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PERSONALIA

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In memory of Lev Petrovich Gor'kov

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Lev Petrovich Gor'kov, one of the originators of modern condensed matter physics, passed away on December 28, 2016.

Lev Gor'kov was born in Moscow on June 14, 1929 into the family of an associate professor at the Institute of Engineers of Railway Transport. In 1947, he entered the Physical and Technical Faculty of M V Lomonosov Moscow State University (MSU) and then, after the faculty was reorganized, he moved to the Engineering Physics Faculty of the Moscow Mechanical Institute (now MEPhI). Gor'kov graduated from the institute in 1953 and was assigned to the Theoretical Department of the Institute for Physical Problems headed by L D Landau, where he worked for over ten years and was moulded into the scientist under the direct influence of Landau. In 1955, the first papers by Gor'kov (together with I M Khalatnikov) devoted to the study of quantum electrodynamics of integer-spin particles were published. In 1956, L P Gor'kov defended his PhD thesis.

The year 1957 was decisive in defining the further scientific interests of Lev Petrovich, when the Bardeen–Cooper–Schrieffer (BCS) theory of superconductivity came into being. The new theory of superconductivity attracted many theorists, but it was L P Gor'kov who managed to make the most important contribution to the theory; in 1958, several months after the BCS work, a paper appeared in which L P developed a new powerful method to describe superconductivity. The paper was only five pages long, but the importance of the results obtained went far beyond the framework of the theory of superconductivity, and it is one of the most significant achievements in modern statistical physics. The whole modern theory of superconductivity is essentially based on the 'Gor'kov equations' derived in this work.

This theory underlay the 1959 series of important studies by L P Gor'kov devoted to the microscopic derivation of the Ginzburg–Landau equations. The nature of the order parameter of the superconducting state was clarified as the wave function of the Cooper pair condensate with charge $2e$. Owing to Gor'kov's work, this theory received a second life and the general recognition as the most simple and universal apparatus for studying the properties of superconductors near the transition temperature.

In 1958–1960, L P Gor'kov, along with A A Abrikosov, developed the theory of superconducting alloys and elaborated the so-called 'cross' diagram technique that allowed the calculation of alloy metal properties to be considerably simplified. In 1960, the authors predicted the phenomenon of zero-gap superconductivity for superconductors with magnetic impurities. This discovery, which at first glance contradicts the Landau superfluidity criterion, provided deep insight into superconductivity as a coherent state for the existence of which the energy gap is not obligatory. The importance of such an interpretation of the nature of the superconducting state especially manifested itself after the discovery of superfluid phases in Helium-3 and high-temperature superconductors with d-type pairing. A significant role in the physics of ultracold atoms is now played by the 1961 paper by L P Gor'kov and T K Melik-Barkhudarov, where the authors calculated with nonexponential accuracy a superconducting gap in gas with a short-range interaction.

Lev Petrovich Gor'kov
(14.06.1929 – 28.12.2016)

Along with superconductivity, in the 1960s L P Gor'kov was also engaged in the theory of solids and quantum statistics. In 1961, Lev Petrovich defended his habilitation thesis. The famous 'green' book, *Methods of Quantum Field Theory in Statistical Physics*, was written by L P Gor'kov with A A Abrikosov and I E Dzyaloshinskii as co-authors in 1962. The book presents the method of Feynman diagrams in application to quantum statistics. The method makes it possible to employ the field theory methods in studying the problems of condensed matter physics. This book was issued several times abroad and has recently been reissued in Russia. It became a reference book for theoretical physicists all over the world and its authors have been awarded the L D Landau Prize in 1989.

In 1966, L P Gor'kov was awarded the Lenin Prize for a series of research studies on the theory of superconducting alloys and in the same year was elected a Corresponding Member of the USSR Academy of Sciences.

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In 1963, L P Gor'kov moved to Chernogolovka, where at first he headed the Theoretical Department of the branch of the Institute of Chemical Physics, and in 1965 became one of the founding fathers of the Institute of Theoretical Physics (ITP) (now named after L D Landau). L P Gor'kov's role was invaluable in the formation, development, and creation of the appropriate scientific atmosphere at ITP, the institute that soon became world renowned and acquired a high recognition in the community of scientists holding key positions in theoretical physics.

In the late 1960s to early 1970s, L P Gor'kov worked on the problem of nonequilibrium superconductivity. Gor'kov's work in co-authorship with G M Eliashberg laid the basis of the theory of nonstationary phenomena in superconductors and fostered many experimental studies in this field. The theory developed in this work was applied to obtain a great many concrete results associated with the behavior of superconductors in variable fields: nonlinear phenomena, vortex dynamics, etc.

In the late 1970s, L P Gor'kov worked on the theory of superconductors with A15 structure and the theory of one-dimensional organic conductors. L P Gor'kov predicted the main features of the interplay between structural instability, superconductivity, and the metal state in organic metals and constructed the localization theory in these compounds that allows the frequency and temperature dependences of conductivity to be found.

