематические исследования были начаты в 1943 г. с созданием Физико-математического института и что с самого начала проводимые работы отличались оригинальностью, а результаты получили всеобщую известность. При этом на примере Армении прослеживаются закономерности, свойственные развитию науки как в нашей стране, так и в мире. Приводятся основные достижения физики в Армении в контексте с рассматриваемыми закономерностями развития науки. Рассматривается также организационное развитие физической науки, образование новых институтов и лабораторий. Отмечаются перспективные направления дальнейших исследований.

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1. Introduction

In the history of development of physics in Soviet Armenia there are distinguished three rather distinct stages, about 20 years each[1]. The first stage begins since the establishment of the Soviet Government and the foundation of the Yerevan State University (YSU),-that is the formation stage including the period from 1920 to 1942. The second stage is characterized by the beginning of systematic investigations in modern physics and covers the period from 1943 to 1959. Finally, the third stage beginning since 1960 is the stage of rapid development of the physical science in the Republic. In the beginning of the sixties Armenia entered the period of the modern scientific-technical revolution with a number of regularities peculiar to it. Since that time the scientific researches in Armenia begin to be rather actively included in the science development process all over the Union. As was mentioned by academician V.A.Ambartsumian, the president of the Academy of Sciences of the Armenian SSR,"the researches being carried out in various republics and their results are so closely connected and mixed up that it does not always seem possible to distinguish and emphasize what refers to the given republic"[2]. At the same

time each republic usually has its own features and does not repeat the researches carried out in the other republics and in the whole Union. This refers also to Armenia where some trends of physical researches have developed with the crucial contribution made to them by the physicians of the republic.

2. The Beginning of Researches (1943-1960)

In 1943 the Academy of Sciences of the Armenian SSR (AS Arm.SSR) was founded, and simultaneously there was organized the Physico-Mathematical Institute (Phys.Mat.Inst.), from which in 1946 the Physics Institute of the AS Arm. SSR (since 1962- the Yerevan Physics Institute - EPI) was separated, A.I.Alikhanian, (1908-1978), the academician of the AS Arm.SSR(Corresponding Member of the Academy of Sciences of the USSR (AS USSR) since 1948) being the head of it. At first the main subject of researches at the institute was cosmic ray physics. These researches not only had their own features, but also have made a significant contribution to science [3].

In 1946 the Bjurakan Astrophysical Observatory (BAO) was founded, with V.A.Ambartsumian, the academician of the AS Arm. SSR, the Corresponding Member of the AS USSR (academician since 1953) at the head of it. From the very beginning the researches performed in the observatory and the concepts developed were remarkable for their originality and nontraditional character. As a result of analysis and interpretation of the observed data the cosmogonic conception significantly differing from the conventional one has been formulated by V.A.Ambartsumian. It consists

in the idea that the star formation is considered the consequence of decay of the prestellar protomatter being in the superdense state, and not the result of the gas-dust matter condensation.

Since 1950 in the Bjurakan observatory radioastronomy started to develop, this having led later on to the original radio-physical researches inherent to the Armenian republic.

In the fifties, theoretical physics began to develop actively in the republic. The theory of the charged particle passage through the matter received a large development effort. In those years while elaborating radiation physics M.L.Ter-Mikaelian (academician of the AS Arm. SSR since 1982) created the coherent bremsstrahlung (CB) theory, and G.M.Garibian (academician of the AS Arm.SSR since 1971) developed the X-ray transition radiation (XTR) theory proceeding from the problems of high energy physics. The theoretical investigations in these fields performed by a great number of Armenian scientists have led in the end to the practical output confirming the regularity that the fundamental researches must outstrip the applied ones[4] and finally find their application in technique, technology. Moreover, the fundamental researches beginning with the theoretical works may have a practical application in the same fundamental researches, and even the output to the national economy. Practically, such a process is observed in all the branches of science. It is noticeable also in the CB and XTR investigations. Thus, the CB theoretical studies have resulted in the elaboration of the methods to obtain the polarized and

monochromatic γ- quanta. The further extension of these studies and, particularly, the investigation of the channeling process has led to developing the method of nondestructive testing of defects in various material structures and its application for investigating the radiation damages in solids. The same may be said about the transition radiation, the study of which first resulted in constructing the XTR-detectors of superrelativistic charged particles having found a wide application in the physical experiment technique; then its usage, e.g., as a soft X-ray radiation source [5] or in superhigh frequency electronics [6] was outlined.

Finally, note the works of V.A.Dzhrbashian (since 1982 - Correspondent Member of the AS Arm. SSR) performed at the end of the fifties, and devoted to the polarization effects in muon atoms. Those works promoted the interpretation of the experiments on parity nonconservation in weak interactions.

