Academician of the National Academy of Sciences of Ukraine Vadym Loktev (to his 80th birthday)

Dear Reader,

You open the special issue of the Low Temperature Physics journal, dedicated to 80 years of outstanding Ukrainian physicist-theorist Vadym Loktev. Doctor of Science in Physics and Mathematics, Professor, Honored Worker in Science and Engineering of Ukraine, Laureate of two State Prizes of Ukraine, Academician of the National Academy of Sciences of Ukraine (NASU), a member of the Presidium of the NASU, Academician-Secretary of the Department of Physics and Astronomy of the NASU.

Vadym Loktev was born on May 3, 1945 in Kyiv. Here, in Kyiv, he graduated the secondary school and in 1968 the Faculty of Physics of the National Taras Shevchenko University. His first scientific degree, candidate of science, he got in 1971 at Bogolyubov Institute for Theoretical Physics (BITP) of the NASU under the supervision of Olexandr Davydov and Elmar Petrov. At that time at the Institute of Physics of the NASU under the leadership of Academician of the NASU Antonina Prykhotko, important experimental results were obtained on unusual spectral properties of solid oxygen, which required theoretical explanation. Theoretical study of the optical and magnetic properties of solid oxygen, a unique crystal which combines properties of a molecular crystal and a magnet, were performed in a group headed by E. Petrov at the BITP. Vadym Loktev joined the group and in 1971 has successfully defended candidate of science dissertation. The second level degree, Doctor of Science, Loktev got in 1983.

Curious from the early childhood, open-minded, working hard, learning from prominent scientists and young colleagues, Vadym Loktev became one of the leading scientists among the world-famous Davydov's scientific school. He has demonstrated not only scientific, but also managerial abilities, and from 1987 till 2016 he was the Head of the Laboratory of Electronic Processes in Ordered Molecular Structures which later was reorganized into the Department of Theory of Nonlinear Phenomena in Condensed Systems. As an Academician-Secretary of the Department of Physics and

Astronomy (DPA) of the NASU from 2004 up to now, he payed a big attention to the scientific-organizational aspects of the Department, has initiated and made significant efforts to organize and carry scientific meetings of the DPA inviting not only well-known experts, but also young scientists to participate in these meetings with the invited talks.

The years spent in scientific groups of A. Prykhotko and O. Davydov, permanent scientific discussions, sometimes with very "hot" arguments, crystallized Vadym's communicativeness, and in his further scientific carrier he easily worked tightly with many researches, it was tight-binding collaboration, rephrasing tight-binding approximation.

Among scientific achievements of Vadym Loktev there are his important results obtained in theory of cryocrystals, magnetic phenomena, disordered systems, superconductivity, and, in particular, high-temperature superconductivity and superconductivity of two-dimensional nematic superconductors, spin-orbit interaction and many others. Based on these studies, Loktev made several predictions which were latter experimentally confirmed. In particular, he has predicted splitting of bi-exciton absorption bands in antiferromagnetic insulators (together with Yu. B. Gaididei), polarization of spectral lines in the region of two-particle light absorption, magnetic structure in one of the low-temperature phases of solid oxygen (the latter was called Loktev structure). Together with V. S. Ostrovskyi he predicted new magneto-optical effect, linear in the external magnetic field, in anisotropic magnetic crystals, which previously was considered impossible. Based on this prediction, collinear domains in antiferromagnets were experimentally visualized.

Vadym Loktev developed theory of the Rashba effect in antiferromagnets and determined the possibility of collective rearrangement in their spectra, irrespective to the impurity concentration. He developed theory of the anomalous enhancement of infrared absorption in disordered antiferromagnets, which became known as the Ivanov–Loktev–Pogorelov theory. Other important results in theory of magnetism, obtained by Loktev, include theory of spin excitations in disordered magnets with strong single-ion anisotropy, explanation of spin waves and formation of a magneto-elastic gap in quasi-two-dimensional antiferromagnets. V. Loktev proposed an explanation, based on quantum theory, of the linear and nonlinear magnetic properties of magnets with strong spin-orbit interaction. Together with V. G. Bar'yakhtar and S. M. Ryabchenko, he developed theory of a new type of magneto-elastic excitations, magneto-bending waves.

Discovery of high-temperature superconductivity in cuprate compounds did not leave Vadym Loktev aside. Together with V. P. Gusynin and S. G. Sharapov, he generalized the Bardeen–Cooper–Schrieffer theory to systems with an arbitrary charge carrier concentration, which explained the crossover from superfluidity to superconductivity and appearance of a pseudogap in the quasiparticle spectrum of charge carriers. Together with Yu. G. Pogorelov, he developed theory of superconductivity in doped, or the so-called bad, metals, in which superconducting condensation occurs within a finite interval of the charge carrier concentration. Important result is development (together with Yu. B. Gaididei) of non-phonon pairing mechanism in high-temperature superconductors (so-called Gaididei–Loktev–Weber mechanism). Together with V. G. Bar'yakhtar, he proposed a full phenomenological theory of nonconducting phases of high-temperature superconductors and determined their magnetic structures. Critical field values for the magnetic phase transformations, calculated by him, and calculations of spin excitation spectra were confirmed experimentally with high accuracy.

