

GENNADII ANDRIYOVYCH MELKOV (to the 80th anniversary of his birthday)



September 24, 2019 marked the 80th anniversary of the birthday of Gennadii Andriyovych Melkov, the well-known Ukrainian radiophysicist, the Honored Worker of Science and Engineering of Ukraine, and the Honored Professor of the Taras Shevchenko National University of Kyiv.

G.A. Melkov was born on September 24, 1939 in the town of Zhizdra (the Kaluga region, Russia) in the family of a military man. In 1952, the family of G.A. Melkov moved to Kyiv.

Even in his school years, Gennadii Andriyovych took a great interest in physics and radio electronics. That is why, in 1957, he entered the recently created (in 1952) “elite” Faculty of Radiophysics at the Taras Shevchenko State University of Kyiv (now, this is the Taras Shevchenko National University of Kyiv). All his further career was linked with this Faculty. After graduating in 1962 from the Faculty of Radiophysics (since 2014, this is the Faculty of Radiophysics, Electronics, and Computer Systems), G.A. Melkov became a postgraduate student, and,

in 1967, he defended his Ph.D. thesis “Saturation effects at frequency multiplication in ferrites” written under the guidance of Prof. I.A. Deriugin. In 1977, at the age of 38, Gennadii Andriyovych defended his doctoral dissertation “Nonlinear properties of ferrites in microwave fields” and had become the youngest Dr.Sci. at the faculty for a long time.

Since 1962, G.A. Melkov had been successfully combining his postgraduate studies with the fulfillment of the laboratory-head duties and, since 1963, with the position of the junior scientific researcher. Such confidence in the young graduate student was associated not only with his extraordinary scientific abilities, energy, and diligence, but also with a high potential that his supervisor I.A. Deriugin, one of the founders of the Faculty of Radiophysics, who was characterized as a “great organizer”, had seen in him.

In 1965–1967, after completing the postgraduate study, Gennadii Andriyovych worked as a junior scientific researcher. After defending his Ph.D. thesis in 1967, he became a lecturer. In 1968, after having worked for a year as an Assistance Professor at the department of quantum radiophysics, G.A. Melkov became a senior lecturer, and a year later he was elected an Associate Professor of this department.

In 1972, the Dean of the Faculty of Radiophysics M.G. Nakhodkin, a future Academician of the National Academy of Sciences of Ukraine (NASU), created a new department at the faculty, the department of cryogenic and microelectronics. He invited young and promising lecturers from other chairs to work there, and the Associate Professor of the department of quantum radiophysics G.A. Melkov was among them. This newly created department became a second motherland for him for all his life. In 1979, Gennadii Andriyovych became a Professor of the department of cryogenic and microelectronics.

In 1994–1998, Professor G.A. Melkov headed the department of electrophysics and, in 1998–2004, the department of cryogenic and microelectronics. Being a radiophysicist-experimenter, Gennadii Andriyovych paid the large attention to laboratory workshops and experimental researches carried out at those departments. It was under his supervision that a substantial modernization of all laboratory practical courses in general physics was performed at the department of electrophysics, and a number of practical courses were created and updated at the department of cryogenic and microelectronics. It was a period of rapid development of experimental researches and an active international cooperation at those departments, which was accompanied by a successful fulfillment of a large number of foreign scientific grants, budget and contract scientific and research works, in which Gennadii Andriyovych actively participated not only as a supervisor, but first and foremost as a scientist.

In 1992, G.A. Melkov was elected the Dean of the Faculty of Radiophysics of the Taras Shevchenko National University of Kyiv. The tenure of this post by Gennadii Andriyovych for ten years coincided with the hardest times of the economic and social crisis in Ukraine, with the decline of science and education in the young Ukrainian state. A struggle with those negative trends both at the Faculty and the University, as well as at the state level, took a lot of forces. In this struggle for preserving the available scientific and educational potential, Gennadii Andriyovych was helped by his colleagues and like-minded people from both the University and the NASU. In particular, these were the Academicians V.G. Bar'yakhtar, V.M. Loktev, M.G. Nakhodkin, and V.V. Skopenko, the Corresponding Members V.S. Lysenko, A.M. Pogorily, and S.M. Ryabchenko, as well as many others. Under the supervision of G.A. Melkov, a highly effective team was created at the Faculty, which actively fought for the ideals that are always close to genuine scientists and teachers. In particular, the team included the Dean's deputy V.I. Grygoruk, P.V. Melnik, O.Yu. Nechyporuk, all heads of the departments, and some of prominent lecturers and scientists from the Faculty of Radiophysics. Despite the unfavorable conditions mentioned above, the Faculty of Radiophysics continued to develop. Under the active support of G.A. Melkov, a department of medical radiophysics was cre-