The researches in cosmic ray physics have stimulated the elaboration of acceleration physics in Armenia. Under the leadership of A.I.Alikhanian and with the support of academicians V.A.Ambartsumian and A.I.Alikhanov (1904-1970) the electron accelerator with 6 GeV energy was constructed in 1967 in Yerevan. A great volume of work was performed on designing the accelerator and then, on its modernization. The new sources of accelerated particles were designed, the new principles of acceleration were elaborated. The Yerevan electron accelerator is still a unique installation in the USSR. Many experiments have been performed on the accelerator jointly with the physicists of the leading institutions of the country as well

as with the foreign scientists.

In the fifties there were started the researches on solid-state physics, mainly, into the X-ray structure analysis,- the researches that later on gave an output to the national economy.

Thus, by 1960 the following trends of investigations had received a development effort in Armenia: astrophysics, cosmic ray physics, theoretical physics. The investigations in the fields of radiophysics, acceleration physics, and solid - state physics had been started. Each of the mentioned branches developed with account of the possibilities and scientists living in the republic in coordination with the researches carried out in the whole country. There was formed a scientific society of physicists performing, in the main, normal sc ntific investigations within the framework of concepts accepted in the scientific world.

However, it is not out of place to mention here the astrophysical investigations being performed in the Bjurakan observatory from the inordinary positions and having the revolutionary character. At the end of the forties, in the beginning of the fifties V.A.Ambartsumian made two discoveries of principal significance for natural sciences in general. The first is the discovery of the stellar systems of the new type named stellar associations, the second is the discovery of the role of galaxy nuclei activity in the galaxy evolution. The stellar association discovery was "the first observational evidence in favour of the concepts of the star formation process going on at present in the Galaxy [7] , as well as of that the origin of the celestial bodies is the result of decay of the superdense

matter. The nonstationary phenomena in the galaxy nuclei also required an assumption of the superdense massive formations existing in them. All that testifies that in astrophysics there is observed a crisis situation in the sense of T.Kuhn [8,9] . Many astrophysicists - theorists do not accept the superdense matter concept, though the idea about the galaxy nuclei activity, also not perceived previously by the majority of scientists, has become conventional now. Just for this reason in the book "The Heritage of Copernicus" [10] the revolutionary idea about the explosive galaxies is called the idea of the Copernican type. The uniformly expanding stationary Universe concept was changed into the one of the nonstationary Universe with the giant explosive processes in it.

3. Rapid Development (since 1960)

Since 1960 the physical investigations in Armenia have been sharply extended. While before 1960 the main part of them (not counting astrophysics) was carried out by the Physics Institute of the AS Arm.SSR, since 1960 there have been founded the new institutions in order to develop in the Republic those branches of physics the need for which began to be felt owing to the development of industry and other branches of science. To extend the investigations a sufficient material basis had already been created and the skilled scientists had grown up.

In 1960 in Ashtarak there was founded the Radiophysics and Electronics Institute (RPEI) of the AS Arm.SSR headed by

E.G.Mirzabekian (1922-1980), the young doctor of sciences, the active organizer of science (academician of the AS Arm. SSR since 1974) who played a great part in organizing the radiophysical investigations in Armenia.

In the beginning of the sixties in the Physics Institute there had been organized the Laboratory of Polymers which in 1962 separated as an independent scientific institute- the Central Research Physico-Technical Laboratory (CRPTL) headed by N.M. Kocharian (1906-1967), the Corresponding Member of the AS Arm. SSR (since 1956). Simultaneously, attaching great importance to the training of highly skilled specialists, N.M.Kocharian had sent many young specialists to the post-graduate studentship in the big scientific-research centers of the country and later, on returning to the Republic, they began to work in the scientific institutes of Armenia.

The research laboratories attached to the Physics Department of the Yerevan State University began to be organized. During 1961-1963 there were established the Problem Laboratories of Semiconductor Physics, Radiation Physics and Solid-State Physics, and then the Chairs of Radiation Physics and Semiconductor Physics. The Earth Artificial Satellite Observation Station was founded.

In 1966 the Research Technological Institute of Microelectronics (RTIM) was founded.

In 1967, on the basis of the CRPTL of the Arm. SSR the Physical Research Institute (PRI) of the AS Arm. SSR was founded, headed by M.L.Ter-Mikaelian.