During last years, among scientific interests of Vadym Loktev are quasi-two-dimensional materials, among them superconducting nematic crystals. He has shown the role of impurity states in the properties of these systems, including possibility of impurity level formation in graphene, demonstrated peculiarities in the band structure of those systems near singular points, such as Dirac points for single-layer graphene or nodal points for high-temperature cuprates, and singular curves (inflection curves for two-layer graphene) (together with Yu. V. Skrypnyk). These results showed preservation of coherent states of quasiparticles near the Dirac points in single-layer graphene in the presence of substitution impurities, while such states become destroyed, if in the system there is an arbitrarily small amount of vacancies. These results show the possibility to induce metal-insulator phase transitions with the help of a certain external modulation of the Fermi level by varying the charge carrier mobility limit. For two-layered graphene with a gap in its spectrum, V. Loktev found that under the action of an external electric field the impurities can cause a reconstruction of the spectrum and formation of a narrow impurity band in the gap. Similar spectrum transformations were shown for a one-layer doped silicene because of the peculiarities in its honeycomb structure, provided that the system is sufficiently ribbed. These results have demonstrated that even a weak external modulation can cause substantial changes in the electric resistance and other observed properties (optical, thermal, etc.) of silicene. For these results, Vadym Loktev (together with Yurii Pogorelov) was awarded the Davydov Prize of the BITP of the NASU in 2019.

Vadym Loktev was the first who established the important role of the Jahn–Teller effect in the mechanism of high-temperature superconductivity in fullerite films (together with E. Pashitskii). Together with Yu. M. Khalak, he predicted a possibility of the formation of an orientational domain structure in fullerite and formation of domains in antiferromagnets associated with the magnetoelastic interaction, the destressing phenomenon, frequency dependence of antiferromagnets on their shape. Together with H. V. Gomonay, he developed a theory of torque, induced by a spin-polarized current in antiferromagnets, and explained the origin of threshold excitation of acousto-luminescence. Together with A. I. Bugrii, V. Loktev suggested explanation of space-inhomogeneous

Bose–Einstein condensation of magnons in thin ferromagnetic films, which can take place at high, up to room, temperatures.

One of the last achievements of Loktev are related with study of the interplay between the spin and spatial degrees of freedom in solid state systems. In particular, V. Loktev, together with A. Eremko, showed that nonmagnetic systems with helical symmetry can possess spintronic properties. Vadym Loktev (together with L. Brizhik and A. Eremko) received important results in study of the external field influence on the spin states of electrons within the Dirac description, and derived, in the nonrelativistic approximation, a generalized operator that describes this influence in the Schrödinger equation, the so-called spin-orbit coupling operator. It was shown that this operator includes not only the well-known Thomas–Frenkel correction term, but also a new, additional contribution, which was called the Brizhik–Eremko–Loktev operator.

That was the sight from outside. Let us have a look what Professor Loktev himself thinks about his achievements (from his CV).

"My Main Scientific Achievements are:

***Biexciton** Optical Splitting (predicted);*

*New **Linear Magneto-Optical Effect** (predicted);*

Spin (Loktev) Structure in La-Oxygen (predicted);

*New – **Coherent** – Kind of Quasiparticles in Non-Ideal Magnets;*

*Theory of **Anisotropic** Magnetic Crystals;*

*New **Attractive** Mechanism for Carriers in High-T_c Superconductors;*

***Jahn-Teller Mechanism** for Superconductivity in Fullerides;*

***Threshold** Nature of Sonoluminescence Crystals;*

*Theory of Superconductivity in Systems with Arbitrary Carrier Densities Which Results in **Pseudogap** in Quasiparticle Spectrum;*

*Theory of **Equilibrium Domain Structure** Formation in Antiferromagnets;*

Theory of High-Temperature Superfluidity.

The most of the above mentioned results were confirmed by experiments."

What one can add? Well done, Vadym Mykhaylovych! Keep on going!

Vadym Loktev has published more than 300 scientific papers in leading international journals, several monographs and text-books. He participated as an invited speaker at numerous international conferences and symposia. For almost 15 years, since 1982, he lectured at the Faculties of Physics and Radiophysics of National Taras Shevchenko University of Kyiv. He was head (part-time) of the Department of General and Theoretical Physics at the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Under his supervision, more than twenty candidate and doctoral dissertations were defended.

Vadym Loktev is the Editor-in-Chief of the Great Ukrainian Encyclopedia, he is a member of editorial boards of many scientific journals and several scientific councils of NASU.

For outstanding scientific and organizational achievements, V. M. Loktev was awarded the Orders of Prince Yaroslav the Wise (of the 5th, 4th, and 3rd degrees), an Honorary Diploma of the Supreme Council of Ukraine, the title of Honored Worker in Science and Engineering of Ukraine, and V. I. Vernadskyi Gold Medal of the NASU. He is a laureate of two State Prizes of Ukraine in science and technologies, of K. D. Sinelnikov and M. M. Bogolyubov Prizes of the NASU. In 2001, V. M. Loktev was elected a full member of the European Academy (Paris).

In recent years, a great deal of attention Loktev pays to the organization aspects of the development of science and education in Ukraine. He wrote many popular articles, was interviewed by TV programs, always focused to improve education in physics and mathematics, to attract young people to scientific research, to prove the crucial role of science and education in the development of Ukraine as an independent state, especially under the conditions of the full-scale invasion of russia in Ukraine. As for every conscious citizen of Ukraine, the last years tragedy of the war has boost the interest to our history, to historic role of Ukraine, to our risings and falls, to the role of individuals and our collective responsibility for our future. These questions he actively discusses not only in press, but also within his "email academician circle", which allows its participants to exchange immediately their pros and cons (pro and contra arguments).

An interested reader can get more information about Vadym Loktev and list of his publications up to 2014 from the biographic book "Vadym Mykhaylovych Loktev", L. S. Brizhik and O. O. Ponezha (eds.), Kyiv, Akademperiodyka, series Biobibliography of Ukrainian Scientists (2015), 192 p. (in Ukrainian).

List of his publications during last five years is attached below.

We congratulate Professor Vadym Loktev with his birthday and wish him Many Happy Returns!

Larissa Brizhik

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