ated at the Faculty in 1995 and a department of semiconductor electronics in 1996. For the first time, the lecturers from graduation departments were actively engaged in lecturing the courses to undergraduate students. A large merit of Gennadii Andriyovych as the Dean was undoubtedly the preservation of the traditions and the scientific and technical potential of the Faculty of Radiophysics that were taken as a basis during its creation and afterwards were developed and improved during the time of the former Soviet Union.

Science always played a key role in Gennadii Andriyovych's life. Since his school years, he was interested in advanced researches in physics, was fond of radioelectronics, and independently developed and professionally created various radio electronic devices. Being a student at the Faculty of Radiophysics, he turned his attention to spin waves and high-frequency effects in magnets, their study was only started at that time. Being a physicist-experimenter in his world outlook, the student G.A. Melkov directed his efforts at the development of experimental studies of high-frequency effects in ferrites, at mastering and developing a sufficiently powerful and advanced experimental base that the faculty possessed at that time. Those studies, which have been continuously going on for almost sixty years, composed the main direction of Gennadii Andriyovych's scientific activity.

G.A. Melkov obtained a number of principal world-class scientific results in the physics of magnetism and radiophysics. He initiated a new scientific direction in Ukraine, the study of nonlinear microwave properties of magnetic crystals. He was one of the pioneers in spin-wave electronics and microwave dielectronics.

G.A. Melkov was the first who experimentally observed multi-quantum processes with the simultaneous participation of 2 to 9 quasiparticles (photons, magnons, phonons), in particular, the three-magnon decay of spin waves, the three-magnon confluence of spin waves, the fine structure of the nonlinear susceptibility of ferrites, size-effects at the parametric excitation of spin waves, the spin-wave relaxation reversal, and others.

Gennadii Andriyovych also managed, for the first time, to calculate and experimentally study the system of coupled magnetic and dielectric oscillations (the magneto-dielectric resonance) in ferrites, which allowed the efficiency of nonlinear processes in such

media to be substantially enhanced. In addition, he discovered new planes of circular polarization in a dielectric waveguide and applied them to create miniature non-reciprocal microwave devices.

On the basis of the revealed nonlinear processes, G.A. Melkov developed new radiophysical methods to study magnetic insulators. With the help of these methods, he experimentally determined, in particular, the main features of the parametric instability of spin waves. He also found the distribution of spin waves in the momentum and frequency spaces. This result, on the one hand, became a basis for the creation of the modern theory of parametric wave turbulence by V.E. Zakharov, V.S. L'vov, and others, and, on the other hand, brought to the development of new ferromagnetic materials with an enhanced instability threshold value for high-power microwave devices. In particular, this made it possible to create a series of highly effective (up to 60%) frequency multipliers with an output power ranging from a few watts to tens of kilowatts.

In collaboration with A.A. Serga, G.A. Melkov experimentally realized the parametric amplification and inversion of the wavefront of microwave spin waves with small amplitudes and envelope solitons; it was done using the nonadiabatic pumping as well. He also obtained conditions for the anomalously high soliton amplification with maintaining the one-soliton regime (in cooperation with V.S. Tyberkevych). With the help of the discovered and investigated nonlinear effects, G.A. Melkov together with V.I. Vasyuchka, O. Dzyapko, Yu.V. Kobljanskyi, A.A. Serga, and A.V. Chumak created a high-performance microwave processor, which combined the functions of a microwave signal amplifier, a backward-wave oscillator, a microwave convolver, an active delay line, and a compressor for the compression of microwave pulses in time and the inversion of their profiles.