In 1968, on the basis of the Superhigh Frequency Department of the RPEI of the AS Arm.SSR there had been organized the Department of Radiophysical Measurements of the All-Union Research Institute of Physico-Technical and Radiotechnical Measurements (AURIPTRM), which in 1971 grew into the All-Union Research Institute of Radiomeasurements (AURIRM) headed by P.M.Gerumi (Corresponding Member of the AS Arm.SSR since 1982). In 1978 for the first time in the Republic there was established at the YSU the Research Institute of Condensed Media Physics (RICMP), headed by Professor V.M. Harutunian. Finally, in 1980 at the AS Arm.SSR the Department of Applied Physics Problems (DAPP) was organized as an independent RI headed by A.R.Mkrtchian, the doctor of sciences. In 1984 the DAPP of the AS Arm. SSR developed into the separate Research Institute of Applied Physics Problems (IAPP) of the AS Arm. SSR. In those years in the Republic there were also founded some institutions who shared their activity between physics and technics.

Thus, during 20 years, since 1960, in the Republic there have appeared 6 large independent research institutes and a number of problem laboratories attached to the YSU. This is illustrated in Fig.1.

The development of science itself, a large number of researches, performed for the national economy, the Space investigations have led to founding in Armenia a respectively large number of new physical institutes, this being one of the manifestations of the modern scientific-technical revolution, since the physical conception is at the head of technical sciences. In other words, the rapid development of physical

researches has been one of the precursors of the modern scientific-technical revolution. The regularities peculiar to the scientific-technical revolution are becoming fully apparent. This is, first of all, the new level of science differentiation and integration, when they appear as one process owing to the science intensification. The fundamental researches are becoming of great importance. Their outstripping character as compared to the applied researches is vocated to secure the development perspectives for the latters. The fundamental researches are becoming more and more closely connected with the modern technics and industry. The integration of fundamental and applied researches is taking place. The discovery of the science and technics development regularities, the historical experience make it possible to elaborate the purpose programmes on solving the most important scientific-technical problems on the basis of prognostigating the development tendencies. The complicatedness of the problems standing before science, and particularly before the fundamental one, the necessity to solve them in close connection with the modern technics and industry have a stimulating influence on the industry, providing it with the new potentialities, new equipment. The principle of labour division in science - the concentration of a certain aspect of researches in a concrete republic, particularly, in Armenia, at the great participation and collaboration of many institutes of the country, becomes more and more significant, this reflecting, in turn, the unity of the soviet science.

Let us consider these regularities, particularly in Armenia.

A. The largest physical institute is EPI, headed since

1973 by Professor A.Ts.Amatuni. The cosmic ray investigations are continuing in the Institute, but they are aimed at the energy region inaccessible yet to the accelerator technique. A long-term programme of researches that must preserve its actuality till 2000 [11] is elaborated. At the high-altitude station "Aragats" there is functioning the unique "PION" installation the most important parts of which are the XTR-detectors being, as was mentioned, the result of theoretical researches of the Armenian physicists. The created scientific-technical basis has served as grounds for uniting the efforts of many institutes of the country and founding the All-Union Cosmic Station on Mountain Aragats. Namely, in the beginning of the eighties the EPI jointly with the Physical-Institute of the AS USSR (PIAS USSR, Moscow) began to construct the biggest in the world complex installation "ANI" (Hadron Ground Investigations) to study the superhigh energy hadron interactions [12] . Such a collaboration testifies to the soviet science unity and is not limited to the given example [13]. Starting up the EPI electron accelerator proved to be a remarkable event in the Soviet and world science. , The fact of its presence in Armenia equalizes the republic with the world greatest scientific centres on studying high energy elementary particle physics-the van of modern science. On the accelerator there were started the systematic experimental researches into the elementary particle electromagnetic interactions. Under the guidance of H.A. Vartapetyan (the academician of the AS Arm.SSR since 1977) there was constructed the modern complex of experimental equipment connected with the computer, by means of which there were

performed a great number of experiments on meson photoproduction on nucleons and nuclei, awarded in 1980 the State Prize of the Arm. SSR. By means of monochromatic and polarized - quanta the asymmetry of the meson photoproduction reaction cross sections on the liquid-hydrogen and liquid - deuterium targets was studied. Though the accelerator has been operating successfully and interesting researches have been carried out by means of it, still it is far from exhausting all its possibilities. There is a large number of works for the other accelerators of the world as well, but the scientists have already encountered a question: how far is it possible to advance in the high energy region using the traditional methods of acceleration and are the principally new methods of acceleration providing considerably higher rates of the charged particle acceleration possible or not? Thus, a problem has arisen: to find principally new ways of accelerating charged particles. The Armenian physicists have become the initiators of the wide All-Union discussion of this question. On the initiative of A.Ts.Amatuni there was held a representative workshop that outlined the first steps on this way. There are all the premises of the further differentiation and integration of various directions of physical researches for solving the raised problem.

