Lev Petrovich Gor'kov

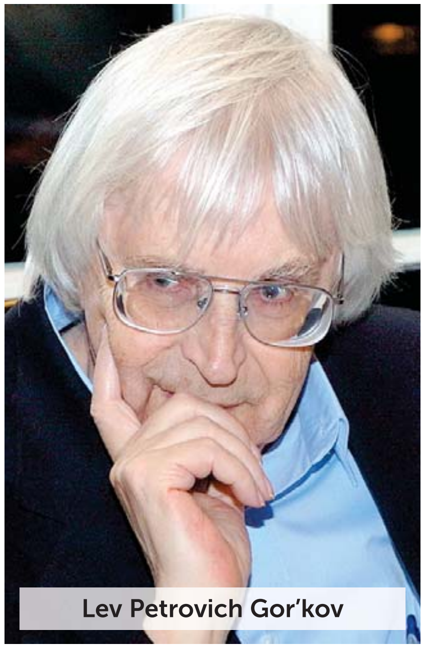
Lev Petrovich Gor'kov, one of the creators of modern condensed-matter theory, died on 28 December 2016 in Tallahassee, Florida.

Born on 14 June 1929 in Moscow, Gor'kov graduated from the Moscow Mechanics Institute in 1953. After passing Lev Landau's famous "theoretical minimum," he was accepted as a PhD student in the theory department headed by Landau at the Institute for Physical Problems. In 1956 he defended his PhD thesis on quantum electrodynamics of particles with integer spin.

During a seminar given in late 1957 by Nikolai Bogolyubov, the Landau group first heard of the microscopic theory of superconductivity developed by John Bardeen, Leon Cooper, and J. Robert Schrieffer. Within a few weeks, and before he had access to the BCS papers, Gor'kov derived what are now known as the Gor'kov equations, which established the field-theoretical formulation of superconductivity. In 1959 he used them to derive the Ginzburg–Landau equations and solved the conceptual meaning of the superconducting order parameter. His theory opened the way to describe inhomogeneous superconducting states in the presence of magnetic fields or electrical currents.

Over the next two years, Gor'kov, with Alexei Abrikosov, used his theory to create the theory of superconductors with nonmagnetic and magnetic impurities. They discovered that magnetic impurities give rise to gapless superconductivity and thus proved that the superconducting state could be an ordered state in the absence of a gap in the quasiparticle spectrum. For that body of work, Gor'kov, Abrikosov, and Vitaly Ginzburg in 1966 were awarded the Lenin Prize, the Soviet Union's highest scientific award. Gapless superconductivity has since been discovered in pure superconductors, including high-temperature cuprate superconductors that feature *d*-wave pairing.

Superconductivity theory and other problems of statistical physics required the development of a new mathematical technique to generalize the Feynman diagram method to finite temperatures. That was the subject of *Methods of Quantum Field Theory in Statistical Physics* (Prentice-Hall, 1963), the famous monograph by Abrikosov, Gor'kov, and Igor Dzyaloshinskii. First published in Russian in 1962, it became the bible for subsequent generations of theoretical physicists.



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In 1963 Gor'kov moved to Chernogolovka to head the theory department of the Institute of Chemical Physics. Shortly thereafter, he cofounded the Landau Institute for Theoretical Physics, which rapidly emerged to world prominence.

During the next two decades, he wrote a remarkable series of papers. In a 1964 landmark paper in mesoscopic physics, Gor'kov and Gerasim Eliashberg calculated the polarizability of small metal particles in a high-frequency field and showed that all three types of Wigner–Dyson level statistics are realized in such particles. In 1965 Gor'kov, Yury Bychkov, and Dzyaloshinskii showed that superconductivity and charge density waves compete in one-dimensional conductors, a discovery that is central to the physics of low-dimensional systems.

At the beginning of the 1970s, Gor'kov and Eliashberg developed a general theory of nonstationary phenomena in superconductors that has subsequently been applied to the description of dynamic dissipative processes. Those processes include the motion of vortices and domain walls in superconductors and in superfluid phases of helium-3, the conductivity of thin superconducting wires and superconductor–normal metal contacts, and the behavior of superconductors in AC fields. In 1984 Grigory Volovik and Gor'kov suggested a symmetry classification of superconducting states in crystals that has become the principal classification of superconducting phases in cuprate and heavy-fermion compounds.

In 1966 Gor'kov became the founding chair of the Problems of Theoretical Physics program of the Moscow Institute of Physics and Technology. During his tenure there, he could hire researchers from among the best students in the annual competitive exams, a measure of the unparalleled respect he commanded at the institute. In turn, he assumed a deep personal responsibility for the destiny of the students he mentored, dozens of whom became world-famous scientists.

During the Cold War years 1966–89, Gor'kov played an important role on the Soviet side in organizing a series of joint workshops on condensed-matter theory that were sponsored by the Soviet Academy of Sciences and the US National Academy of Sciences. One workshop, a landmark five-week meeting in Aspen, Colorado, that Gor'kov cochaired with Schrieffer, resulted in nine joint publications.