Together with his disciples (O.D. Dzyapko, A.A. Serga) and colleagues (S.O. Demokritov, V.E. Demidov, B. Hillebrands, and A.N. Slavin), Gennadii Andriyovych managed, for the first time in the world, to experimentally observe the Bose–Einstein condensation of magnons (spin waves) at room temperature and the associated phenomenon of electromagnetic radiation emission from the bottom of spin-wave spectrum, the frequency of which could be controlled by varying the magnetic field magnitude. An article reporting about those researches, which was pub-

lished in the Nature journal, was marked by the American Institute of Physics (AIP) among the top 10 papers in physics in 2006.

After the discovery of high-temperature superconductivity in 1986, Gennadii Andriyovych began active researches in this domain of science, which was considered as extremely promising at that time. Together with O.L. Kasatkin and E.A. Pashitskii, he developed a phenomenological model that could explain the features in the behavior of the microwave surface impedance of high-temperature superconductors in the magnetic field. Under his supervision, V.Yu. Malyshev carried out experimental researches that confirmed the main conclusions of the theory and gave impetus to the creation of effective microwave devices based on high-temperature superconductors. On G.A. Melkov's initiative and with his active participation, a unique center was created for the certification of films of high-temperature superconductors. At that time, this center had no analogs in the world.

The next stage of Gennadii Andriyovych's scientific activity in the domain of applied superconductivity included the development of the microwave superconducting resonator of a new type, the surface wave resonator. It was a film of a high-temperature superconductor located on a dielectric substrate. Due to the strong localization of the electromagnetic microwave field created by the surface wave near the film surface, strong nonlinear effects associated with the interaction between the microwave radiation and the high-temperature superconductor film could be observed in this system even at a low power of an external signal. Using those effects, G.A. Melkov and his disciples (O.M. Ivanyuta, V.Yu. Malyshev, O.V. Prokopenko, and V.M. Raksha) succeeded in creating high-performance microwave superconducting devices based on the surface wave resonator, such as Josephson microwave generators, Josephson voltage standards with about 400 synchronized junctions, microwave radiation detectors, magnetically tunable microwave filters, and others.

Since the 2000s, significant efforts were aimed by G.A. Melkov at solving some challenging problems in spintronics and magnonics. Together with his disciples (D.A. Bozhko, V.I. Vasyuchka, R.V. Verba, O.V. Prokopenko, A.A. Serga, D.V. Slobodianiuk, V.S. Tyberkevych, and A.V. Chumak), Gennadii Andriyovych had studied new nonlinear effects in arrays

of magnetic nanoelements. They developed new types of microwave generators and detectors on the basis of spintronic magnetic nanostructures. Practical constructions of magnon devices with improved parameters were proposed, and optimal operating conditions for such systems were determined.

On the one hand, all researches performed by Gennadii Andriyovych were simple and illustrative; on the other hand, they demonstrated a deep understanding of the physics of examined processes; they were characterized by a virtuous execution of experimental studies, an ability to find non-standard approaches to obtain world-class scientific results. This trait of Gennadii Andriyovych – to achieve in physics what seems impossible at first glance, but afterward becomes widely known, understandable, and important for practice – has been transferred to a lot of his disciples. Now, many of them occupy key positions at the universities in Ukraine, Europe, and the USA.

The scientific activity of G.A. Melkov for many years resulted in the appearance of a whole group of talented radiophysicists, which had grown in the framework of the Ukrainian scientific school of radiophysics and functional electronics headed by Gennadii Andriyovych for more than 40 years. This science school is one of the most powerful among the relevant scientific schools in Europe. Its research directions include the fundamental problems of radiophysics, the development of devices and units of functional electronics, the studies in such domains as dynamic processes in separate magnetic nanoelements and their arrays, the properties of magnetic fluids, thermodynamics of alloys with the shape memory effect, magnetic properties of solids, spin-dependent phenomena in the medium, magneto-optical effects, physics of information technologies, and physics of low-dimension systems.

