To the 80th birthday of Serhiy Mykhailovych RYABCHENKO

On October 22, 2020, the outstanding Ukrainian scientist, the Corresponding Member of the National Academy of Sciences of Ukraine (NASU) Serhiy Mykhailovych Ryabchenko turns 80 years old. He is known not only for his brilliant scientific works in radiospectroscopy, the physics of magnetic phenomena, magneto-optics, high-temperature superconductivity, and nanophysics, but also for his significant scientific-managerial activity in Ukraine.

Serhiy Mykhailovych was born in Dnipropetrovsk (now Dnipro). He graduated from the Physics Department of the Faculty of Physics and Mathematics of the Dnipropetrovsk State University in 1962. Serhiy Mykhailovych underwent the pre-graduation practical training and prepared his diploma thesis at the Institute of Physics of the NASU in Kyiv, at the department headed by Academician Antonina Fedorivna Pryhot'ko. After the brilliant defense of his diploma thesis, he obtained a proposition to begin his career at the Department of Physics of his native faculty at the Dnipropetrovsk State University as a gifted and promising graduate.

For a year, Serhiy Mykhailovych had been combining his duties at the department in Dnipropetrovsk with creative missions to Kyiv, to the department of A.F. Pryhot'ko, for whom solid-state spectroscopy had been the main scientific passion since the time of her collaboration with I.V. Obreimov at the Ukrainian Institute of Physics and Technology. Therefore, it is not surprising that, in 1963, Serhiy Mykhailovych became a graduate student and a disciple of Antonina Fedorivna. She determined the direction of research for the gifted graduate student: it was radiospectroscopy. At that time, the peculiarities in the behavior of low-dimensional systems, their phonon spectra and magnetic ordering were one of the most discussed issues in solid state physics. Soon, Serhiy Mykhailovych acquired a high skill level in the powerful scientific team created by Antonina Fedorivna.

A significant role in the formation of Serhiy Mykhailovych as a scientist had been played by the physicist-theorist Mykhailo Fedorovych Deigen. From 1947 to 1960, M.F. Deigen worked at the Institute of Physics of the NASU, where he was dealing with the development of the electronic theory of crystals. In this domain, he was a disciple of Solomon Isakovych Pekar, the founder of the physics of polarons. In collaboration with Solomon Isakovych, Mykhailo Fedorovych developed the concept of deformation potential and built the theory of electron autolocalization in nonpolar crystals.

It is known that teachers are not those who teach, but those who have something to learn from. Serhiy Mykhailovych highly appreciates Mykhailo Fedorovych as an outstanding scientist and his teacher. To a great extent, the scientific destiny of the teacher found its specular reflection in the scientific destiny of the disciple. Mykhailo Fedorovych, being a theorist, created and headed a successful department of experimental radiospectroscopy. Serhiy Mykhailovych, being an experimenter, deeply mastered the methods of theoretical physics and widely used them in his research. He collaborated with such theoretical physicists as Academician V.G. Bar'yakhtar, the Corresponding Member of the NASU E.A. Pashitskii, and others. The department headed by him achieved the outstanding progress in the study of magnetic phenomena and became a true scientific school keeping the traditions introduced by Antonina Fedorivna for a lot of young physicists.

Radiospectroscopic studies of exciton spectra in magnetically mixed (diluted magnetic) semiconductors with a layered structure using the method of paramagnetic resonance led Serhiy Mykhailovych and the scientific group headed by him to a discovery of a new phenomenon, the giant spin splitting in excitonic spectra. The theoretical results obtained by M.F. Deigen were used to explain the nature of this beautiful phenomenon. It consists in that the spins of magnetic impurities, being polarized by an external magnetic field, orient the spins of electrons and excitons by means of the exchange interaction, which is much stronger than the interaction of spins with the magnetic field. That is why the giant splitting of levels and associated effects appear. This work led to the emergence of new directions in the world science associated with the study of the optical, kinetic, and magnetic phenomena in semimagnetic semiconductors.

The research of this phenomenon and its nontrivial variants dominated in the further studies performed by Serhiy Mykhailovych. The defense of the Ph.D. thesis devoted to the research of spin-spin interactions in crystals using the electron paramagnetic resonance method (in 1968) and the preparation (within a relatively short time interval) and defense of the doctoral dissertation devoted to the study of magnetic resonances in quasi-two-dimensional crystals (in 1977) became an official confirmation of the success of Serhiy Mykhailovych's creative achievements.