The investigations on the elementary-particle physics have provoked the occurence of the new trend (differentiation) - instrumental physics. In this field there is also a certain progress in Armenia. To construct the experimental installations not only the world attainments of the physical experiment technique were used, but the new, original methods and apparatus

were also created. Besides the mentioned XTR- detectors, the monochromatic and polarized γ- quanta beams, there were constructed the magnetic mass spectrometers, the description of which is included in many test-books (the Alikhanov-Alikhanian) mass spectrometers), was elaborated the track chamber methods awarded the Lenin Prize of 1970 (A.I.Alikhanian, T.L.Asatiani jointly with the scientists of Moscow and Tbilisi), were synthesized the plastic scintillators awarded in 1980 the Gold medal in the Leipzig fair, etc.

The electron accelerator - an instrument for fundamental researches, on which, as was mentioned, a great programme of elementary-particle and nuclear physics researches was fulfilled, began to be used for the applied purposes. This was the manifestation of the fundamental and applied research integration peculiar to the modern science. The synchrotron radiation (SR) being an interference at the electron acceleration is becoming a powerful tool for studying solids. The Yerevan electron accelerator as a source of synchrotron radiation is beginning to be actively used for applied purposes. By means of it the calibration of the astrophysical apparatus mounted in the artificial satellites was carried out, the investigations of properties of the radiation defects in solids, as well as of the SR influence on the biological objects were started. Great opportunities of revealing structural peculiarities of solids by means of SR are offered by the method of Extended X-Ray Absorbtion Fine Structure (EXAFS) which has also begun to be used in Armenia. During the works with the application of SR the Armenian scientists collaborate not only with the scientific centres of the country (e.g. the Institute of Semiconductors

of the AS USSR, the Institute of Solid-State Physics of the AS USSR, etc), but also with those of foreign countries (e.g. the Central Electrophysics Institute of the Academy of Sciences of the German Democratic Republic). The application of the ionizing radiation sources intended for the fundamental researches allowed to introduce a number of achievements into the industry, which, thus, have enriched its equipment, and yielded economical effect.

B. Since the sixties the theoretical physics works have been essentially activated. The investigations on the theory of the charged particle passage through matter were traditionally continued. These works have been recognized all over the world, the evidence of which are two international symposia on the high-energy particle transition radiation that were held in Yerevan in 1977 and 1983 [6,14].

The studies of the fast electron and positron radiation at their passage in certain directions of the crystal lattice (the channeling) have received the further development effort. The collaboration of the EPI with the I.V.Kurchatov Atomic Energy Institute on the study of this radiation properties has been outlined. Important experimental results have been obtained in joint researches of the EPI, Kharkov Physico-Technical Institute and Stanford Linear Accelerator. On the Stanford accelerator the beams of high-energy positrons with the energy 4 to 14 GeV were obtained and the spectra of the electromagnetic radiation of positrons of their channeling were for the first time measured.

In the beginning of the sixties academician V.A.Ambartsum-

ian and G.S.Sahakian (academician of the AS Arm.SSR since 1982) performed the fundamental investigations on the degenerate superdense gas of the elementary particles. Thus, in the theoretical astrophysics there was founded a new trend-the physics of superdense celestial bodies, which began to develop at the Chair of Theoretical Physics of the YSU Physical Department. This trend arose at the boundary of several disciplines: the gravitation theory, nuclear physics and elementary particle physics. It is the manifestation of unity of the science differention and integration processes: the extraction of the new trends (differentiation) of researches at the junction of several disciplines (integration). Thus, D.M.Sedrakian (Corresponding Member of the AS Arm. SSR since 1982) suggested the mechanism of formation of the strong magnetic fields in the rotating neutron stars by means of the ideas of the superfluidity and superconductivity theory. The concept of the superdense- state matter suggested by V.A.Ambartsumian has proved to be highly fruitful and found its application in nuclear and elementary-particle physics (the quark-gluon plasma occurring in the superdense state not only in astrophysical objects but also in the relativistic nuclei collisions).