The scientific works of G.A. Melkov include more than 400 scientific papers and 12 author's certificates. Gennadii Andriyovych is also a co-author of 9 monographs, including "Magnetization Oscillations and Waves" (together with A.G. Gurevich) published in the United States in 1996. On the opinion of the international scientific community, this monograph is a "bible" for everybody who deals with spin waves and magnetization dynamics. It has a significant impact on the development of the physics of magnetism in the world. It became a classical work on magnetism and allowed thousands of students and graduate stu-

dents around the world to make their first steps in the physics of magnetism. In addition, it had demonstrated a considerable potential and a high level of the Ukrainian science to many scientists in the world.

The scientific-managerial work, as well as the support of international scientific relations, played an important role in the professional activity of Gennadii Andriyovych. In due time, G.A. Melkov was a supervisor of several dozens of budget and contract research projects. He was one of the sponsors of active international cooperation at the Faculty of Radiophysics. Most of the contacts with leading scientific groups in Germany, USA, Spain, Australia, China, Portugal, and other countries, which were initiated by him, have been mainly retained till now. Gennadii Andriyovych was a co-head of an international project on parametric soliton amplification, which was supported by the US National Science Foundation. He was also a Ukrainian co-head in a number of successful projects of the American Foundation for Civil Research and Development and the head of the project of the Science and Technology Center in Ukraine.

G.A. Melkov participated in the creation of the Board of the State Fund for Fundamental Researches of the State Committee for Science and Technology of Ukraine, and he was its first chairman. He was the chairman of the section "Physics of high-temperature superconductivity" of the interdepartmental scientific council "Solid state physics" of the NASU, a board member of the section "Spin-wave electronics" of the Council "Physical electronics" of the Russian Academy of Sciences, a member of the professional council on natural sciences of the Ministry of Education of Ukraine, and a member of the section "Transport phenomena in metallic materials" of the interdepartmental scientific council "Physics of metallic state" of the NASU. For decades, G.A. Melkov had been the chairman and a member of the specialized scientific councils on defending Ph.D. and doctoral theses.

For more than 40 years, as long as his health permitted, G.A. Melkov persistently continued the pedagogical activity. He prepared and lectured more than 10 normative and special lecture courses, including "Theory of Oscillations", "Molecular and Statistical Physics", "Radioelectronics", "Microwave Engineering and Electronics", "Cryogenic Electronics", and others. At the Faculty, he organized special work-

shops in the framework of the courses “Radioelectronics”, “Microwave Electronics”, “Cryogenic Electronics”, “Physics and Technology of Low Temperatures”. In his lectures and at the workshops, Gennadii Andriyovych always followed the principle that any educational material must have a solid scientific basis. It was due to this position that his lectures and workshops were remembered by the audience owing to the clarity and consistency of the material presentation, and even the most difficult issues were easy to understand and master. A substantial lecturing experience of Gennadii Andriyovych manifested itself in his five textbooks and many teaching and methodological works, which always have been and continue to be popular among his students and colleagues.

During all his life, G.A. Melkov actively participated in the training of high-skilled personnel. He favored the involvement of young people into scientific work. Among his disciples, there are four Dr.Sci.’s and 14 Ph.D.’s.

In 1999, G.A. Melkov was awarded the title “Honored Worker of Science and Engineering of Ukraine”. His merits were awarded the Honorary Diploma of

the Presidium of the Supreme Council of Ukraine (in 2004), the Honorary Diploma of the Cabinet of Ministers of Ukraine (in 2009), and the Honorary Diploma of the Ministry of Education and Science of Ukraine (in 2019). In 2005, for the works on the wave-front reversal, G.A. Melkov together with Yu.V. Kobljansky was awarded the I. Pulyui Prize of the NASU. In 2011, G.A. Melkov became Honored Professor of the Taras Shevchenko National University of Kyiv. The next year, as well as in 2018, the IEEE (USA) honored him for distinguished achievements in physics of magnetism. In 2016, Gennadii Andriyovych was conferred the highest award of the Kyiv University, the Honor Sign of the Academic Council of the University.

With the great gratitude and a profound bow, we wish the dear hero of the jubilee good health, creative inspiration, plenty of new scientific ideas and new disciples, inspiration and pleasure from life and from the results of his undoubtedly great work.

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and COLLEAGUES*