Below is a brief list of significant results obtained by Serhiy Mykhailovych and his colleagues in the 1970s–1980s.

• The giant spin splitting of excitonic bands in magnetically mixed layered semiconductors was comprehensively studied, and a profound theoretical explanation of this phenomenon was given.

• In the course of those studies, the peculiarities in the temperature dependences of the intracrystalline field parameters and the spin-lattice relaxation times were determined from the spectra of electron paramagnetic resonance and nuclear quadrupole resonance, in which the bending and low-frequency optical vibrations in crystals manifest themselves.

• When studying the band reconstruction in a vicinity of the phase transition, peculiarities in the critical broadening of electron paramagnetic resonance lines were revealed in quasi-two-dimensional magnets near the temperature of the transition into a magnetically ordered state, and peculiarities in a change of the character of the nuclear magnetic resonance spectrum in the inner superfine field of the layered antiferromagnet with easy-plane anisotropy, when the degree of magnetic quasi-two-dimensionality changes owing to the intercalation of those layered carbon antiferromagnets were elucidated. If the concentration of intercalated carbon increases, the spin interactions between the layers change until the complete magnetic two-dimensionality is achieved.

• In the work by Serhiy Mykhailovych and E.A. Pashitskii (1979), the ferromagnetic ordering in semimagnetic semiconductors induced by current carriers was predicted for the first time. Now, this phenomenon, which was observed in crystals of the $A^{III}MnB^{V}$ type at relatively high temperatures, is actively studied in a number of foreign research centers.

• The results obtained while studying the influence of magnetoactive impurities in zinc selenide on the giant spin splitting of excitonic states made an important contribution to the laser technology in the infrared interval.

At the end of the 1980s, a significant number of those results were published in a series of works for which Serhiy Mykhailovych Ryabchenko and his colleagues were awarded the State Prize of Ukraine in Science and Technology (in 1991).

The methods of spin-resonance researches in the radio and optical frequency intervals are successfully applied while creating various advanced materials and studying their properties. In the 1990s, when analyzing the spectra of antiferromagnetic resonances in layered antiferromagnetic dihalides of the iron group with easy-plane anisotropy, Serhiy Mykhailovych and his colleagues discovered a significant spontaneous magnetostriction. The magnetoelastic nature of antiferromagnetic domains in layered easy-plane antiferromagnets was established, and the manifestations of the transformations of this domain structure in the magnetostriction and magnetization were analyzed. The results obtained extended the scope of applications of magnetostriction effects in devices and technologies.

High-temperature superconductors (HTSCs) also belong to quasi-two-dimensional layered systems. When the progress in the physics of HTSC in layered cuprate metal-oxide compounds was in full swing, Serhiy Mykhailovych, being a person with a broad scientific world view, could not stay apart from this problem. In the Department of Physics of Magnetic Phenomena headed by him, he initiated the study of new cuprate HTSC compounds not only using the available experimental facilities, but also on a specially designed, principally new installation for measuring the complex magnetic susceptibility in a frequency interval from 30 Hz to 10 kHz. This direction of research turned out to be the most fruitful. The measurements of the temperature and magnetic-field dependences of the critical current density and magnetic flux creep in epitaxial HTSC films with a mosaic-block structure and low-angle boundaries allowed the scientist to elucidate the nature of the critical current density excess in films by two to three orders of magnitude as compared with that in the bulk. The proposed theoretical model allowed such parameters as the average size and the size dispersion of single-crystalline blocks, as well as the average angle of their mutual disorientation, to be determined.

The beginning of the new millennium was marked by the rapid development of the physics of nanosystems and nanotechnology. Recently, the relevance of the studies of nanofilms and nanopowders has drastically increased. New phenomena were revealed owing to the discovery of the "giant" and, afterward, "colossal" magnetic resistances in certain materials. The comprehension of those phenomena requires that new ideas concerning the mechanisms of their implementation should be developed. This situation provoked Serhiy Mykhailovych to study magnetic nanoobjects and structures with the giant and colossal magnetoresistance, as well as the magnetoelectric interaction in magnetic specimens and structures. A number of interesting results have been obtained so far. In particular, the manifestations of the colossal magnetoresistance in a submicron manganite film were observed, the peculiarities in the magnetization of nanopowders of substituted manganites were analyzed, and the formation of superferromagnetic and superspinglass states in nanogranular films was studied.