As was mentioned earlier, the elementary-particle theory began to be studied in Armenia as far as in the fifties. At first the concrete calculations of effects in quantum electrodynamics were performed. In the sixties the elementary-particle theory development began to be determined in many respects by the problems occurring in connection with the experiments planned on the accelerator being constructed. The questions

of the strong interaction theory, field theory were studied along with the electrodynamic problems. On the basis of investigating the Compton effect on the moving electron the Yerevan physicists suggested the method of obtaining the high-energy photon polarized beams. At the end of the sixties, in the beginning of the seventies the activity of physicists being concerned with the elementary-particle theory grew higher. The range of investigations widened significantly and covered practically all the most important trends of the elementary-particle physics, including the theory of electromagnetic, strong, weak and gravitational interactions. It should be noted, that the elementary-particle theory is a rather rapidly developing field of science. Many search works are performed here, particularly the ones concerning the information of all the interactions known in the nature-the problem, the solution of which is prognosticated by the World Association of Physicists. The physicists of the Republic seriously consider the fundamental researches of the theory principal questions. Under the guidance of S.G.Matinyan (Corresponding Member of the AS Arm. SSR since 1982) great successes were achieved in the studies on the quantum chromodynamics - the theory pretending to the description of the elementary-particle strong interactions. Particularly, the gluon condensation phenomenon - the energy decrease of the main state in the gluon field (the Matinyan-Savvidy effect), was discovered theoretically. The discovery of this effect gave rise to the new direction in the gauge field theory both in our country and abroad. In July 1983

in Yerevan there was held a Soviet-American Workshop on the Gauge Theories, where 10 of 50 reports were made by the EPI theorists. Many theoretical works are performed in connection with the experiments on the Yerevan accelerator and the other accelerators of the world.

C. Since the sixties the investigations indissolubly connected with the All-Union purpose programmes on the solution of the most important R&D problems have been receiving still larger development effort. Thus, since the foundation of RPEI of the AS Arm.SSR in 1960 the Republic has begun to take part in realization of the space research programme. The investigations on creating the radiosystems for the super-distant space communication, radiolocation, radionavigation, radioastronomy, etc, have developed extensively. The unique radiometers for various radiosystems of the USSR were developed and constructed under the guidance of E.G.Mirzabekian. The works on masers began to hold large place in the researches. Thus, e.g. for the greatest in the USSR radiotelescope PATAH -600 at the RPEI there was constructed the maser radiometer for the 1,35 cm wave-length. Since 1980 the director of the Institute is R.M. Martirossian who heads the works on constructing the masers on the decimetric, centimetric and millimetric wave bands.

The new trend of scientific researches-antenna measurement metrology, which began to develop in Armenia, becomes of All-Union significance. At the AURIRM there was organized the All-Union Antenna Measurement Standard Centre, were elaborated the Antenna and SHF phase measurement State standards.

D. 1. The consequence of integrating the fundamental and applied investigations was the extension of the solid-state physics investigations begun in the sixties. Such trends of investigations as quantum electronics and nonlinear optics, semiconductor physics, closely connected with the industry, were new for Armenia. Thus, the YSU Chair of Solid-State Physics together with the Problem Laboratory organized in 1964 became the centre of the solid-roentgenographic studies-the studies of great applied significance. The theory of real X-ray beam scattering in crystals elaborated at the Chair Solid-State Physics allowed to develop new methods of studying the Imperfections in Solids.

2. In the beginning of the sixties, under the leadership of N.M.Kocharian there were started the polymer physics extensive investigations having led to discovering in polymers a number of interesting properties, particularly, piezoelectric and pyroelectric. Those works also had an applied character from the very beginning. The PRI having been founded, a part of the solid-state physics studies carried out at the CRPTL was continued at the PRI and the Computing Centre of the AS Arm. SSR.

3. Besides, in the beginning of the sixties in the Radiation Physics Problem Laboratory of the YSU the studies in the new, rapidly developing field-quantum electronics, were started under the guidance of M.L.Ter-Mikaelian. In the Republic there had already been organized the production of synthetic rubies at the Kirovakan Chemical Factory and their treatment at the Arzni Accurate Technical Stone Plant. Therefore the studies

begun at the YSU and then continued at the PRI were highly actual for the Republic and were stimulated by the already developing industry. In a short time the first successes were achieved and the ruby laser full-scale production at the Arzni Plant was organized; the generator "Razdan-2" was demonstrated in the Leipzig fair. The new techniques of growing various crystals for quantum electronics were developed. Due to the collaboration with the physicists the industry of Armenia became ready for producing the ruby elements for the lasers. For many years the Kirovakan Chemical Factory and the Arzni Accurate Technical Stone Plant were the suppliers of the ruby active elements for the whole country. For these works on the industrial organization and production of the corundum ware a group of engineers of these enterprises was awarded in 1975 the State Prize of the Arm.SSR. The works on quantum electronics, growing crystals for it were carried out in close connection with many central research institutes of the country. And it is no mere chance that for a cycle of works on investigating, developing and organizing the industrial production of pulsing solid-state lasers for the scientific researches and technological purposes the collective of scientists and engineers of the Arzni industrial union "Sapphire", was awarded in 1980 the State Prize of the Arm. SSR.