As far back as the 1960s, L P Gor'kov and G M Eliashberg became interested in the electrodynamics of small-size particles. They showed that in such particles all the three types of Wigner–Dyson level statistics are realized, depending on the conditions. In 1979, L P Gor'kov, A I Larkin, and D E Khmel'nitskii developed the method of calculating quantum corrections to mesoscopic system conductivity, thus laying the foundation of the diagram description of weak localization. These studies are now of particular importance in connection with the development of nanostructure physics. The collaboration between L P Gor'kov and V L Berezinskii in the study of disordered one-dimensional metals was also very fruitful.

In the mid-1980s, L P Gor'kov got engaged in superconductors with 'heavy fermions', and after the discovery of high-temperature superconductivity he took an active part in studies in this field. Together with G E Volovik, he gave a general symmetry classification of possible types of superconducting paring, which is most important method of diagnostics of superconducting phases in high-temperature superconductors and superconductors with heavy fermions.

In 1987 L P Gor'kov was elected a Full Member of the USSR Academy of Sciences.

Lev Gor'kov was a highly qualified theoretical physicist and at the same time always took an interest in experiments, so that experimentalists were amazed at his knowledge of measured quantities up to particular values.

Along with his scientific activity, Lev Gor'kov always devoted a great deal of energy to the education of young theorists. Over a quarter of a century (1966–1991) he was Head of the Problems of Theoretical Physics Department of the Moscow Institute of Physics and Technology (MIPT). A distinctive feature of L P Gor'kov was that he always took care of each student. With yearly competitive examinations, the department was able to choose the best students at MIPT, which was largely due to the Head being highly respected and having authority with Fiztekh. A considerable number of ITP workers, from junior to senior, are graduates from this department. Graduates can also be found in many leading scientific centers around the world: S Brazovskii, P Wiegmann, G Volovik, O Dorokhov, Viktor Dotsenko, Vl Dotsenko, K Efetov, A Kitaev, N Kirova, N Kopnin, A Lebed', L Levitov, V Mineev, Yu Nazarov, M Feigelman, A Finkelshtein, and other theorists, who later became world renowned, took their first steps in science in Gor'kov's department.

In 1991, L P Gor'kov left for the USA. At first, he worked at the University of Illinois at Urbana-Champaign and then at the National High Magnetic Field Laboratory in Tallahassee (Florida). There, he devoted himself to the physics of high-temperature superconductivity, manganites, and multiband superconductors.

All this does not even come close to exhausting the scientific results obtained by L P Gor'kov. He also did important work on hydrodynamics, the semiconductor theory, and many others. Not long ago, World Scientific publishers issued the "Selected Papers of Lev P Gor'kov", where he himself summed up the main results of his scientific activities.

Lev Gor'kov played an important role in the organization of Soviet-American collaboration. In the most tense times of the cold war, joint symposia and meetings with the participation of ITP workers and leading American theorists were held regularly in turn in the USA, the USSR or in neutral Denmark and Sweden. Having moved to the USA, he organized and headed the program of support of collaboration between the National High Magnetic Field Laboratory and scientists from countries of the former USSR that allowed many researchers from Russia and CIS countries to carry out their theoretical and experimental studies at the US National Laboratory.

In 1993, Gor'kov, together with A A Abrikosov and V L Ginzburg, received the John Bardeen Prize for a series of studies on the theory of superconductivity. In 1999, he was awarded the Humboldt Prize and in 2004, together with C T Belyaev, he received the Eugene Feenberg Medal for the outstanding contribution to the development of many-body physics. In 2005, Gor'kov was elected to the National Academy of Sciences of the USA. He was Doctor Honoris Causa of the Universities of New York and Illinois. In 2015, the Rome International Center for Materials Science awarded Gor'kov the Ugo Fano Gold Medal.

Lev was not only a prominent scientist but also a remarkable and original artist. Many people remember the playing cards he made for Landau's 50th birthday, where the Teacher was painted as a joker capable of playing in combination with any of his colleagues and scholars whose portraits were distributed about cards of different denominations from eights to aces.

In spite of the disease that had been diagnosed a year before his death and left no hope, Lev Gor'kov continued working hard until his last days. In 2016, he published papers on the mechanism of superconductivity in strontium titanate with a low carrier concentration and high-temperature superconductivity in sulphur hydride and in a two-dimensional electron gas at the $FeSe/SrTiO_3$ interface.

Lev Petrovich Gor'kov will remain in our memory as an eminent scientist always focused on at work, as a deeply respectable person assuming responsibility for everything he did, and as a teacher, a tutor, and a guide to several generations of theoretical physicists working at many universities and laboratories around the world.

A F Andreev, G Boebinger, G E Volovik,
I E Dzyaloshinskii, S V Iordanskii, V P Mineev,
D Pines, L P Pitaevskii, V L Pokrovskii,
G B Teitelbaum, I M Khalatnikov, G M Eliashberg