Serhiy Mykhailovych and his colleagues obtained excellent results when studying the spectral bands of semiconducting manganese-doped cadmium telluride in external magnetic fields. A specific feature of this nanostructured material consists in that it contains double quantum wells with extraordinary excitonic bands. Owing to the giant spin splitting effect, the magnetic field makes it possible to control the level structures and the transition intensities. The scientists managed to detect indirect excitons, the electron and the hole of which are located in different wells. They also observed the effects of the dipole-dipole interaction between excitons at high irradiation intensities and the influence of charges in the quantum wells on the positions of excitonic levels. At certain sizes of the wells, the resonance between direct and indirect excitons can manifest itself.

The style of Serhiy Mykhailovych's scientific activity is characterized by a high strictness to the results. Serhiy Mykhailovych does not take the latter "on trust". He always verifies and analyzes them as a physicist. He actively participates in both the experiment and the theory. His proposals of new approaches to the solution of certain scientific problems turn out extremely important.

The scientific-managerial activity of Serhiy Mykhailovych and the results of his work as a statesman have to be mentioned separately. S.M. Ryabchenko has a bright personality. He is a worthy example of a person who has realized himself and managed to gain authority and respect not only in the scientific world, but also in various circles of the state, political, and public life of both the former USSR and independent Ukraine.

S.M. Ryabchenko as a principled person with strong beliefs and an active life position was formed at the Institute of Physics of the Academy of Sciences of the Ukrainian SSR (now the National Academy of Sciences of Ukraine) when working together with the distinguished Ukrainian scientists A.F. Prikhot'ko and M.F. Deigen and in creative collaboration with his colleagues physicists. Such personalities had been summoned by the time of change that came in the late 1980s.

In 1989, Serhiy Mykhailovych was elected a People's Deputy of the USSR. He was a member of the Supreme Soviet of the USSR and a member of the Interregional Group, working as Deputy Chairman of the Committee on Science, Culture, and Education of the Supreme Soviet of the USSR (later, the Committee on Science and Technologies of the Supreme Soviet of the USSR). Without hesitation and reservation, S.M. Ryabchenko accepted the Act of Declaration of Independence of Ukraine. With his inherent energy and using the experience obtained in the Supreme Soviet of the USSR, he joined in the creation of new institutions of the young state.

In 1991, S.M. Ryabchenko was appointed Chairman of the Committee on Scientific and Technological Progress of the Cabinet of Ministers of Ukraine, which was later transformed into the State Committee for Science and Technology. In this position, he became an initiator and executor of a number of actions aimed at creating modern principles for developing science in Ukraine. This side of S.M. Ryabchenko's activity has not been properly appreciated yet by the scientific community of Ukraine. It would be worthwhile for the eyewitnesses of the extraordinary events of that time to reserve their memories about that, filled with a special meaning, creation of Ukraine as an example to the modern young generation.

At that time, one of the coauthors of this preface had to ask S.M. Ryabchenko for help in connection with the organization of scientific space researches in Ukraine. The State Space Agency of Ukraine has not been created yet, there were no necessary government regulations on the space activity, but there was an urgent need to represent Ukraine as a scientific space state in the world. S.M. Ryabchenko supported the request of the Commission on Space Research of the Academy of Sciences of the Ukrainian SSR to create and finance the corresponding program of such researches. This is only one of the bright examples illustrating the responsibility and initiative work of Serhiy Mykhailovych in the public service.

Being a talented scientist, S.M. Ryabchenko has always highly estimated the role of public scientific organizations in the creation of the national scientific community. He was one of the initiators and active organizers of the Ukrainian Physical Society, as well as its president in 1998–2005.

Today, the non-indifferent attitude of Serhiy Mykhailovych to various issues of the scientific and economic life, the state formation, academic integrity, and so forth can be heard from a lot of tribunes and read at the electronic sites of our state. His viewpoint is not always supported unanimously, but it is not lost among the others because it is always reasonable, clear, and principal with respect to that or another event.

The friends, colleagues, and disciples of Serhiy Mykhailovych dedicate the papers published in this special issue of the Ukrainian Physical Journal to his birthday and congratulate him on his 80th jubilee. We wish him health, indefatigability, and the further progress in the science that he loves so much.

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On behalf of the Editorial Board of the Ukrainian Physical Journal, we also congratulate Serhiy Mykhailovych and express him our deep gratitude for his considerable contribution to the development and improvement of the UJP.

Editor-in-Chief of UJP,
Academician of the NASU A.G. ZAGORODNY