4. The quantum electronics investigations extended still more after founding in 1978 the RICMP, where there were constructed the original devices - new lasers for the national economy having been demonstrated at the Exhibition of the National Economic Achievements of the USSR and awarded the medals,

as well as a number of other instruments.

The development of quantum electronics in Armenia stimulated the nonlinear optics investigations that had been started by M.E.Movsessian (Corresponding Member of the AS Arm.SSR since 1977). The resonance phenomena in gases and metal vapours began to be studied theoretically and experimentally, this having led to discovery of a number of new effects and phenomena.

5. In the field semiconductor physics the works were began by G.M.Avakiants (1919-1984) (Corresponding Member of the AS Arm. SSR since 1965) and were aimed mainly at the creation of new fundamental elements with various properties for their application in the nontransistor electronics and microelectronics. The works are carried out in various aspects and at many institutes of the Republic, (RPEI, YSU, Yerevan Polytechnical Institute, Yerevan Pedagogical Institute, EPI) mostly in collaboration with the leading centres of the country.

6. The works performed at the IAPP of the AS Arm.SSR are of great fundamental and practical significance. The ultra - sound coherent influence leading to the oscillations of the Messbauer absorption spectrum compounds having been detected by the scientists of the DAPP served as a basis for practical applications. The Messbauer spectroscopy and its possibilities are widely applied in acoustophysics to construct the devices and apparatus necessary for the national economy. Of great importance appeared the discovered in 1982 possibility to transfer the whole intensity of the X-rays incident on the crystal to the Bragg direction by means of ultrasound or temperature gradient. The X-ray deflector was constructed basing

on this effect.

7. The orientation of scientific researches (including the fundamental ones) on the construction of new devices and technologies, as e.g. at the IAPP, is one of the manifestations of the process of transforming the science into the productive force of the society [15]. The products of the most modern branches of science and technics are called in our days the "science-overfilled" production, which is the result of the almost direct introduction of the R&D into the new technology and production. It means that the motto of the future is superior technology and the account of the science development modern tendencies requires more and more serious attention to the science planning and financing, to organizing its interaction with the industry.

8. Thus, the period since 1960 is characterized by a number of peculiarities:

- the number of physical institutes in the Republic has rapidly increased;
- the physical researches covering, practically, the majority of the most important trends, have considerably extended (for details see [16]);
- the All-Union relations of the physicists of the Republic have become stronger and closer;
- the works carried out in Armenia have been recognized all over the Union and the world [13];
- the scientific production has considerably increased;
- the connection with the industry has become closer, and the significance of the applied researches has grown;

As one more quantitative illustration of the rapid growth of the physical activity in the Republic since 1960, Fig.2 presents the number of printed works of only one institute of the Republic - EPI - before 1960 and since then. It is apparent from the figure that since 1960 there has begun the new stage of physics development in Armenia: the Republic begins to be extensively drawn into the process of modern scientific-technical revolution.

Thus, in a relativity short period of time, a little more than 60 years, Soviet Armenia has turned into a republic of advanced science and technics. The successes achieved are due to the socialist way of development, active participation in the modern scientific-technical revolution, enthusiasm of the scientists of the Republic and extensive collaboration with the leading scientific centres and industry of the country.

In conclusion the authors would like to express their gratitude to A.Ts. Amatuni and V.P.Vizgin for the attentive reading of the manuscript and useful remarks, as well as to all the colleagues, the discussions with whom promoted the clearing up of questions set forth in the paper.