In 1991 Gor'kov left the Soviet Union to become a leading member of the US condensed-matter community, first as a distinguished visiting professor at the University of Illinois at Urbana-Champaign and then as cofounder with Schrieffer of the theory group at the National High Magnetic Field Laboratory in Florida. Diagnosed with cancer in 2015, Gor'kov continued to work intensively until his last days. In 2016 he published articles on superconductivity in low-doped strontium titanate, superconductivity under high pressure in sulfur hydride, and superconductivity enhancement at the iron selenide–strontium titanate interface.

Gor'kov was also a remarkably talented artist who expressed reality in surprisingly whimsical forms. His colleagues remember playing cards he created for Landau's 50th birthday; Landau was pictured as a joker, who could be played in any combination with cards on which his disciples—Isaak Pomeranchuk, Evgeny Lifshitz, Abrikosov, Isaak Khalatnikov, and others—appeared in caricature.

Gor'kov will be remembered as an accomplished scientist, a devoted mentor, and a gifted author, a man and artist whose gentle personality and keen sense of humor are treasured by those who had the pleasure of his company.

Greg Boebinger
National High Magnetic Field Laboratory
Florida State University
Tallahassee

Sergey Iordansky
Landau Institute for Theoretical Physics
Chernogolovka, Russia

David Pines
Santa Fe Institute
Santa Fe, New Mexico

Lev Pitaevskii
University of Trento
Trento, Italy
Kapitza Institute for Physical Problems
Moscow, Russia

Stanley Mandelstam

Theoretical physicist Stanley Mandelstam died on 11 June 2016 in Berkeley, California. He was a leading expert and contributor to quantum field theory (QFT), the S-matrix approach, and string theory. His influences on theoretical and mathematical physics are deep and diverse and cut across almost all current major research efforts to deepen our understanding of the physical universe.

Born in 1928 in Johannesburg, South Africa, Stanley obtained a BSc in chemical engineering from the University of Witwatersrand in 1952. He switched his studies to theoretical physics at Trinity College, Cambridge University, from which he obtained a BA in 1954. Two years later he earned a PhD from the University of Birmingham under adviser Rudolf Peierls.

Stanley continued his research at Birmingham for another year before moving to New York City. From 1957 to 1958 he was a Boese research fellow in the department of physics at Columbia University. The next four years, 1958–62, can be called Stanley's miracle years.

In a 1958 paper, he initiated what we now know as the Mandelstam representation in the Mandelstam variables for S-matrices. It was a daring leap from the insights Stanley had gained from perturbative results in QFT, the subject of his thesis, and from his advanced knowl-

UNIVERSITY OF CALIFORNIA, BERKELEY, DEPT OF PHYSICS

Stanley Mandelstam

edge about functions of more than one complex variable. His presentation of the paper at the 1958 American Physical Society meeting in Washington, DC, caught the attention of Geoffrey Chew. The two met after Stanley finished his talk. At the end of their discussion, Chew offered Stanley a researcher position at the University of California, Berkeley, and Stanley accepted right away.

Stanley had two productive years at Berkeley. He consolidated the Mandelstam representation into its final form with the Mandelstam variables, worked with Chew to implement the representation into the S-matrix approach that Chew and his collaborators had developed, and initiated the idea of using Regge poles for high-energy behaviors in S-matrices.

In 1960 Stanley returned to Birmingham as a professor. His research output continued at a spectacular pace. During the next two years, with Berkeley and Birmingham colleagues, he published papers that consolidated the S-matrix approach. He not only delved deeper into the complex plane of angular momentum with Regge poles and cuts, but he also pioneered two far-reaching new directions: the gauge-invariant path-dependent fields for quantum gauge theories and the coordinate-independent path-dependent fields for quantum Einstein gravity. For both, he developed their Feynman rules in 1968.

Because of his achievements, he was one of the youngest participants invited to the prestigious 1961 Solvay Conference on Physics, which celebrated the 50th anniversary of the famous inaugural 1911 conference.

Stanley returned to Berkeley in 1963 as a professor in the department of physics. Among the groundbreaking work he produced during his 31-year career, there was the development of the precursor for the discovery of string theory, the elucidation of mechanisms for quark confinement in quantum chromodynamics, the nonperturbative constructions of the bosonization (or fermionization) in $(1+1)$-dimension QFTs, and the proof of the perturbative UV finiteness and $\beta = 0$, in any gauge to all orders, of $N = 4$ supersymmetric Yang–Mills theory. In 1992 he published the long-awaited first proof of the perturbative UV finiteness of string theory, so string theory can be considered as a contender for the theory of quantum gravity.

In 1994 Stanley became a professor emeritus. Until his death he continued to do research, to use his department office, and to live in the same Berkeley apartment that he had been in since 1980.

Stanley is being remembered admiringly by his colleagues in Berkeley's physics department (http://physics.berkeley.edu/remembering-stanley-mandelstam) and by his colleagues, students, and friends in the forthcoming *Memorial Volume for Stanley Mandelstam*, edited by Nathan Berkovits, Lars Brink, Kok Khoo Phua, Charles Thorn, and me (World Scientific).

Stanley's influences live on. In his quiet, polite, attentive, and kind way, Stanley won the respect and love of his colleagues and friends. He is deeply missed.

Ling-Lie Chau (喬玲麗)
University of California, Davis PT

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