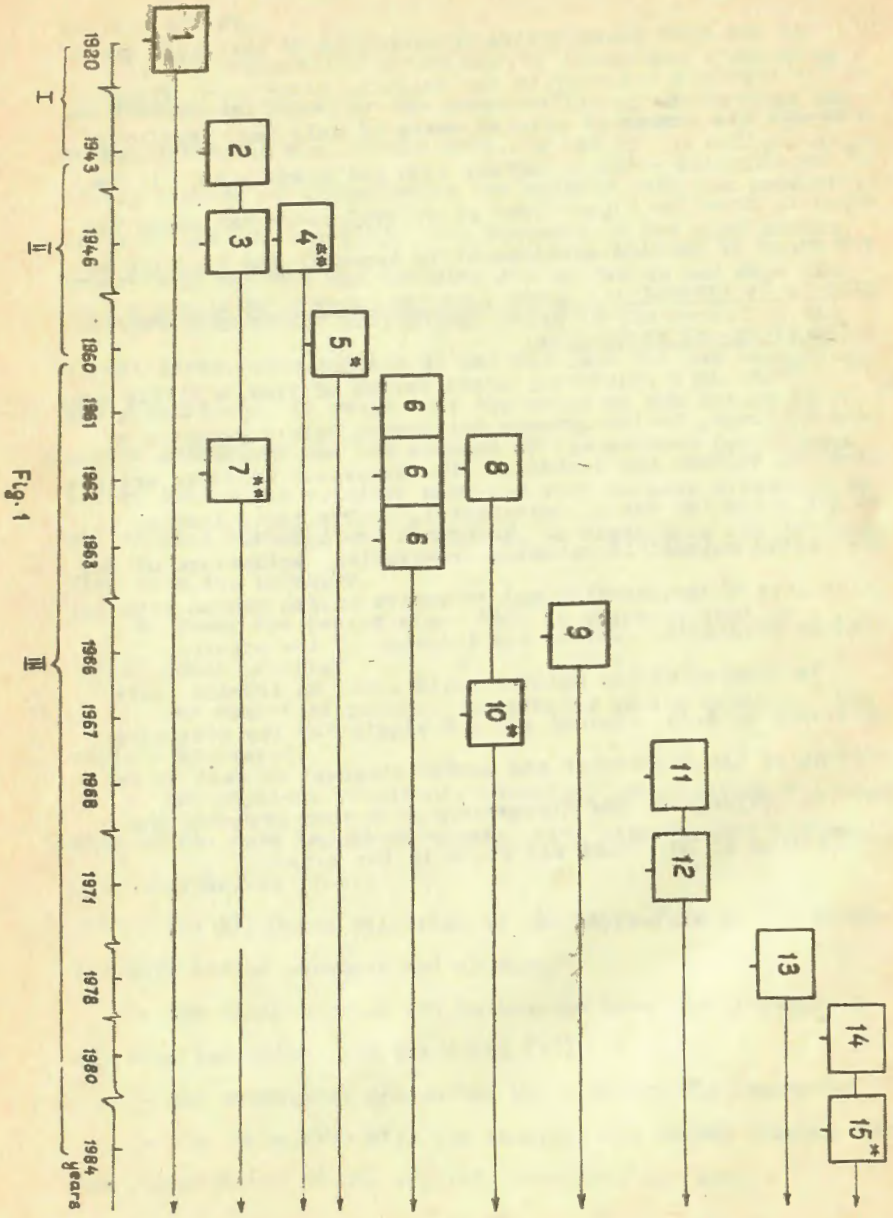

Fig.1

Fig.1 The dynamics of the growth of number of the physical research institutes of the Republic. Asterisks at the institutes names denote those having the councils of conferring the bachelor's (single-aster.)or doctor's (double aster.) degree.

1. YSU
2. Phys.Mat.Inst. AS Arm.SSR
3. PI AS Arm SSR
4. BAO**
5. RPEI*
6. Probl.Lab. YSU
7. EPI
8. CRPTL
9. PRI
10. RTIM
11. AURIPTRM department
12. AUPTRM
13. RICMP
14. DAPP AS Arm.SSR
15. IAPP*

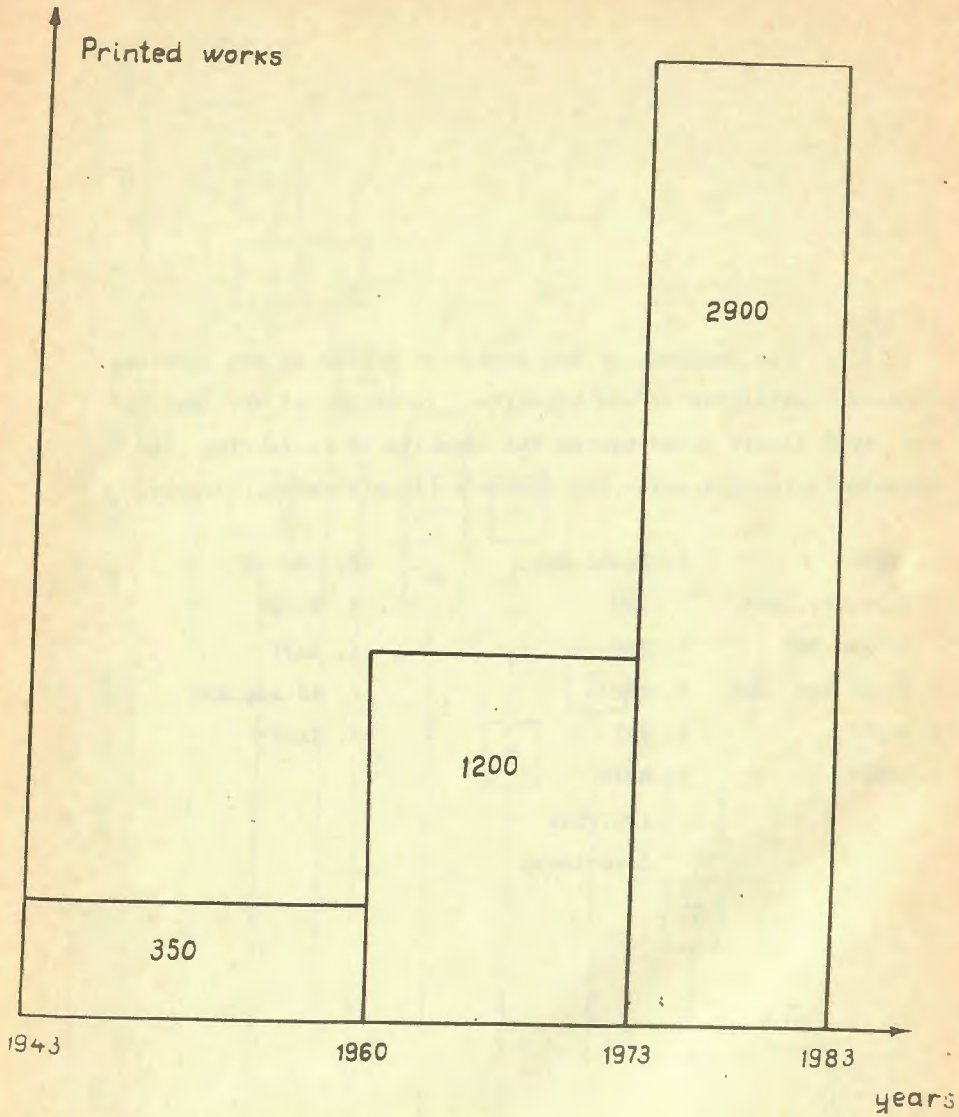

Fig.2 The dynamics of the EPI printed works during 40 years.

References

I. Гарибян Г.М., Сардарян Р.А. Основные направления развития физики в Армении. Известия АН АрмССР, Физика, I980, т.I5, с.409-4I6.
Garibyan G.M., Sardaryan R.A. Basic trends in the development of physics in Armenia. In XVIth Int.Congr.Hist.Sci. Bucharest 1981 sec. 3/4, p.2-11.

2. Амбарцумян В.А. Наука в Советской Армении. В сб.Советская наука: итоги и перспективы. М.: Наука, I982, с.46I-475.

3. Аматуни А.Ц., Асатиани Т.Л., Мамиджанян Э.А., Сардарян Р.А. Итоги первых высокогорных экспедиций по изучению космических лучей. Известия АН АрмССР, Физика, I983, т.I8,с.263--275.

4. Гарибян Г.М., Сардарян Р.А. О некоторых закономерностях развития науки и техники. Известия АН АрмССР, Физика,I98I, т.I6, с.I58-I69.

5. Библиография работ по переходному излучению заряженных частиц. Изд. 3-е,дополненное и переработанное. Составители Л.А.Варданян, И.Г.Мелкумова/ под редакцией Г.М.Гарибяна. ЕрФИ, Ереван, I983.

6. Материалы II симпозиума по переходному излучению частиц высоких энергий, ЕрФИ, Ереван, I984.

7. Амбарцумян В.А., Мирзоян Л.В. Астрофизика. В сб.Достижения науки в Советской Армении. Изд.АН АрмССР, Ереван, I984, с.52-63.

8. Кун Т. Структура научных революций. М.: Прогресс, I975.

9. Физика XX века: развитие и перспективы. М.: Наука, 1984.

10. The Heritage of Copernicus. The Copernican Volume of the National Academy of Science, ed. T.Neyman. MIT Press, Cambridge, Mass., 1974.

11. Аматуни А.Ц. Физика высоких энергий в Армении. Вестник АН СССР, 1980, т.11, с.108-120.

12. Сотрудничество ЕрФИ-ФИАН СССР: Аматуни А.Ц., Мамиджанян Э.А., Матинян С.Г. и др. Известия АН АрмССР, Физика, 1982, т.17, вып.3-4, с.129-232.

13. Гарибян Г.М., Сардарян Р.А. Армянская физика на всесоюзной и международной аренах. Известия АН АрмССР, Физика. 1982, т.17, с.301.

14. Труды I Международного симпозиума по переходному излучению частиц высоких энергий. Ереван, ЕрФИ, 1977.

15. Винокуров В.А., Митин Б.С. Технология и наука. Вопросы философии, 1965, № 1, с.55-63.

16. Гарибян Г.М., Сардарян Р.А. Физика. В сб.Достижения науки в Советской Армении. Изд-во АН АрмССР, Ереван, 1984,с.36-52.

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